

Comparing Vocalizations between Matrilines of Southern Resident Killer Whales (*Orcinus orca*)

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Proposal

Introduction

Literature Review

Southern Resident killer whales (*Orcinus orca*) are a social species that travel together in pods, known as J, K, and L pod. Within these pods there are matrilines which consist of a female, her sons and daughters, and offspring of her daughters. Matrilines can contain one to 17 individuals spanning one to five generations (Ford et al 2000). Matrilines have more cohesion than pods do, and rarely part for more than a few hours, while each matriline may separate from the pod for up to a couple months.

Vocalizations are an important aspect to this species; they are used in communication, foraging, and navigation. Killer whales have three types of vocalizations; clicks, whistles, and pulsed calls (Ford 1989). Clicks are brief pulsed sounds, and can sometimes be produced in a form called click trains. Clicks are generally used while echo locating for navigation and hunting/foraging. Frequency of these click are generally between 4-18 kHz but extend up to 50-85 kHz (Ford 1989). Whistles are generally recorded at 8.3 kHz, and last 1.8 seconds on average. Southern Residents produce whistles for both long-range communication (e.g., during foraging and slow traveling) and social interactions (Riesch et al 2006). Pulsed calls are

the most commonly produced sound in killer whales which, to humans, sound like squeaks, squawks, or screams. The repetition rate can reach up to 4,000 pulses per second, last about two seconds, with frequencies of one to six kHz, but can reach up to 30 kHz. There are three different types of pulsed calls that are distinguishable; discrete, variable, and aberrant (Ford 1989). Variable and aberrant calls are less common but usually given after animals join together and interact in a social way (Ford 1991). Discrete calls are more common, therefore also studied more. Discrete calls are the dominant sound produced during foraging and traveling, and are used for maintaining acoustic contact with other group members, especially for those out of visual contact (Miller 2002).

As mentioned, killer whales have different call types, but to be able to distinguish the different dialects and individualize them has been an ongoing interest. Vocal dialects can be defined as differences in the structure of vocalizations among animals that come into acoustic contact (Deecke et al 2010). Pods with similar dialects make up social groups defined as clans (ie J, K, and L pods make up the J clan). In the resident killer whales there are seven to 17 distinctive call types (Ford 1991). Dialect variation has been identified and documented in complex species from a wide variety of taxonomic background such as; songbirds, parrots, bats, cetaceans, and primates. (Deecke et al 2010). Similar dialects are likely to reflect on levels of relatedness within pods and matriline (Miller and Bain 2000). It has been shown that while killer whale call repertoires are stable over long periods of time, they can have subtle changes due to frequently associating matriline through vocal learning. This could be an after effect from older individuals dying, being hunted, or as pods and matriline grow and split (Miller 2004). It is thought that younger individuals develop imitations of calls through learning from closely related individuals, instead of through genetics (Yurk et al 2002).

A study was done by Volker B. Deecke et. al (2010) that showed differences in call structure of six of the same call type in different matriline in the Northern Resident population. One of the greater differences they found between matriline was the abrupt drop in pulse-repetition rate towards the end of the N9 call (Deecke 2010). In other species vocal signals contain important information as well. It has been shown that greater spear-nosed bats (*Phyllostomus hastatus*) have group specific screech call, but are not individually distinctive (Nousek et al 2006). In other cases vocal signals can contain information about levels of social affiliation; such as in chimpanzees (*Pan troglodytes verus*) who share the same features of call between groups, but individuals will vary (Nousek et al 2006). In other cetaceans, such as the bottlenose dolphin (*Tursiops truncatus*), signature whistles can be individually distinctive, when in isolation. A study done by Stephanie Watwood et al. examined whistle production in 17 free-ranging bottlenose dolphins that were temporarily restrained. The results suggested that these signature whistles may be a way of both vocal learning and developing social relationships (Watwood et al 2004).

Problem Statement

The goal of this study will be to examine the call structures between matriline of Southern Resident killer whales, in the Salish Sea. By studying this I hope to find out more about their social dynamics as a whole as well as their communication with-in pods. Being able to indentify matriline acoustically would contribute to knowledge and current ongoing research of how these animals communicate and if there is a certain meaning behind signature calls. We would also be able to start to see their vocal interactions between the different members of matriline. Many of the vocal studies on killer whales have been done on

the Northern Resident population; it would be valuable to do a study on the Southern Resident population, to be able to compare results of the two populations. The questions I will focus on will be: Are there variations within the matrilineal calls, such as abrupt variations in pulse repetition, changes in frequency, or call duration? Does each matriline have a certain variation of calls to recognize each other? Can these features be seen on the individual level in this population? I hypothesize that there will be recognizable physical variations of the call structure on the matrilineal level in the Southern Resident killer whale population.

Methods

Data Collection

Data will be collected from a 42' catamaran, the Gato Verde, from mid September 2010 through the end of October 2010 in the Salish Sea. During data collection we will follow the Washington State law which includes the Be Whale Wise guidelines by paralleling the whales by at least 100 meters. Hydrophones will be deployed and towed on both the port and starboard stern of the vessel. The four hydrophone array (Labcore 40's Array with a peak frequency of 5 kHz) will be towed on the port stern side of the vessel and the CRT (Single Cetacean Research Technology C54 XRS/266, a high frequency hydrophone with a flat response curve from one to thirty kHz) on the starboard stern side of the vessel. All hydrophones will be calibrated using the Inter Ocean Systems Model 902 Listening Calibration System.

The total length of the array from the stern of the vessel will be 49.54 meters, which is where the fourth and final hydrophone is located. The first and third hydrophones are located at 16.40, and 38.34 meters, respectively. The CRT will be located 28.05 from the stern of the vessel . Both the CRT and the array will be weighted to a depth of 1.85 meters in the water. The CRT will take the place of the second hydrophone on the array during recording in order to record higher frequencies for other studies being done in the same time period. The CRT will take the place of the second array hydrophone when plugged into the acoustic recorder. The four hydrophones being used will be connected to ports of two Sound Devices (702 audio recording devices), which will be connected to act as one unit recording. Hydrophone one and the CRT will be plugged into the first sound device and hydrophone three and four in the second. The gain settings on the sounds devices for the three array hydrophones will be set at 43.5 and the CRT's gain setting will be set at 37.5 in order to not clip any sounds.

Recordings will be done at a speed of 2.5 knots unless under special circumstance, such as avoiding whales. During acoustic recordings of the whales there will be a couple different things that need to be done. There will be someone recording phonation data by listening to the hydrophones projected into headphones and speakers from the sound devices. Each minute will be monitored for clicks and calls, if the array is straight, along with the orientation of the whales in relation to the boat, using a clock face reference with 12 o'clock at the bow of the vessel and 6 o'clock at the stern of the vessel (appendix A). There will also be a couple people taking ID photos for later identification. At the end of each recording they will be downloaded onto a hard drive in order to maximize space for the next recording. The photos will be downloaded daily and kept in folders by date they were taken. All of the

cameras and watches used during data collection will be synched to the time on the sound devices.

Data Analysis

The recordings that were collected in the sound devices will be downloaded and spliced minute by minute for a more successful and easier analysis. I will first look through the photos to identify a whale. Once I am certain of the animal identified I will correlate the time of the photo with the time on the phonation sheet to first see if there are recordings during the time of the photo and second to see if there were any calls during that specific minute. If there were not calls in that minute I will look at the surrounding minutes (not more than a 2 minute on either side of the minute on the photo) to see if they had changed position drastically and if there were calls heard. If they change position drastically I will not take those calls. I will then load the .wav file that has a call in it into Ishmael version 1.0 to localize the calls. Ishmael calculates the time delay to each hydrophone; produces a bearing to the animal and an estimated location using phone pairs and the hyperbolic method. I will be using 1482m/s as the speed of sound. If the call can be localized I will compare the information that Ishmael gives me to the information from the phonation sheet, and photo. Information from the photo will include, general orientation that can be seen in the photo. This will help confirm that the localization from Ishmael is giving accurate results or not. Once I have been able to rule out most errors and confirm information on Ishmael I will put the information I have been able to use and the data from Ishmael into an excel sheet, and the same sound file will be loaded into audacity to identify the call used and measure the frequency and duration of the same call localized. To measure frequency the program Ishmael will be used. I will measure the frequency of one harmonic in each call, keeping the harmonic measured

consistent, at the beginning, center, and end of the call. When enough of the same calls within the same pod have been localized I will compare call structures to see if there are any variations between matriline. A two-way ANOVA statistical test will be run on this study.

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Appendix

Appendix A:

