**The Evergreen State College**

**Graduate Program on the Environment**

### Thesis Prospectus

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
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**STUDENT AGREEMENT:**

**SIGNATURE: \_\_\_\_Text, letter

Description automatically generated\_\_\_\_\_\_\_\_\_ DATE\_12/10/20\_\_\_\_\_\_\_\_**

**FACULTY READER APPROVAL:**

**SIGNATURE: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ DATE\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**MES DIRECTOR APPROVAL:**

**SIGNATURE:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ DATE\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Supplemental Figures Pages: 18-24**

**Preliminary bibliography Pages: 25-27**

1. **Provide the working title of your thesis[[1]](#endnote-1).**

Do boats affect the behavior of foraging North Puget Sound gray whales, known as “Sounders", during their time in Puget Sound?

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

There is a unique population of gray whales that visit North Puget Sound every year, called “Sounders.” Recent legislation requiring boats to stay 400 meters from Southern Resident Killer Whales, could ironically increase pressure on the Sounders because of the inability of boat captains to get near killer whales. In addition to this stressor, over the last two years, over 384 gray whales died on the West Coast of North America from Mexico through Alaska. Some scientists estimate total mortality to be five times greater. A shortage of food, outside of this area, may be the cause possibly forcing the gray whales to focus more on Puget Sound, where prey is still plentiful. This change has led to the number of gray whales utilizing the Puget Sound to increase. In addition, few studies exist about gray whales and whether boats negatively affect them. Some researchers conclude that boats have adverse effects on whale behaviors, resulting in disrupted foraging, erratic movements, energy expenditure, avoid and abandon high-disruption areas, and alter their communication Effects on behaviors are dependent on different factors and may vary by species.

My research hypothesis is that boats affect the Sounders and exhibit altered behavior in their presence. This observational study will address the dearth of information about such effects and inform decision-makers regarding appropriate conservation measures. I propose to assess mean dive times, direction and deviation indices, average swimming speeds, and change in surface behaviors, which are based upon a 2002 study by Williams *et al*.

1. **State your research question(s).**

**Research Question**: Do boats affect the behavior of foraging North Puget Sound gray whales?

**Research Objectives**: The goal of this study is to measure the impacts if any on Sounders’ behaviors. If yes, at what proximity are the Sounders’ behaviors affected by boats?

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

**Significance of Boat Impacts on Whales**: Few studies exist about gray whales and whether boats impact them negatively. Therefore, we mainly rely on studies about other whales, which brings up the issue of the lack of consensus in the scientific community.

Some researchers conclude that boats have adverse effects on whales, including their behaviors, resulting in not eating and an increase in erratic movement, which combine to cause calorie deficits (Senigaglia et al., 2016). These disturbances can cause whales to avoid and abandon high disruption areas (Lusseau & Bejder, 2007), which may be the case with the Sounders. In addition, boats have been known to alter gray whales’ (Burnham & Duffus, 2019) and humpback whales’ communications (Fournet et al., 2018). In 2017, one of the Sounders was hit by a boat in Puget Sound (CRC, 2017b).

Documented effects on whales' behaviors, however, are dependent on a variety of factors (Senigaglia et al., 2016). Boats may not affect blue whales as they have been recorded in high use shipping lanes (McKenna et al., 2015) and have no effect on humpback whales’ reproduction success (Weinrich & Corbelli, 2009). In a technical report for Canada’s Department of Oceans and Fisheries in 2001, Dr. Jon Lien states that humpbacks were not influenced by boat activity.

**Impacts of Killer Whale Legislation on Gray Whales**: With some legislators believing that boats negatively impact whales, they have tried to partially address this subject with recent legislation requiring boats to stay 400 meters from Southern Resident Killer Whales in Washington Waters (SRKW, 2018). But, these changes do not mention gray whales. General marine mammal protections require boats to stay a minimum of 100 meters from the whales in the United States (NOAA, 2020c). This change in killer whale legislation could ironically cause an increase in pressure on gray whales because of the inability of commercial boat captains to get near killer whales.

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?**

Certain previous studies have shown that whales have been negatively impacted by boats, while other studies have shown results to the contrary. In 2019, over 200 gray whales are reported to have died with mortality estimated at five times greater. This stressor on gray whale populations and the die off is continuing into 2020.

An additional stressor is due to an increase in boat traffic and gray whales utilizing the same areas in Puget Sound. Recent state legislation requires that boat traffic stay 400 meters away from killer whales but says nothing about gray whales. While this legislation appears beneficial for killer whales, this causes an attended consequence is transfer of boat proximity to gray whales.

Some previous research has shown that boat pressure causes whales to abandon feeding areas. This study will measure at what proximity boat traffic will illicit changes in whale behavior. Can we risk not knowing whether boat traffic impacts these whales? This work might point the way to policy remedies useful in protecting gray whales while in Puget Sound.

With so little known about the gray whale and specifically those that utilize the Puget Sound, the significance of learning about these animals cannot be overestimated. The addition of this knowledge to both the academic and scientific community should provide the building blocks to further understanding of human behavior on these creatures.

1. **Summarize your study design[[2]](#endnote-2). 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)?**

I will be conducting an observational study, specifically a cross-sectional study, on the Sounders to see if boats negatively affect their behavior.

**Measurements/Methods:** The effects that the boats have on the Sounders will be recorded using mean dive times, direction and deviation indices, average swimming speeds, and change in behaviors (defined below). My methodologies, unless otherwise stated, are based upon the 2002 study by Williams and others, which was a study to understand the impacts of boats on killer whales. In the spring of 2020, I conducted a pilot project which, although successful, was abbreviated due to COVID. I refined the observation plan, which is as follows:

We will record information about the whales both when there are and are not boats within 1000m of the whales. When boats are present, then the number of boats will be recorded and divided into three categories based on distance from the whale of 100m, 400m, and 1000m.

**Average Swimming Speed, Deviation and Direction Index, & Mean Dive Times**: The researchers will record the GPS locations of the whales for distance traveled, and time tracked to estimate swimming speed. The researchers will record the length of the whales’ dives to calculate a mean dive time. The directionality of the whale will be measured using the recorded locations of the whales to see if there is a predictability in the path (Williams et al., 2002).

**Change in Surface Behaviors**: While the whale is on the surface, its behavior will be recorded as either resting, traveling, foraging, or socializing, which was determined through talking to professionals that study gray whales.

**Methods for Recording Boats & Research Team:** Three researchers will be based on Hat Island to collect data. The theodolite operator will use a DT5A (Sokkia) theodolite and the software Pythagoras (program allowing computer to record data from theodolite) to record the boats’ and whales’ locations. The spotter will spot and verbally communicate information about boats and whales, announce whales’ behaviors, record length of dives using a stopwatch, take identification photos of the whale, and direct theodolite operator. The computer operator will use the computer to record the locations of the whales and boats, whales’ behaviors, dates, times, boat information, duration of dives, and proximity of boat to whales.

Emphasis will be to record a whale’s first and final surfacing by theodolite. A given whale will be tracked for as long as possible, but the track lines will be divided into 15-minute time segments for analysis. While the whale is diving, information (GPS location, proximity of whale to boat, boat type, whale-watching status) of all boats within 1000m of a whale will be recorded. I will distinguish between whale-watching and nonwhale-watching boats.

**Equipment Check:** Before the season starts, all of the equipment will be checked thoroughly for functionality and reliability. At the start of the research, there will be a theodolite calibration session comparing GPS data from the boat to data from the theodolite.

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[[3]](#endnote-3).**

I will gather my own data using the processes listed above.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Boat Within 100M** | **Boat Within 400M** | **Boat Within 1000M** | **No Boat** |
| **Mean Dive Times** |  |  |  |  |
| **Direction Indices** |  |  |  |  |
| **Deviation Indices** |  |  |  |  |
| **Average Swimming Speeds** |  |  |  |  |
| **Change in Surface Behaviors** |  |  |  |  |

1. **Summarize your methods of data analysis. If applicable, discuss specific techniques that you will use to understand the relationships between variables (e.g., interview coding, cost-benefit analysis, specific statistical analyses, spatial analysis) and the steps and tools (e.g., lab equipment, software) that you will take to complete your analyses.**

The data will be recorded using Microsoft Access and Excel onto the laptop. Then, it will be transferred into the R-Studio computer program, where it will be broken down. Dive times, direction and deviation indices, swimming speeds, and behavior type will be compared between data sets where boats are within 100m, 400m, 1000m, or absent. Significant differences between these data sets will be tested using both a one-way and two-way ANOVA; sequential changes in behavior will be examined with Makarov Chains. While it would beneficial to use the CAL to analyze the data, it is not necessary. In addition, I already have access to Microsoft Office, R-Studio, ArcGIS, and Pythagoras, which are all of the software programs required to analyze the data.

1. **Address the ethical issues[[4]](#endnote-4) 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).**

This research topic is complex and controversial causing there to be ethical issues surrounding this research. Because this is a noninvasive study on whales, there are no direct ethical issues related to the observations. The ethical issues primarily relate to the potential impact on the whale-watching companies. If the study was to show that boats within a set distance of the whales drastically change the whales’ behaviors negatively, then a law might be created to increase the minimum distance from the boats to the whales. Alternatively, if the study showed that the whales were greatly affected by the presence of multiple boats, this might lead to legislation requiring that only one boat be around the whale or whales at a time. While these results aren’t a certainty, if even one of these possible rules are put into effect, then this could have a negative impact on the whale-watching industry. By having these new regulations, the number of customers could decrease, because of the inability of the companies to get their customers close to the whales. On the other hand, benefit could potentially accrue to the people or businesses that would appreciate less whale watching traffic, such as island residents, shore-based sightseers, and those who cater to them.

1. **List specific research permits[[5]](#endnote-5) or permissions you need to obtain before you begin collecting data (e.g. landowner permissions, agency permits).**

This project will not fail because of a lack of permits or permissions. While these are marine mammals, I am not required to have any permits to make shore-based observations. Five landowners on Hat Island have already given me permission to use their lands to observe the Sounders.

1. **Reflect on how your positionality as a researcher could affect your results and how you will account for this in the research process[[6]](#endnote-6).**

As a Pacific Northwest native and an environmentalist, I have a bias towards the preservation and protection of nature and the animals in it. To avoid these biases effecting my data, I have completed a literature review to gain an understanding of the best methods of evaluating the possible impacts of boats on whales. From this literature review, I have created my own methodologies to evaluate the possible impacts. By following these methodologies, I will be unable to put my own bias into the data. The data analysis plan tests for correlations between boats and whale behavior and does not assume an effect, but instead tests for one; it is possible that there will be no statistically significant impact on the whales.

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Description** | **Cost/Unit** | **Approximate Quantities** | **Total Project Costs** | **Funds Raised** |
| **Lodging & Food** |  |  |  |  |  |
| House Rental | Temporary Living Quarters for Research Team | $2250/per month | 3 months | $6,750 | $200 |
| Food |  | $60/per day | 90 days | $5,400 |  |
| **Equipment & Supplies** |  |  |  |  |  |
| Gas for Rental Car |  | $3 a galloon | 133 Gallons | $399 |  |
| Hat Island Ferry Tickets | Tickets used for the ferry to get on the island | $9/ per one-way adult ticket | 20 Tickets | $180 | $180 |
| Renting High-quality camera lenses |  |  | 1 Lense | $600 |  |
|  |  |  |  |  |  |
| **Total Costs** |  |  |  | $13,329 | $380 |
|  |  |  |  |  |  |
| **Remaining Funds Needed** |  |  |  | $12,949 |  |

1. **Provide a detailed working outline of your thesis.**

**Thesis Outline**

**Title Page:**

Do boats affect the behavior of foraging North Puget Sound gray whales, known as “Sounders" in the Spring of 2021?

**Abstract:**

**Table of Contents:**

**List of Figures:**

**List of Tables:**

**Introduction:** The Sounders were or were not affected by boats.

**Literature Review:**

Eastern North Pacific Stock

Sounders

History of Whale-Watching

Current Whale-Watching

Benefits of Whale-Watching

Whales Affected

Whales not Affected

**Methods:**

Measurements/Methods

Average Swimming Speed

Deviation and Direction Index

Mean Dive Times

Change in Surface Behaviors

Recording Boats

Research Team

Equipment Check

**Results:**

Three Months of Field Observations of Gray Whales

Interacting

Not Interacting with Boats

Data Analysis

Normality Testing

T Tests

Non-Parametric Tests

One-way & Two-way ANOVA

Makarov Chains

Thesis

Share Results

Blogs

Conferences

Local Community & Whale-Watching Meetings

Scientific Journals

**Discussion:**

Quality of Data

Are Results Valid?

**Acknowledgements:**

**Bibliography:**

1. **Provide a specific work plan and a timeline for each of the major tasks in the work plan. Be as realistic as you can, even though you will probably need to alter this schedule as you complete the tasks. Remember that faculty readers take time to return your drafts and that the final polishing and formatting of your thesis for binding will take longer than you ever imagined.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Month** | **Day** | **Activity** |
| **2020** |  |  |  |
|  | **Fall** |  |  |
|  | **October** |  |  |
|  |  | **27th** | Applied to Lawrence Foundation Grant |
|  |  | **27th** | Applied to Explorers Club Grant |
|  | **November** |  |  |
|  |  | **1st** | PADI Grant Opens |
|  |  | **11th** | WATWS Blind Proposal Sent in |
|  |  | **30th** | Submit WAITT Grant |
|  | **December** |  |  |
|  |  | **15th** | WATWS Grants Due |
|  |  | **17th** | Animal Behavior Society Grant Due |
| **2021** |  |  |  |
|  | **Winter** |  |  |
|  | **January** |  |  |
|  |  | **1st** | Send Emails to Professors About Research Assistant Positions |
|  |  | **1st** | Advertise Research Assistant Positions |
|  |  | **15th** | Apply to MES Thesis Research Fund by |
|  | **February** |  |  |
|  |  | **1st** | Pick up Gear from Cascadia Research and Evergreen State College |
|  |  | **2nd** | Sync and Update Gear |
|  |  | **4th** | Buy Gear and Supplies |
|  |  | **17th** | Train on Theodolite |
|  |  | **18th** | Train on Theodolite |
|  |  | **24th** | Team training |
|  |  | **25th** | Team training |
|  |  | **26th** | Team training |
|  |  | **27th** | Move Gear Onto Hat Island |
|  |  | **28th** | Move Gear Onto Hat Island |
|  | **March** |  |  |
|  |  | **1st** | Begin Field Observations & Theodolite Measurements |
|  |  | **14th** | Food Resupply & Continuation of Observations |
|  |  | **28th** | Food Resupply & Continuation of Observations |
|  | **Spring** |  |  |
|  | **April** |  |  |
|  |  | **11th** | Food Resupply & Continuation of Observations |
|  |  | **25th** | Food Resupply & Continuation of Observations |
|  | **May** |  |  |
|  |  | **9th** | Food Resupply & Continuation of Observations |
|  |  | **23rd** | Food Resupply & Continuation of Observations |
|  |  | **30th** | End Field Observations and Theodolite Measurements |
|  |  | **31st** | Move off Hat |
|  | **June** |  |  |
|  |  | **5th** | Clean Gear |
|  |  | **6th** | Return Gear |
|  |  | **11th** | End of Spring Quarter |
|  |  | **15th** | Start Summer Position |
|  | **Summer** |  |  |
|  | **July** |  |  |
|  | **August** |  |  |
|  | **September** | |  |
|  |  | **26th** | End Summer Position |
|  |  | **27th** | Fall Quarter Begins |
|  | **Fall** |  |  |
|  | **October** |  |  |
|  |  | **4th-8th** | Compiling and Formating Data |
|  |  | **11th-15th** | Data Cleanup |
|  |  | **18th-22nd** | One-way and Two-way ANOVA Analysis |
|  |  | **25th-29th** | One-way and Two-way ANOVA Analysis |
|  | **November** |  |  |
|  |  | **1st-5th** | Makarov Chains Analysis |
|  |  | **8th-12th** | Makarov Chains Analysis |
|  |  | **15th-19th** | Buffer Week |
|  |  | **22nd-26th** | Thanksgiving Break |
|  | **December** |  |  |
|  |  | **29th-3rd** | Trouble Shooting |
|  |  | **6th-10th** | Re-Analysis |
|  |  | **13th-17th** | Eval-Week |
|  |  | **20th-2nd** | Winter Break |
| **2022** |  |  |  |
|  | **Winter** |  |  |
|  | **January** |  |  |
|  |  | **3rd** | Winter Quarter Starts |
|  |  | **3rd-7th** | Revisit Literature Review and Add to Literature Review |
|  |  | **10th-14th** | Add Methods to Thesis |
|  |  | **17th-21st** | Add Results to Thesis |
|  |  | **24th-28th** | Add Discussion to Thesis |
|  |  | **28th** | Send John Updated Thesis |
|  | **February** |  |  |
|  |  | **31st-4th** | Revise Previous Sections |
|  |  | **7th-11th** | Add Acknowledgements and Bibliography to thesis |
|  |  | **14th-18th** | Add Introduction to thesis |
|  |  | **21st-25th** | Add Abstract to Thesis |
|  | **March** |  |  |
|  |  | **28th-4th** | Add Table of Contents, List of Figures and Tables to Thesis |
|  |  | **4th** | Send John Updated Thesis |
|  |  | **7th-11th** | Revise Sections |
|  |  | **11th** | Format Thesis |
|  |  | **14th-18th** | Buffer and Eval Week |
|  |  | **21st-25th** | Spring Break |
|  |  | **28th** | Spring Quarter Begins |
|  | **Spring** |  |  |
|  | **April** |  |  |
|  |  | **28th-1st** | Rewriting Thesis |
|  |  | **4th-8th** | Rewriting Thesis |
|  |  | **11th-15th** | Create Thesis Presentation |
|  |  | **18th-22nd** | Create Thesis Presentation |
|  |  | **25th-29th** | Buffer Week |
|  | **May** |  |  |
|  |  | **2nd-6th** | Buffer Week |
|  |  | **9th-13th** | Buffer Week |
|  |  | **16th-20th** | Presenting Thesis |
|  |  | **23rd-27th** | Presenting Thesis |
|  | **June** |  |  |
|  |  | **30th-3rd** | Work on Final Thesis and Get it Signed |
|  |  | **30th** | Submit Final Signed Thesis and Fees to Office |
|  |  | **6th-10th** | Eval-Week |
|  |  | **10th** | End of Spring Quarter |
|  |  |  |  |
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| --- |
| **Unscheduled Events That Will Be Added to Calender in Future** |

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| --- | --- |
| **Send Local News Summary of my study** | the Kitsap Sun, Seattle Times, Union-Bulletin, KOMO News, KING 5 Media Group, Herald Net, NW News Network, KIRO 7, Q13 FOX, the Olympian, Seattle PI, and our local NPR station KUOW |
| **Present to Local Organizations** | Hat Island community, Pacific Whale Watch Association, Port Townsend Marine Science Center, Sound Water Stewards, Stream team, and at the Welcome the Whales Parade by Orca Network |
| **Present at Conferences** | Washington Chapter of the Wildlife Society Annual Meeting, Northwest Student Chapter of the Society for Marine Mammalogy Annual Meeting, Society for Marine Mammalogy Conference, Salish Sea Ecosystem Conference, and Society for Northwestern Vertebrate Biology Annual Meeting |
| **Submit to Journals** | the Marine Mammal Science journal or The Journal of Wildlife Management or The Wildlife Society Bulletin |
| **Write up Blogs** | for the Cascadia Research Collective website (https://www.cascadiaresearch.org/), LinkedIn, and the Masters in Environmental Studies Blog (https://www.evergreen.edu/mes/blog) |

1. **Who, beyond your MES faculty reader, will support your thesis? Indicate support both within and 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.**

**John Calambokidis of Cascadia Research:** John has been an essential part of this project. He has provided me with countless hours of advice on my thesis. His organization also has provided me with almost all of the gear needed for the field portion of my thesis. He would like to be put down as one of the authors if I am able to publish the results of my study in a scientific journal.

**Bill Vogel of United States Fish and Wildlife Service and Washington Chapter of the Wildlife Society:** Bill also has been an essential part of this project. He has provided feedback on my grant applications. He also has suggested sources of possible funding for my project. I plan to put Bill in the acknowledgement sections.

**Lori Christopher a Member of Hat Island Community:** Lori has been invaluable by getting the team access to the private island and by providing critical information for the best location to observe the whales. She has also communicated with the Hat Island community providing information about the ferry and how to deal with COVID on the island. I will put her in the acknowledgment sections of my paper.

1. **List the 3-5 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. For each annotated reference, explain how your project specifically connects to the source by extending, challenging, or responding to the conclusions, methods, or implications. For any other sources cited in this document provide a complete bibliographic citation.**

Cascadia Research Unpublished Data. (CRC) (2020). *Information and Updates About the Sounders (North Puget Sound Gray Whales)* [Personal communication].

This source provides me with the most up to date information about the Sounders and other gray whales that utilize the Puget Sound, including numbers, locations, and general trends of the Eastern North Pacific Stock of gray whales, which the Sounders are part of.

Senigaglia, V., Christiansen, F., Bejder, L., Gendron, D., Lundquist, D., Noren, D., Schaffar, A., Smith, J., Williams, R., Martinez, E., Stockin, K., & Lusseau, D. (2016). Meta-analyses of whale-watching impact studies: Comparisons of cetacean responses to disturbance. *Marine Ecology Progress Series*, *542*, 251–263.

This paper provides an excellent overview of the possible impacts of boats on whales’ behaviors through a variety of metrics.

Williams, R., Trites, A. W., & Bain, D. E. (2002). Behavioural responses of killer whales (Orcinus orca) to whale-watching boats: Opportunistic observations and experimental approaches: Behavioural responses of killer whales to whale-watching. *Journal of Zoology*, *256*(2), 255–270.

This paper is one of the prominent examples of how to evaluate the possible impacts of whale-watching boats on whales. For that reason, I have decided to use it as the primary source for the methodologies of my study,

**Supplemental Figures**

**Figure 1**

**Title:** Combined 2019-2020 Gray Whale Strandings

**Chart, bar chart

Description automatically generated**

**Note:** Combined 2019-2020 Gray Whale Strandings by month in California, Oregon, Washington, and Alaska compared to the past 18-year average. (NOAA, 2020c.)

**Figure 2**

**Title:** Map of Gray Whale Strandings 2019-January of 2020

**Map

Description automatically generated**

**Note**: Map of gray whale strandings along the West Coast of North America through Jan 10, 2020. (NOAA, 2020c.)

**Figure 3**

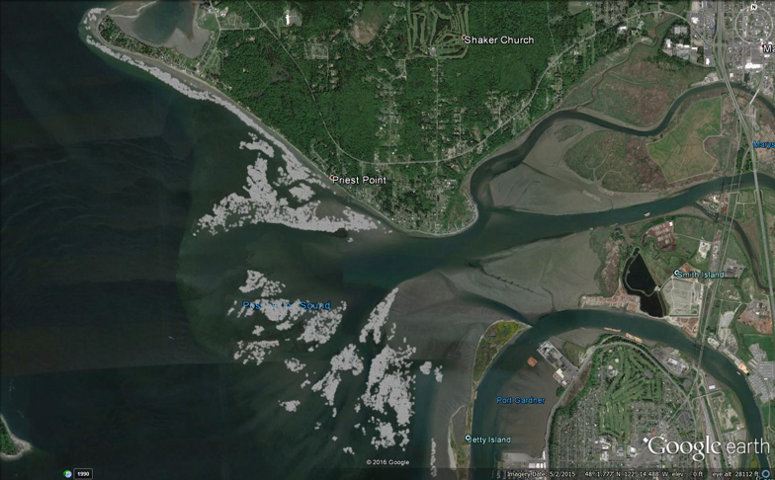
**Title:** Sounder Interacting with Boat**A small boat in a large body of water

Description automatically generated**

**Note:** Picture taken by author during pilot project to show how close boats get to the whales, in this case estimated at less than 20 meters. (own photo)

**Figure 4**

**Title:** 14,000 Feeding Pits in Snohomish Delta

**Note:** Locations of some of the almost 14,000 feeding pits documented on the Snohomish Delta from Google Earth images in spring and early summer from 2005 to 2015. (*Calambokidis, 2018)*

**Figure 5**

**Title:** Feeding Pits made by Gray Whales off Whidbey Island, Puget Sound

**Note:** This image shows a closer view of the feeding pits left by the gray whales off Whidbey Island, Puget Sound. (Calambokidis, 2018)

**Figure 6**

**Title:** Gray Whale Feeding in shallow water off Camano Island

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**Note:** This gray whale has flipped to have its stomach in the air, after it has fed in shallow water off Camano Island. (Calambokidis, 2018)

**Figure 7**

**Title:** Aerial Photograph of Feeding Gray Whale in Strait of Juan de Fuca

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Mud plume

Head of whale

**Note:** This image shows an aerial photograph of feeding gray whale in Strait of Juan de Fuca, which results in a mud plume. (Calambokidis, 2018)

**Preliminary bibliography**

Bejder, L., Samuels, A., Whitehead, H., & Gales, N. (2006). Interpreting short-term behavioural responses to disturbance within a longitudinal perspective. *Animal Behaviour*, *72*(5), 1149–1158.

Burnham, R., & Duffus, D. (2019). *Gray Whale Calling Response To Altered Soundscapes Driven By Whale Watching Activities In A Foraging Area*. 23.

Calambokidis, J. (2018, March 13). *New perspectives on gray whale feeding in the Pacific Northwest examined with new suction-cup attached video tags*. The Washington Chapter of the Wildlife Society Annual Meeting.

Cascadia Research Collective. (CRC) (2017b, May 11). *The Sounders (NPS gray whales)*. Cascadia Research.

Cascadia Research Collective. (CRC) (2019, June 7). *Spring 2019 Gray Whale Surveys*. Cascadia Research.

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1. [↑](#endnote-ref-1)
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