### Thesis Prospectus 2022-23

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**Faculty Reader Approval (date): 1/18/2023**

**MES Director Approval (date):**

1. Working title of your thesis.

Age Class and Body Size Differences of False Killer Whales (*Pseudorca crassidens*)

1. In 250 words or less, summarize the key background information needed to understand your research problem and question.

False killer whales (*Pseudorca crassidens*) are tropical odontocetes that are listed as Near Threatened with an unknown population trend under The IUCN Red List of Threatened Species.[[1]](#footnote-1) This data deficient species has gotten more attention around the Hawaiian Archipelago which is home to three genetically distinct stocks of false killer whales: two island stocks (Northwestern and Main Hawaiian Insular) and one pelagic.[[2]](#footnote-2) The Main Hawaiian Insular (MHI) stock was listed as endangered under the Endangered Species Act in 2012.[[3]](#footnote-3) The distribution, abundance, habitat use, life history, and fisheries interactions of these stocks are well-studied through satellite tagging, skin and blubber biopsies, long-term photo-ID, and vessel surveys.While it is known that individuals vary in length between populations, it is unknown how Hawaiian false killer whales compare to other individuals and stocks.[[4]](#footnote-4) Using the methods of photogrammetry coupled with morphometrics to assess body size and age class from dorsal fin and satellite/laser tag measurements can provide the data needed to compare Hawaiian stocks with other stocks such as those included in the Central America catalog of false killer whales managed by Annie Gorgone with CRC. This data can also contribute to a growing pool of knowledge on the physiology and population structures of this species.

1. State your research question(s).

How do morphometrics among false killer whale stocks differ? Or more specifically, for a given age class, does body size differ across stocks of false killer whales (Hawaiian insular and pelagic, Central America insular and pelagic)?

1. Situate your research problem within the relevant literature. What is the theoretical and/or practical framework of your research problem?

While false killer whales are found in the open ocean (pelagic), some populations are known to utilize shallow waters closer to shore (insular) which also allows the formation of island-associated populations.[[5]](#footnote-5) Important conservation implications for wide-ranging pelagic species that have an island-associated presence include pollution, fisheries bycatch and prey depletion, marine ecotourism, and vessel traffic.[[6]](#footnote-6)

Most of what is known about false killer whale ecology is based on data from a long-term study on the island-associated MHI stock.[[7]](#footnote-7) This stock is not only one of the three false killer whale populations in Hawaiian waters with one of those being a data-deficient pelagic stock, but also one of potentially hundreds of populations around the world of both pelagic and insular false killer whales.

It is known that body length varies between populations of false killer whales, but it is unknown how body size in Hawaiian animals compares to other populations as only two Hawaiian individuals (MHI) have been measured and aged in necropsy.[[8]](#footnote-8) The twenty-four-year-old female necropsied was 4.2 m (~13’9”) and the twenty-two-year-old male was 4.45 m (~14’7”).[[9]](#footnote-9) False killer whales are born about 1.5 to 2.1 m (4’11” to 6’11”) and stop growing when they are between twenty-five and thirty years old.[[10]](#footnote-10) The longest recorded false killer whale length was 5.96 m (~19’7”) so the two necropsied whales were likely still growing.[[11]](#footnote-11)

In 1999, 181 false killer whales mass stranded along both coasts of the Strait of Magellan, Chile. Researchers necropsied 25 of the individuals which included 3 juveniles and 22 adults. The juveniles had body lengths ranging from 2.21 to 2.59 m (~ 7’3” to 8’5”), adult females from 4.04 to 4.84 m (~ 13’3” to 15’9”), and adult males from 4.91 to 5.47 m (~ 16’1” to 17’9”).[[12]](#footnote-12) Sexual dimorphism exists in this species as adult males are 0.7 m (~ 2’3”) longer than females. While exact age was not reported for the two Hawaii and 25 Chile strandings, comparing catalogs with known age of individuals can aid in determining whether differences exist between populations for age and size.

Due to the endangered status of the rarely sighted MHI stock of false killer whales, it is critical to gather data that is especially difficult to collect to make accurate inferences regarding the recovery of this population and others.[[13]](#footnote-13) There is a need for technology to measure “uncatchable” animals in the field such as cetaceans. While drones are big up-and-comers for this moving forward, there are a lot of historical photos taken of individuals that need to be assessed to acquire baseline physiological measurements of these animals if possible. Therefore, the methods of photogrammetry coupled with morphometrics can effectively “measure” photographed and tagged (satellite or laser) individuals to assess their body size and age class.

1. Explain the significance of this research problem. Why is this research important? What are the potential contributions of your work? How might your work advance scholarship?

The significance of this research is highly geared toward the preservation of species by contributing physiological and population data to the growing pool of knowledge on false killer whales that aids in informing management practices. I think that this research is important because it not only can give researchers baseline data for population structure and dynamics, but it can also aid in predicting the persistence of this species. For example, if these methods can accurately assess age class and body size of individual cetaceans, it can be implemented as a non-invasive and non-lethal method of assessing these traits for numerous if not all cetacean species. Cetaceans are also hard to sample so this would be a great method for sampling! I think this work could advance my scholarship in that it is not a highly researched topic, and these species are “hanging in the balance” with a lot of data deficiency. It is also a fairly novel method of measuring animals which I feel like I have nearly mastered and can employ to measure many other species.

1. Summarize your study design[[14]](#endnote-1). If applicable, identify the key variables in your study. What is their relationship to each other? For example, which variables are you considering as independent (explanatory) and dependent (response)?

In order to obtain accurate estimates of body size and age class of individuals, proficiency in ACDSee Photo Studio Pro and ImageJ software is essential. ACDSee is a tool used to vet photos of individuals for angle and clarity. ImageJ software is a tool that allows researchers to make insertion points on an object in the photo and measures the distance between them in pixels. Using known satellite tag dimensions or the standard 15 cm distance between laser lights projected onto the animal from afar, these pixels are then extrapolated into absolute lengths in centimeters. I will be analyzing data generated from these methods in a few different ways (insular vs pelagic, Hawaiian vs Central America, individual1 vs individual2 etc.) but generally do find a positive relationship with the number of years the animals have been documented in the catalog and the size of their dorsal fins. The categorical age and continuous body size variables are dependent upon the categorical stock or location type of false killer whales.

1. Describe the data that will be the foundation of your thesis. Will you use existing data, or gather new data (or both)? Describe the process of acquiring or collecting data[[15]](#endnote-2).

The data I will be using for this research will be a combination of existing and new. CRC will provide two catalogs (Hawaii and Central America) of unique identified false killer whale individuals. I have previously measured all measurable false killer whales with satellite tags and/or laser light tags in the CRC catalog as of December 2021. I will be measuring any new additions of this species as well as all false killer whales with tags (satellite and laser) from the central America catalog. While the number of individuals to be measured is unknown at this point in the research, I know that I can effectively measure 1 individual in 10 minutes or less depending on how many photos exist for that individual. It took me approximately 2 weeks total to measure 222 photos of 73 false killer whales in the Hawaii catalog. I’m confident that I can measure this many and more for Winter term.

Acquisition of Photos:

During vessel surveys or opportunistic sightings by citizen scientists, photographs are generally taken of the breaching animals. For research surveys, biopsies and satellite tags are sometimes deployed to obtain more data. When satellite tags are deployed, photographs are taken parallel to the animal as they are tagged. This is the same in the case of laser light “tags”. Those photos are sent to CRC and analyzed to be matched to known individuals in the catalog. My job will be to acquire all the photos of tagged IDs and vet them for the best angle of photo taken parallel to the animal with a clear image of the tag (laser or satellite). I will then upload that photo into the software, ImageJ, and begin the process of drawing reference points (anterior insertion, posterior insertion, topmost point of fin, posterior point of tip, and apex of trailing edge). The distance between those points is measured in pixels. Then, I measure the dimensions of the tags and compare with known dimensions of the tags in cm. Finally, the pixels from the fin measurements are extrapolated into absolute lengths using tag dimensions.

1. Summarize your methods of data analysis. If applicable, discuss any specific techniques, tests, or approaches that you will use to answer your research question.

I plan to manage data in an excel spreadsheet and hope to conduct ANOVA tests to determine whether significant differences exist among body size and age class of stocks, individuals, and locations of individuals. This test is useful in determining whether there are significant differences between stocks, individuals, and location in their composition body size and age class.

Categorical variables of sex and age class will be compared between stocks, individuals, and location of individuals using a chi square test of independence. This test will help to determine if the proportion of whales of a particular age/size differs between Central America and Hawaii stocks of pelagic and insular false killer whales.

1. Address the ethical issues[[16]](#endnote-3) raised by your thesis work. Include issues such as risks to anyone involved in the research, as well as specific people or groups that might benefit from or be harmed by your thesis work, perhaps depending on your results. List any specific reviews you must complete first (e.g., Human Subjects Review or Animal Use Protocol Form).

Ethical issues potentially raised by my thesis work might include ensuring authorship of the photogrammetry and morphometric methods are clearly given to Shelby Yahn et al. as she developed and taught them to me, reference is clearly made to photographers and researchers who contribute to the catalogs and tag data, and to provide all research permit numbers to ensure the highest standards for treatment of animals are and were used in tagging and vessel survey efforts.

1. List specific research permits[[17]](#endnote-4) or permissions you need to obtain before you begin collecting data (e.g. landowner permissions, agency permits).

All research permits and permissions were obtained previously by CRC when initially collecting data and conducting research. These permit and permission IDs will be provided in an acknowledgement section and as they pertain to figures, graphs, and citations.

1. Reflect on how your positionality as a researcher could affect your results and how you will account for this in the research process[[18]](#endnote-5).

I believe that my personal, professional, and intellectual positionalities cohere with my research inquiry but recognize my privilege as not only a white individual with access to a comfortable space for research but also as a graduate student and colleague with CRC with access to its server.

1. Provide at least a rough estimate of the costs associated with conducting your research, if any.  Provide details about each budget item so that the breakdown of the final cost is clear.

So far, I have spent $110 on a software (Microsoft 11 pro) upgrade to allow for remote server access. I don’t believe I will accrue any other costs.

1. Provide a detailed working outline of your thesis.

# Chapter One: Literature Review: Biology and Population Structures of Odontocetes and Use of Conservation Physiology Methods in Cetaceans

## Introduction

## Biology and Population Structures of Odontocetes

## Age Class and Body Size Studies

## Conclusion

# Chapter Two: Introduction: False Killer Whales

## Distribution, Population Structure, and Status

## Anthropogenic Threats

# Chapter Three: Methods

## Survey Effort

## Satellite Tags

## Parallel-Laser Photogrammetry

## Dorsal Fin Insertion Points

## Morphometric Analysis

# Chapter Four: Results

# Chapter Five: Discussion

# References

1. Provide a specific work plan and a timeline for each of the major tasks in the work plan. Be as realistic and specific as you can at this point, including the deadlines for Spring quarter.

Winter Term: Gather and statistically analyze data and interpret results, write Ch 1, 2, and 3

Spring Break: Write Ch 4

Spring Term: Write Ch 5 and revise.

1. Who (if anyone), beyond your MES thesis reader, will support your thesis (in or outside of Evergreen)? Be specific about who they are and in what capacity they will support your thesis. If you are working with an outside agency or expert, be specific about their expectations for your data analysis or publication of results.

Dr. Robin Baird and Sabre Mahaffy will be overseeing my work with CRC and the use of its data. They will also guide me in ensuring my measurements are correct as well as providing me with resources regarding tag dimensions and false killer whales in Central America (Annie Gorgone) and Hawaii. They may also be a liaison for obtaining a New Zealand catalog of tagged false killer whales. Robin and Sabre are excited to utilize the data I generate in other studies of false killer whales as well as the use of these methods in other studies they may conduct.

1. Provide the 5 most important references you have used to identify the specific questions and context of your topic, help with issues of research design and analysis, and/or provide a basis for interpretation. Annotate these references with notes on how they relate to/will be helpful for your thesis. For any other sources cited in your prospectus in other answers, provide a complete bibliographic citation here as well.

Baird, R. (2013). Odontocete Cetaceans Around the Main Hawaiian Islands: Habitat Use and Relative Abundance from Small-Boat Sighting Surveys. *Aquatic Mammals*, *39*(3), 253–269. <https://doi.org/10.1578/AM.39.3.2013.253>

*“I will be working directly with Robin Baird and other staff at CRC so I think it’s important to draw from their knowledge of the species and location I’ll be researching for my thesis. Also, this source will be a great synopsis of the species in my study as well as their life histories, population structures, and habitat use”*

Madliger, C. L., & Love, O. P. (2015). The Power of Physiology in Changing Landscapes: Considerations for  the Continued Integration of Conservation and Physiology. *Integrative and Comparative Biology*, *55*(4), 545–553. <https://doi.org/10.1093/icb/icv001>

*“Madliger has several publications on the use of conservation physiology and how it can effectively inform management. I like this article because it connects both conservation and physiology research as a powerful tool in the face of climate change.”*

Weisgerber, J. N., Medill, S. A., & McLoughlin, P. D. (2015). Parallel-Laser Photogrammetry to Estimate Body Size in Free-Ranging Mammals. *Wildlife Society Bulletin (2011-)*, *39*(2), 422–428.

*“Along with morphometric analysis using satellite tags, I will also be using parallel-laser photogrammetry to estimate body size and age class of those individuals. This source has successfully used parallel-laser photogrammetry to accurately estimate body size in wild horses. While I’m not employing this method to measure terrestrial animals, the source is strong in that the science of parallel-laser photogrammetry as a means to estimate body size has been used successfully in this case.”*

Yahn, S. N., Baird, R. W., Mahaffy, S. D., & Robertson, K. M. (n.d.). Sexually dimorphic characteristics of short-finned pilot whales, false killer whales, pygmy killer whales, and melon-headed whales assessed using fin and body morphometrics from photographs taken at sea. *Marine Mammal Science*, *n/a*(n/a). <https://doi.org/10.1111/mms.12963>

*“Shelby Yahn actually taught me how to assign reference points to the dorsal fins of false killer whales in order to measure them in the software program ImageJ and extrapolate the pixel measurements into absolute measurements using known satellite tag dimensions. She also studies blackfish physiology which will be a large portion of my samples. This paper details the methods she used (similar yet different to mine) as well as the species she used them on (blackfish species) to determine sexual dimorphism.”*

Yahn, S. N., Baird, R. W., Mahaffy, S. D., & Webster, D. L. (2019). How to tell them apart? Discriminating tropical blackfish species using fin and body measurements from photographs taken at sea. *Marine Mammal Science*, *35*(4), 1232–1252. <https://doi.org/10.1111/mms.12584>

*“This is another publication for Shelby and one that I have referenced in past studies on photogrammetry and morphometrics. She details the insertion points used to measure dorsal fins which is an important aspect of the work I’ll be doing to assess body size and age class. She used these methods to determine which species belonged to the dorsal fin she measured. My work will dive deeper into what the magnitude of those measurements have on various parts of the species’ physiology.”*

1. . Baird, Robin. “The IUCN Red List of Threatened Species.” IUCN Red List of Threatened Species, July 23, 2018. https://www.iucnredlist.org/species/18596/145357488. [↑](#footnote-ref-1)
2. . Baird, Robin W. “The Oceanic Dolphins.” Essay. In *The Lives of Hawaiʻi's Dolphins and Whales: Natural History and Conservation*, 23–46. University of Hawaiʻi Press, 2016. [↑](#footnote-ref-2)
3. . Baird, *The Lives of Hawaiʻi's Dolphins and Whales,* 29. [↑](#footnote-ref-3)
4. . Baird, *The Lives of Hawaiʻi's Dolphins and Whales,* 29. [↑](#footnote-ref-4)
5. . Bradford, Al, Rw Baird, Sd Mahaffy, Am Gorgone, Dj McSweeney, T Cullins, Dl Webster, and An Zerbini. “Abundance Estimates for Management of Endangered False Killer Whales in the Main Hawaiian Islands.” *Endangered Species Research* 36 (August 29, 2018): 298. <https://doi.org/10.3354/esr00903>. [↑](#footnote-ref-5)
6. . Martien, Karen K., Robin W. Baird, Nicole M. Hedrick, Antoinette M. Gorgone, Janet L. Thieleking, Daniel J. McSweeney, Kelly M. Robertson, and Daniel L. Webster. “Population Structure of Island-Associated Dolphins: Evidence from Mitochondrial and Microsatellite Markers for Common Bottlenose Dolphins (Tursiops Truncatus) around the Main Hawaiian Islands.” *Marine Mammal Science* 28, no. 3 (July 2012): E208–32. <https://doi.org/10.1111/j.1748-7692.2011.00506.x>. [↑](#footnote-ref-6)
7. . Bradford, “Abundance Estimates for Management,” 298. [↑](#footnote-ref-7)
8. . Baird, *The Lives of Hawaiʻi's Dolphins and Whales,* 29. [↑](#footnote-ref-8)
9. . Baird, *The Lives of Hawaiʻi's Dolphins and Whales,* 29. [↑](#footnote-ref-9)
10. . Baird, *The Lives of Hawaiʻi's Dolphins and Whales,* 29. [↑](#footnote-ref-10)
11. . Baird, *The Lives of Hawaiʻi's Dolphins and Whales,* 29. [↑](#footnote-ref-11)
12. . Mariano Koen Alonso et al., “Stomach Contents of False Killer Whales (Pseudorca Crassidens) Stranded on the Coasts of the Strait of Magellan, Tierra Del Fuego,” *Marine Mammal Science* 15, no. 3 (1999): pp. 712-724, https://doi.org/10.1111/j.1748-7692.1999.tb00838.x, 718-719. [↑](#footnote-ref-12)
13. . Bradford, “Abundance Estimates for Management,” 297. [↑](#footnote-ref-13)
14. [↑](#endnote-ref-1)
15. [↑](#endnote-ref-2)
16. [↑](#endnote-ref-3)
17. [↑](#endnote-ref-4)
18. [↑](#endnote-ref-5)