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**Supervised Project Report
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***Title [A Geologist Attempts Minke Whale Outreach – A
literature Review]***

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Abstract/executive summary (ca. 200 words):

[With a population estimated to be between 400 and 600 thousand, the Antarctic minke whale is one of the most abundant whale species in the Southern Ocean. Due to this, it is likely that minke whales play an important and underappreciated role in the Southern Ocean's ecosystem. This report reviews the available literature to create examples of values-based outreach aimed to inform senior high school students on minke whales.]

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Introduction:

Balaenoptera bonaerensis, also known as the Antarctic minke whale is the smallest within a group of baleen whales known as the rorquals (Horwood 1990). Rorquals are the largest sub-group of baleen whales and includes the blue whale, sei whale, fin whale, humpback whale, Bryde's whale, Omura's whale, and the northern and southern minke whales. As minke whales were deemed too quick and too small to catch by whalers during the early 1904 commercial whaling operations, their population remained mostly untouched in comparison to the larger and more profitable species of whales (Horwood 1990; Ward 2001; The Marine Mammal Science Education Committee 2019). Due to the relatively high population of minke whales in the Southern Ocean, it is possible that they play a significant role in the ocean's ecosystem (Horwood 1990; Shirihai et al. 2008). However, as our knowledge of these whales is somewhat lacking, their true value to the ecosystem is unknown (Horwood 1990). This report summarises the known literature and attempts to synthesise the information for future use in outreach projects.

As the main purpose of this report is outreach based, the literary review section will primarily consist of information which may appeal to the values of the wider public. A values-based approach has been chosen as public interest in animals tends to be based mostly around superficial values such as cuteness. This contrasts with an outcome-oriented approach which focuses on more practical values such as how the loss of an animal will impact the ecosystem and what that may imply for the future. (Gunnthorsdottir 2001; Perry et al. 2008; O'Brien et al. 2010). Due to this, the literature review will cover the basic physiology of the minke whale, the feeding habits of minke whales, whaling past and present, and the krill surplus hypothesis. The outreach aspect of this project is targeted towards senior high school students and will focus on the use of humour in education to convey and retain information. An example poster, mini quiz, and power point presentation have also been attached as potential templates for future outreach.

Literature Review:

Minke Whale Physiology:

Minke whales are the smallest rorqual whale in the world at roughly 7-11m in length and 6-9 tonnes in weight (Knox 2007; Shirihai et al. 2008). Due to their small size, minke whales can associate themselves with sea ice with relative ease in comparison to larger whales such as humpback or fin whales (Friedlaender et al. 2014; World Wildlife Fund 2018). Rorquals are defined as surface lunge feeders which typically feed on concentrations of small prey by stretching their mouths wide open and quickly accelerating through these clusters. Water and prey quickly fill up their expandable mouths, and once the mouth is closed, the tongue is used to expel water outwards causing prey to be left trapped behind sieve-like baleen plates (Potvin et al. 2012; Kot et al. 2014). Due to the massive size of the rorqual whales, they are classed as the largest predators on earth (Kot et al. 2014).

The term rorqual is derived from the Norwegian word for “furrow” and refers to the largest subgroup of baleen whales which includes the world’s largest whale, the blue whale (M Ranneft et al. 2019). The name rorqual was derived from the word “furrow”, as rorquals have characteristic throat grooves (or furrows) which can expand greatly when feeding (Fig 1). In the case of minke whales, there are between 55 and 75 grooves which run along the underside of the throat and belly (Fig 2). The grooves cover roughly a third of the whale’s body length and can be contracted when swimming to maintain a streamlined body (Fig 2) (Peter Valentine et al. n.d.).



Figure 1: A minke whale feeding by expanding its mouth (Peter Valentine et al. n.d.).

Image by Stan Kielbaska



Figure 2: Minke whale throat grooves streamlined when swimming (Peter Valentine et al. n.d.).

Image by Matt Curnock

In humans, extensive stretching of nerves can lead to severe damage (Mahan 2019), however, rorquals have adapted their nervous system to accomplish the frequent and rapid throat expansions that occur during feeding. To prevent injury during the expansion of the mouths and throats, rorquals have developed nerves with two levels of waviness and the entire nerve core is tightly folded when recoiled (Fig 3) (Vogl et al. 2015). In some cases, the nerves within the mouth and throat can be stretched more than twice their original length thus allowing for huge mouthfuls of water and prey to be taken in (Fig 4) (Balma 2015; Vogl et al. 2015).

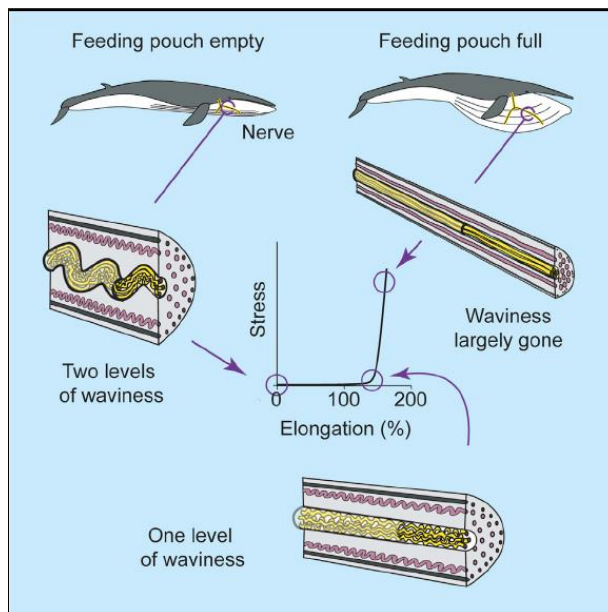
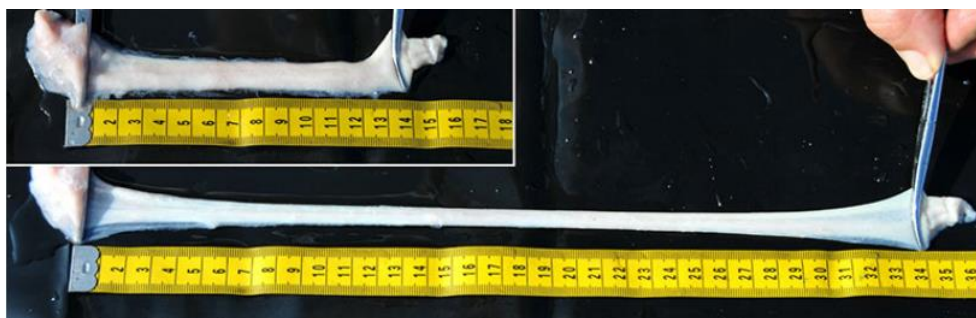


Figure 3 (left): Two level waviness of rorqual whale nerves (Vogl et al. 2015).

Figure 4 (below): Extreme elasticity in rorqual whale nerves (Balma 2015).



When not feeding, minke whales are beautifully streamlined, and have a characteristic pointed snout (Fig 5) which lead to the northern minke whale being named *B. acutorostrata* aptly meaning “with a sharp snout” (M Ranneft et al. 2019).



Figure 5: Characteristic pointed snout of a minke whale (Peter Valentine et al. n.d.).

Image by Alastair Birtles

Feeding Habits:

The well adapted physiology of rorquals, and small size of the minke whale in comparison to other baleen whales in the Southern Ocean allows them near exclusive access to sea-ice environments (Horwood 1990; Friedlaender et al. 2014; World Wildlife Fund 2018). Furthermore, the ability for minke whales to filter feed gives them a distinct advantage over smaller competitors such as penguins and seals which typically feed on individual prey. Due to the combination of size, sea-ice habitat, and feeding style, minke whales appear to occupy a rather comfortable niche within the Southern Ocean's ecosystem (Friedlaender et al. 2014).

Although minke whales live relatively solitary lives either travelling alone or in groups of two to three, schools of minke whales do occur but are highly variable in size. Groups of minke whales can range from more common sizes of 10 to 25 individuals to much larger aggregations reaching up to 400 whales (Knox 2007; Shirihai et al. 2008). Most of these large groups have been observed around active feeding grounds, and either represent an area with an overabundance of krill or could be indicative of group hunting tactics and cooperation.

When hunting around or under sea ice, minke whales have been recorded to lunge up to 24 times per dive, thus giving them the highest feeding rates of any lunge feeding whale. From a record of 649 foraging dives, minke whales were observed to maintain a high level of feeding activity performing up to 22 ± 2.82 lunges per dive with an average dive depth of 18 ± 5 m and an average dive time of 1.4 ± 0.4 minutes. The maximum dive depths and times recorded were 105 ± 1 m and 7.2 ± 3.2 minutes respectively. From the above, minke whales were determined to perform 102 ± 6 lunges per hour when foraging for food (Friedlaender et al. 2014). Minke whale stomachs can hold roughly 140 kg of food, and as they need to consume about 4% of their body weight (6-9 tonnes) daily, this would mean they need to fill their stomachs twice a day (Knox 2007). When compared to crabeater seals who eat 7% of their body weight per day and Adélie penguins who eat more than 20% of their body weight per day, minke whales appear to be extremely efficient users of the energy they have available (Perry et al. 2008).

Predator and Prey:

The main component of food found within fully packed 140 kg minke whale stomachs is 10-20 mm long *Euphausia superba* also known as Antarctic krill (Fig 6) (Horwood 1990; Knox 2007). Aside from *E. superba*, Antarctic minke whales are also known to eat the smaller and less common *E. crystallorophias* (ice krill or Antarctic coastal krill) and various copepods.



Figure 6: Close up of *E. superba* (Arkive 2010).

On the other end of the spectrum, Antarctic minke whales are preyed upon by the star dolphin of the Southern Ocean, the orca (killer whales). Type A killer whales appear to have a strong preference for minke whales, and as such their diet consists mainly of their whale cousins. Type B killer whales also have a taste for minke whale as well as penguins, although their main food source are various species of seal (Pitman et al. 2003; Ford et al. 2005). This distinction between the prey type of minke whales versus the prey type of orca plays a key role in the value-based outreach covered later in the paper.

Whaling:

The exploitation of Antarctic whale stocks began taking off in 1904 after Norwegian whaler C.A. Larsen opened a whaling station in South Georgia. Due to the success of his operation, other whalers began migrating south. Between 1910 and 1925, the Southern Ocean became the centre of the whaling world and accounted for over 50% of global whale catches. This continued until 1971/1972, but with such heavy exploitation, the numbers of large whales reached incredible lows (Knox 2007). Until 1971/1972 the minke whales were left relatively untouched, however once the great whale populations became scarce, the whaling industry turned towards the minke. From this time onwards, minke whales became the largest component of the southern baleen whale catch (Horwood 1990; Knox 2007). In the present day, there is a moratorium of whaling in the Southern Ocean, however, minke whales were still hunted for scientific purposes by the Japanese Scientific Whaling Program until the end of 2018. Luckily for the minke whales in the Southern Ocean, Japan withdrew from the International Whaling Commission at the end of 2018, but have now resumed commercial whaling in their own waters (Fobar 2018).

The Krill Surplus Hypothesis:

Due to the massive reduction in whale stocks in the Southern Ocean, it was hypothesised that there would be a huge increase in krill populations. However, in 2006 it was discovered that krill populations in the Southern Ocean had decreased by 80%. Two explanations for this decrease was put forth, one explanation claims that a reduction of sea ice along the Antarctic peninsula due to climate change also reduced krill recruitment (Smetacek 2006; Knox 2007). The other explanation claims that whales helped recycle the limiting nutrient of iron from depths to the surface waters thus allowing the growth of phytoplankton and algae, the main food source of krill. Due to the loss of a huge portion of the whale populations, less iron is being brought to the surface waters, and thus less phytoplankton and algae grow, therefore meaning less food for krill (Smetacek 2006). It is likely that the real driver behind the reduction in krill populations is due to a combination of both the loss of sea ice, and loss of whales in the Southern Ocean. If the iron-recycling hypothesis is accurate, as one of the last remaining relatively abundant whales (400-600 thousand (Horwood 1990)), it is even more imperative that we attempt to understand the role that minke whales play in the ecosystem. Due to this, the next section of this report will utilise some of the material collated in this literature review in an attempt to gain public interest and awareness on the subject of minke whales and their role in the ecosystem.

Outreach:

One of the larger challenges for science communication in the present day is the question of how to improve public engagement (McLean et al. 2016). In an effort to create awareness around minke whales and their role in the ecosystem, this section of the report will focus on using values-based outreach methods based on information gathered in the literature review section. Several outreach components have been designed, including a poster, a mini quiz, and a power point presentation (Appendix A, B, C respectively). The use of humour in the form of puns and memes was used in all three components as it is known that the use of humour may help generate interest and retain the attention of students (Morrison 2008).

Poster (Appendix A):

In general, when people think about Antarctic animals, the first few creatures that are likely to pop into their minds are orcas and penguins as opposed to minke whales. This is confirmed when Google Trends is used, as the searches for orca (Fig 7) and emperor penguins (Fig 8) far exceeds the searches for minke whales.

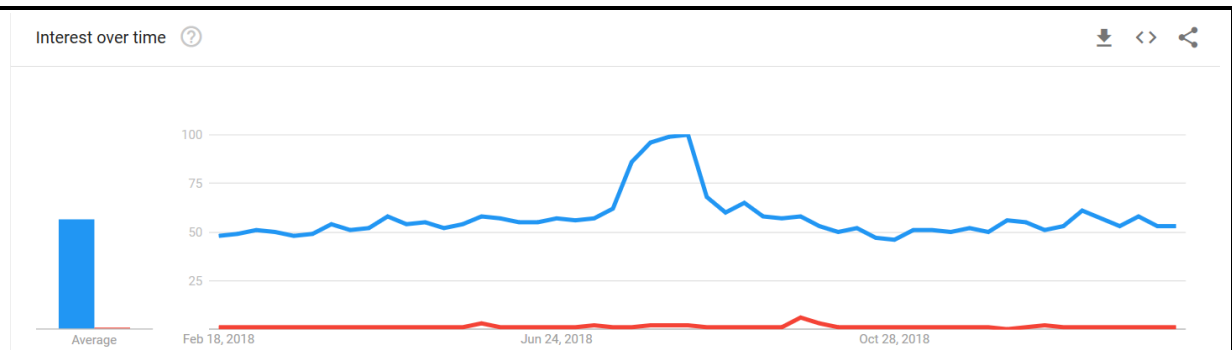


Figure 7: Comparison of relative Google search popularity between orca (Blue) and minke whales (Red).

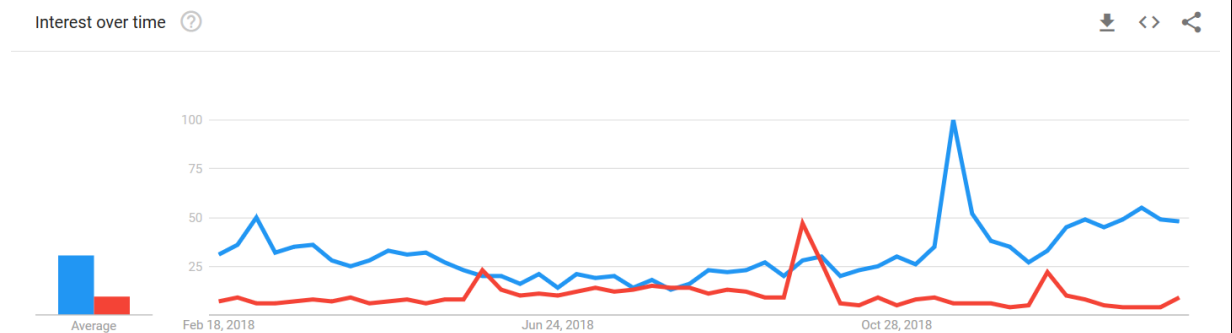


Figure 8: Comparison of relative Google search popularity between Emperor Penguins (Blue) and minke whales (Red).

The argument used for this poster utilises the fact that the public is more likely to want to protect “cute” species of animals, and as orca often prey on these cute animals, whereas minke whales do not (Gunnthorsdottir 2001; Knox 2007). In the poster, orca are referred to as killer whales in an attempt to reinforce the fact that they are the killers of cute animals, while interesting facts about the minke whale are presented to paint them as the “good guys”.

The overall style of the poster is based on the well-known and frequently used “who would win” internet meme format (Fig 9). For effective communication to the public, it is ideal for the medium of communication to reflect and to fit in with the popular culture of its time. Pop culture is generally a reflection and reinterpretation of everyday life, experiences, and happenings in a society, and the internet meme has been described as a visual symbol of this reinterpretation. Memes speak to the ever-decreasing attention span of younger generations, and thus allows the ability to convey a message or idea to such audiences with relative ease (Kuehn 2012; Scardina 2017; Putra et al. 2018; Serano 2018). The idea behind the “who would win” internet meme format is to suggest that one of the two subjects of comparison is “better” than the other despite not being as advantaged (Fig 9). In the example of the poster (Appendix A), the main idea put forth is that minke whales are “better” than orca, and thus deserve more attention in the community. At a glance from a distance, this message should be quickly received by students, and the further information provided on the poster is nothing more than for interest alone (Scardina 2017).

Who would win?

3000 NASA Scientists



20min Flat Earth Youtube Video



Voted "BEST FLAT EARTH PROOF 2017"

TheFullArmor 00

1 month ago • 950,208 views

2017 IS THE YEAR of TRUTH FOLLOW us on TWITTER @110M7
REALM MEDIA show Friday @110M7

Figure 9: Example of a standard “who would win” internet meme format which mocks the logic behind Flat Earthers.

Mini Quiz (Appendix B):

A short 5 question mini quiz was designed using the free online educational learning platform called Kahoot!. Kahoot! provides game templates for sets of multiple-choice questions and is an interactive quiz game which requires participants to use cell phones, or other personal electronic devices to answer the timed questions projected on screen. Depending on how the quiz is set up, participants will either be playing individually or in groups, while the aim of the quiz is to answer each question as quickly as possible, thus creating mild competition within the room. Each question is presented one by one and, the program provides stimulating music and colourful animated shapes to keep participants engaged in the activity while graph displays of how many participants chose each of the possible answers provides immediate feedback for class discussion (Bryant et al. 2018). Kahoot! quizzes have been used with success in classrooms, but especially when used to close a session (Aktengin et al. 2018; Bryant et al. 2018; Kuo et al. 2018; Bawa 2019).

The mini quiz created (Appendix B) has 5 questions each with a 20 second time limit. The questions provided present the participants with an interesting fact and ask the participant which one of four Antarctic animals the fact pertains to. The first four points are light hearted and informative points, with all four belonging to the minke whale. The final question asks the participants “Which one of these animals eats penguins, seals, and other cute creatures?” and presents them with 3 choices of “Orca/Killer Whale” and one option of “Minke Whale”. This again plays on the fact that minke whales can be interesting, and orca can be interesting, but minke whales don’t kill cute things.

Power Point Presentation (Appendix C):

As with most lectures and classes, power point presentations are used to inform students or the public on a topic or several topics. As part of this project required a 10-minute presentation to be given to an audience of academic staff at the University of Canterbury, the presentation was created and given using the research in the above sections. The aim of the presentation was to inform the audience of the existence of minke whales, provide the audience with interesting facts about the minke whales, to hopefully inspire individuals to conduct further research on minke whales. The presentation uses humour in the form of puns and memes to present ideas and facts which has been shown to help retain student attention as well as help with learning (Scardina 2017; Saxey 2018; Serano 2018). The presentation was recorded by a UC technician, and reviewed by a certified trainer for presentation skills. The feedback provided may help benefit those conducting future outreach presentations of this style.

Presentation Review:

The feedback provided shall be split into two sections, with one section covering what could be improved in future, and the other describing what was done well overall.

After reviewing the presentation, the following improvements were suggested in order of importance with 1 being the most important:

1. Look at the audience more, not the slides. Check the laptop screen instead of the projector if you have forgotten anything or need reference to something, as it keeps you facing the audience.
2. Walk with purpose and stop with purpose for a few seconds. Face the audience and then continue walking.
3. Use hand to point instead of laser pointer. Laser pointers can be distracting and hard to see.
4. Keep up voice intonation as it is good in some points but lacking in others.
5. Keep hands visible and not in sleeves.
6. Find a chance to move across the screen to the other side. You want to cover as many angles of the presentation as possible.
7. Make bigger hand gestures. The use of gestures in the presentation were good, but they need to have more emphasis placed on them.
8. Smile instead of laugh, as laughing is a filler. Refrain from the use of “Ums” as they are also fillers and can be distracting.
9. Don't look at floor or at the laser pointer. Again, it is important to face the audience.

From the feedback provided, it is clear that presenting is not as simple as standing in front of a group of people and talking. However, during the presentation it was also clear to see that the audience was enjoying themselves and was very engaged and open to new information.

As a further positive, the good points noted about the presentation, in no particular order were that:

1. The slide design was good.
2. Animations were simple and consistent.
3. The colour scheme was well picked and suited the presentation topic.
4. Audience interaction was well conducted.
5. Humour was not overdone and was not awkward.
6. The presentation had a good rhythm and pace.
7. The presentation was very interactive while still managing to be informative.

Although there may be a lot to improve upon, it should be safe to say that overall the presentation can be considered successful as it succeeded in retaining audience interest and attention by the use of humour.

Conclusion:

In conclusion, the information present in the literature review section of this report was used as a template to create examples of three different ways to assist in minke whale outreach. The three examples utilise the concept of humour in education to draw in and retain the interest of an audience and can be used independently or together depending on the resources and needs of the individual. As there is still a lot unknown about minke whales and their role in the ecosystem, it is imperative to gain public awareness about their existence and their potential importance to spur further research in the scientific community.

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