

Comments by Dr Amélie Augé on the following draft report (11 January 2012):

A review of evidence for indirect effects of commercial fishing on New Zealand sea lions (*Phocarctos hookeri*) breeding on the Auckland Islands
produced by WD Bowen
as part of the DOC project POP 2010-01 New Zealand sea lions-Population Study.

My brief general comments on this document are that it is poorly organised, misses significant information that are easily available to the public or published in scientific journals, presents erroneous data in several instances and poorly addresses the fishery side of the competition, especially the effects that fisheries may have on the overall ecosystem. It also contains parts that are irrelevant to the review. Here, I will only deal with the part on marginal habitat as it is my expertise and I have conducted most of the research in this area and I will only make a few other comments on different aspects. I have completed my PhD on the marginal habitat research. My thesis has been available since August 2011 on the University of Otago library archive and is open-access. It can be downloaded by anyone at <http://hdl.handle.net/10523/1702>. It was cited by the author in this document.

On page 20, the author started discussing the marginal habitat of remnant populations, when presenting data on growth and reproduction. He wrote:

“The study found that age-specific growth rates of females were lower than that estimated in Steller sea lions. This may be a species-specific difference, but Chilvers et al. (2010) suggested that it might reflect the results of occupying marginal habitat. This notion that the habitat is marginal for the species is pervasive throughout the literature – but there seems little direct evidence to support this conclusion (see below).”

Here, the author failed to acknowledge the recent research published in my doctoral thesis that he actually cited later in the text and in his reference list (Augé 2010). As the author cited this thesis, he must have possessed a copy of it and looked at it. However, there is no mention that I compared the value from the Auckland Islands with Otago and found that Otago female New Zealand sea lions had faster growth rate and, at same age, were heavier and had higher body mass index. This can be found in Chapter 5 of my thesis. Consequently, this proves that the slow growth rate found at the Auckland Islands is not species-specific and the term “pervasive” used by the author is inappropriate as there are evidence to support the fact that the Auckland Islands sea lions are exploiting a marginal marine habitat for this species. These data were available to the author as he had a copy of my thesis (he cited it therefore he must have had a copy), he had all this information available.

In this same section on page 20, the author also wrote:

“There is evidence that sea lions currently inhabit an area of comparatively low productivity (see Murphy et al. 2001), but this has most likely been the case for sometime, perhaps over much of their evolutionary history, and there seems no a priori reason to think that they are not somewhat adapted to this environment, as suggested by their comparatively deep diving behaviour and associated physiology.”

This statement shows that this draft report contains severe inconsistencies. The New Zealand sea lion was originally found all around New Zealand and the colonies in the Auckland Islands are remnant populations found at the edge of the historical distribution of the species following human

extirpation (as shown in Childerhouse and Gales 1998 that the author has cited). The author failed, here, to acknowledge this fact and that the habitat at the Auckland Islands is different and significantly less productive (although he actually wrote this and see Figure 8.6 in my thesis). Habitat quality varies within a species' distribution range and this is the reason why not all species are found everywhere. Again, if the author had looked at my thesis (Chapter 3), he would have been able to review the fact that Otago female New Zealand sea lions dive at much shallower depths than at the Auckland Islands. This information is also now published in Augé et al. 2011:

Augé A.A., Chilvers B.L., Davis L.S. & Moore A.B. (2011) In the shallow end: Diving behaviour of recolonising female New Zealand sea lions around the Otago Peninsula. *Canadian Journal of Zoology*, **89**, 1195-1205.

Consequently, contrary to what the author thinks (and had wrongly written), the deep diving and associated physiology of sea lions at the Auckland Islands has been shown to be related to the poor habitat quality (marginal habitat) of the Auckland Islands.

On page 22, the author also “created” a section entitled “*Remnant colonies are in marginal habitat*” in which he discusses specifically my research as he cited Augé (2010) i.e. my PhD thesis and Augé et al (2011) i.e. one of the published papers out of my PhD. He first wrote:

“To test this hypothesis, in 2008 they studied the at-sea movements of 8 females (all the adult females) from the Otago colony”.

This is wrong. We studied a total of 13 females, including 8 adult females (that were all the known-to-be-alive adult females i.e. 4 years or over) and this study was conducted in 2008 and 2009 (later in the text the author wrote this himself!). We also did not only study the at-sea movements, we studied foraging trips, foraging areas, diving behaviour, diet, body condition, pup condition, milk fat content, foraging site fidelity, pupping rate etc (all data available in the thesis and some data in published papers) that are all related to the evidence that the Auckland Islands marine habitat is marginal for sea lions. There is consequently a major lack of available information in this section.

He also wrote:

“a recolonizing site considered to be part of the core of the species historical distribution and thus in good habitat.”

Otago is not just “considered” to be part of the core of the species' historical breeding distribution. This is a fact that was proven through archaeological studies of Maori middens as summarised in Childerhouse and Gales (1998) that the author cited, but also based on the original research presented in the following:

Smith, I. W. G. 1985. Sea mammals hunting and prehistoric subsistence in New Zealand. Thesis submitted for the degree of Doctor of Philosophy in Anthropology, University of Otago, Dunedin, New Zealand.

Smith, I. W. G. 1989. Maori impact on the marine megafauna: pre-European distributions of New Zealand sea mammals. *New Zealand Archaeological Association Monograph* 17:76-108.

The author then makes some comments on what would strengthen the results I presented for Otago:

“Although the behavioural differences between these colonies seem clear enough, the conclusion about habitat quality would be strengthened by data on the extent of interannual variation in foraging behaviour (which can be large in other otariid species (Boyd 1999) and the consequences of these behavioural differences on reproductive success.”

In Chapter 6 of my thesis, I present the foraging site fidelity of female New Zealand sea lions at Otago. In 2010, we studied six animals that were previously studied in 2008 and 2009 to determine if they behaved similarly in different years. All animals behaved very similarly. Therefore, not only we obtained three years of data during which behaviours were similar, but we also showed that each female showed no interannual variation in foraging behaviour. Consequently, we did obtain data to show that behaviours are very similar each year with no interannual variation. In Chapter 5 of my thesis, I presented a range of data related to reproductive success of Otago sea lions, including pup growth, pup mortality, pupping rate etc and compared all these values with values from the Auckland Islands. I am copying below (on the next page) Figure 8.7 of my thesis as this figure summarises some of the overall data that the author wrote are still needed whereas they were available to him for this review. I explained in details the results and compared these data in between years and with data from the Auckland Islands.

The sentence below shows again the poor level of writing of this draft:

“Although adult females at the Otago colony were studied in two years, 4 in 2008 and 4 in 2009 (Auge 2011), the number of females in this colony is too small to draw inferences about interannual variability in foraging behaviour.”

This is contrary to what the author himself wrote previously (i.e. that animals were studied only in 2008 which was a wrong statement). This is a bit more correct but still does not give the real available information. The number of females at Otago may be low but it is the entire population hence analyses have more power than most other studies where only a few dozens of animals are studied whereas the population may have millions of individuals. Saying this, this is of no importance as in 2010, we conducted a study of interannual foraging behaviours on the same animals during two different years that the author failed to acknowledge here as I explained just above, and we showed that there is no interannual differences in foraging behaviour in female New Zealand sea lions. I would like to point out that Auge 2011 is also incorrectly cited (it should be Augé et al. 2011). Also, I want to point out that Chivers (2008b), as cited by the author, has also showed that female New Zealand sea lions exhibited foraging site fidelity between years and hence exhibit no interannual differences in foraging behaviour. The author not only missed my study but did not even try to use already published information in an international journal to inform himself on the New Zealand sea lion's behaviour.

The author concluded this section with:

“Estimates of prey abundance will also be needed to confirm the conclusion that habitat quality and not some other feature, such as the spatial distribution of prey underlie the observed differences.”

This is non-sense. The spatial distribution of prey is part of the marginal habitat. A marginal habitat for sea lions may contain as much food resources within an area as in a better habitat (although this was shown not to be the case between Auckland Islands and Otago based on primary production) but these food resources may be more difficult to obtain because they are deeper, more spread, farther from the colony or more dangerous to handle. There may also be the impact of the presence of predators that may not allow sea lions to use a particular area. The assessment of the marginality of a habitat is made of all these parameters together. The conclusion of my study is that the Auckland Islands are a marginal habitat where food resources are more difficult to obtain than in the core historical range of the species such as at Otago (including, but not solely, because food resources are farther from the breeding colony). The need for estimates of prey abundance at the Auckland Islands should also have a higher emphasis in other sections as this is one of the most important pieces of information that is needed to assess indirect competition between the Auckland Islands sea lions and commercial fisheries.

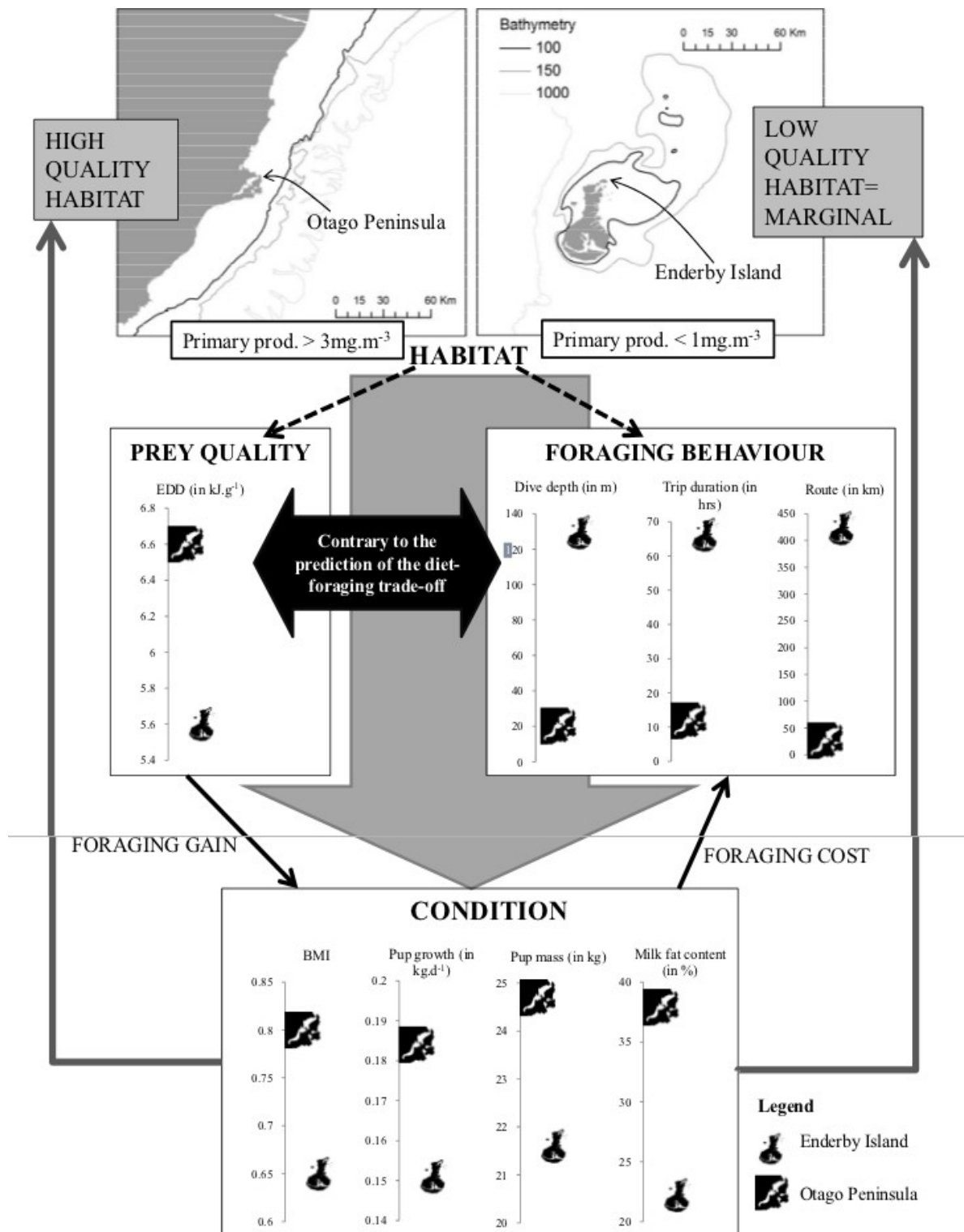


Figure 8.7: Effects of marine habitat quality on condition of female New Zealand sea lions at the Otago Peninsula (mainland New Zealand) and at Enderby Island (Auckland Islands). EDD: Energy Density of Diet; BMI: Body Mass Index (females ≥ 11 years old); Primary prod.=chlorophyll a concentration within 20km from shore (from Aqua Modis, NASA); Pup mass given for 30 May. The middle of the icons corresponds to the value. All data for Enderby Island are from Chilvers et al. (2005, 2006), Chilvers et al. (2007a), Meynier et al. (2009), Riet-Sapriza et al. (2009) and Childerhouse et al. (2010a).

I am now making a few random comments on the contents of the document. These struck me. There are many others but I did not have time to spell them all. Here are the comments:

- Figure 2 is not useful, contains mistakes and does not show how indirect effects (in this case again the author only considers resource competition anyway) affect sea lions. There are also no details on what the different terms are or mean. The bottom line should be “foraging effort high” (not low as the author has written). There is no difference made between environment (natural state) and fisheries (human effects) on how these affect the sea lions.
- Table 1. “CV of 50% Kernel home range (%)” This value must be in km² not in %.
- Table 2. Missing information of the diet of female New Zealand sea lions at Otago Peninsula. This information was available to the author as it was in my PhD thesis that he cited, and is now published:
Augé A.A., Lallas C., Davis L.S. & Chilvers B.L. (2011) Autumn diet of recolonising female New Zealand sea lions based at Otago Peninsula, South Island, New Zealand. *New Zealand Journal of Marine and Freshwater Research*, DOI:10.1080/00288330.2011.606326.
- Table 3. Striking me: the expected directions of change corresponding to indirect effects of fishing correspond exactly to the differences observed between the Auckland Islands and Otago (see the figure from my thesis that I have copied on the previous page). Again, the author had all these data available to him in my PhD thesis but did not incorporate them.
- There are data on foraging of juvenile sea lions around the Auckland Islands available, including some results in a DOC report available to anyone on the DOC website at: <http://www.doc.govt.nz/publications/conservation/marine-and-coastal/marine-conservation-services/csp-reports/assessing-the-demographic-parameters-and-at-sea-distribution-of-nz-sea-lions/>
The author could have also contacted Louise Chilvers as one of her PhD students has analysed most of that data and is in the process of publishing this information.
- There is the need for clarification on the locations that information or data are from. Most are from the Auckland Islands and this needs to be clearly stated every time as the author sometimes mixed data or information from Auckland Islands, Otago, Campbell or the overall species distribution in the same sentences.
- Breeding at Otago started in 1994 (as the author wrote later) therefore it has not been within the last 10 years (as written in this draft report), but within the last 17 years.
- For Campbell Island, the author needs to cite the 2 others studies (McNally et al. 2001 and Childerhouse et al. 2005) that gave pup numbers as he wrote “earlier estimates” without references. These studies also contain some values for pup growth and mass that the author of this draft report did not mention whereas he wrote that there was a need to obtain them. I did compare these values for Auckland Islands, Campbell Island and Otago in my thesis (discussion of Chapter 5).
- There is one study on foraging behaviour of female New Zealand sea lions at the Auckland Islands in winter. Again this was available to the author on the DOC website: <http://www.doc.govt.nz/upload/documents/science-and-technical/DSIS33.pdf>

- Last paragraph page 9: the author almost only cited a few studies in this paragraph, mainly on grey seals. There are much more literature available, especially on sea lions rather than on seals, which would be more relevant here as these groups behave quite differently. I also cannot see the aim of this paragraph there and this needs re-written with proper citations.
- *“Apart from the time series of pup production estimates at the Auckland Islands, there are few time series with which to test competing hypotheses about causes of the decline.”* Figure 5 in Meynier et al. (2010), cited in this draft report, presents a long time series of fishery catches versus sea lion diet clearly showing that they were related, especially that the collapse in hoki catches around the Auckland Islands (likely collapse of stocks) matched the decrease of hoki in the diet of sea lions. This should be a real clue that resource competition exists and, clearly, the author has not described this.
- *“We also have a rather poor understanding of the quantity of food available to sea lions and so testing hypotheses involving the effects of food competition is problematic.”* The author here makes a really good point: there is no data available on fish stocks around the Auckland Islands (the TAC values for fishery management are made up with very little scientific data and fish stock sizes behind it). Yet he fails to acknowledge that this is one of the most important information needed to determine resource competition. This should be one of the priority for research.
- The author does not seem aware that no New Zealand sea lion is to be held captive by laws and DOC enforces this. Hence any of the recommended “experimental feeding studies” are not possible.

In conclusion, this review needs major revisions before it is in an acceptable format as a final report. In its current form, it poorly reviews the evidence for indirect effects of commercial fishing on New Zealand sea lions and my main issue is that it missed significant information (on sea lions but also on the fisheries involved) and has several major mistakes. I recommend that this draft report that I have reviewed should not be finalised and stamped by the Department of Conservation unless these major revisions are made. These revisions must include (but are far from all that needs to be changed):

- Changing the statements about the marginality of the habitat at the Auckland Islands and properly citing the information available.
- Emphasising in discussion and conclusion that there is a lack of data for fish stock assessments and that some fisheries appear to have already collapsed around the Auckland Islands (this is somewhat describes but never put in the context of resource competition with sea lions).
- Acknowledging that indirect effects also include effects on the overall ecosystems (which in turn may indirectly affect sea lions) and adding a part where there is a review of what is known of marine ecosystems and how fisheries may impact them (i.e. not just fish stocks that are directly depleted but the consequences of the removal of these stocks for the overall food chain). There is one section that is meant to do this but that is poorly written and give very little information and only a couple of references of little relevance.

I agree that there may not be full evidence that indirect effects of commercial fisheries affect New Zealand sea lions and the author explains clearly that these are very difficult to obtain even for projects such as for the Steller sea lions that have over 100 times more financial resources. However, there are numerous cues that indicate that it may happen, including the fact that the Auckland Islands are marginal habitat for the species; many of which have been missed in this draft report.