INTRODUCTION

-resident killer whales are incredibly social animals that live in stable matriarchal groups

-communication necessary for group cohesion, foraging and reproduction

-anthropogenic noise (human made) can mask killer whale calls depending on frequency and amplitude and prevent them from communicating

-in 2007, Dr’s Val and Scott Veirs did a survey of the noise in Haro Strait and found that the majority of the noise in Haro Strait was caused by large vessels (ships!)

-Haro Strait is an important part of the whales’ summer habitat and has been designated part of their critical habitat

-it is also centered on a large shipping lane and several ferry routes

-ship ! noise is very consistent, very loud and concentrated in very low frequencies

-Click...classic example

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HYPOTHESIS

-to continue necessary communication or conserve energy, it makes sense that killer whales would change their acoustic behavior to account for the noise generated by ships

-already studies which show that they change some acoustic behaviors in response to boat presence and background noise

-changes that could occur

-making calls louder to be heard over the ships

-changing how often they call calling more frequently to get the message across or less frequently

-making calls longer to avoid masking

-changing call frequency, for example pitching calls higher to be heard over low frequency ship noise

-changing where they concentrate the power of the call to avoid masking

-this study focuses on call duration, call fundamental frequency, and call power ratio

-will explain those measurements later

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METHODS

-data collected over 5 week period in the Salish Sea on J pod and part of K pod

-sound recorded using calibrated Labcore hydrophone array and two Sound Device recording devices

-AIS, automatic identification system, is a ship ID required for all ships over 65 feet

-AIS receiver recorded data using software program called ship locator which logged ship’s speed, ID number, and distance from GV depending on adjustable range

-after measuring various ships’ noises, decided that the adjustable range would be 5NM despite variation in ship noise

-behavior states were monitored to control for potential difference in factors between behaviors

-behavior states were those established by National Oceanographic and Atmospheric Association, 2004-playing, milling, resting, traveling, foraging

-boats! within 0.5 NM were counted to account for effects caused by boats rather than ships

-sea state in Beaufort scale recorded to control for excess noise interference from natural sources

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METHODS

-measured S1 call which is the most used call of J-pod (main pod recorded)

-Click...classic example

-measured call duration which is total duration of call (INDICATE HIGHLIGHTED PURPLE AREA)

-measured fundamental frequency, which is the lowest frequency produced by subtracting two most visible harmonics

-took a 0.05 second segment starting 0.35 seconds and analyzed the power spectrum using sound program Audacity

-measured power ratio by looking at power spectrum (graph which has sound power in dB on Y axis and frequency on x axis) and subtracting 2nd harmonic from 3rd harmonic

-clipped 1second files from within 3 seconds of each call and analyzed background noise in dB re 1 microPa using MatLab

-measured 141 S1 calls from 5 days of recording over 3 behaviors

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S1 CALL FACTORS

-just to give an idea of the numbers range and type of numbers I found in the calls

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RESULTS

-background noise varies significantly with both boat count and ship presence

-as background noise increases so does the boat count and ship presence due to positive correlation

-both boat and ship presence appear to have some control over background noise

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RESULTS

-no significant change in the acoustic behaviors I measured based on background noise, vessel count or ship absence/presence

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-these graphs show the relationship between background noise and call factors, all nonsignificant

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Discussion

-couple of things to consider

-sample size was small, next step is to test statistical power

-only able to analyze absence presence comparison in 2 behaviors, foraging and traveling

-only collected data on 3 behaviors, foraging, traveling, playing

-full comparison, full data set

-despite the fact that all ships over 65 feet are required to have an AIS transmitter, it is not necessarily working or turned on

-AIS received appears to have a lag or calibration necessary which is difficult to do with large ships

-area has significant naval presence from both Canadian and US sides

-navy doesn’t always have AIS on for security reasons

-extreme variability among ship noise, some very quiet, some very load...why?

-interesting to study what is causing those differences...prop type? engine efficiency? Propulsion system?

-whales could still be compensating by increasing amplitude, or changing call rate or call selection

-precedence for increasing amplitude..Marla Holt

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**Many thanks to teachers, classmates**

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**Questions?**