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Orca Conservancy

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COLLEGE OF THE ENVIRONMENT

WESTERN WASHINGTON UNIVERSITY
MAKE WAVES.

Internship Title: Orca Conservancy

Student Name: Alexandra Miller

Internship Dates: 6/20/22 - 8/15/22

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STUDENT SIGNATURE Alex Miller

DATE: 8/15/22

Orca Conservancy

6/20/22-8/15/22

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Introduction

The organization I had the opportunity to intern for over the summer is called Orca Conservancy and the main goal they aim to achieve is to protect Southern Resident killer whales from extinction. Orca Conservancy is a Washington State 501c3 non-profit organization that started in 1996. Luckily for me, I got to work under chief scientist Dr. David Bain who has studied killer whales since 1978 and specializes in the effects of disturbance. My mother and father play football (soccer for Americans) with Dr. Bain so I am very lucky to have that connection with him. This internship was important for me because I got to have hands on experience at what I love to do. I love anything to do with animals and trying to protect a species. I want to take what I learned and use it for a future career in the conservancy field. There are three main threats to orca whales: prey scarcity, pollution, and vessel disturbance (Orca Conservancy). There are many other threats to these amazing mammals, but Orca Conservancy focuses on the top three to hopefully recover the whale population. The orca whale population has dramatically declined in the past few years due to disturbance, not being able to find food, and pollution. In December 2020, US EPA confirmed that there was only 74 Southern Resident Killer Whales (SRKW)(EPA). During my internship I got to: Experience how to manage prey scarcity by helping with wetland restoration, learned how to use a theodolite, understand and interpret whale calls, visit SR3 which is another marine life organization, and for fun I got to identify each of the whales. I also helped with invasive species extractions when I had the time.

Restoration Project

I participated in a restoration project organized by Whale Scout and Orca Conservancy. Whale Scout is an organization that aims to protect Pacific Northwest Whales through land-based conservation experiences (Whale Scout). This restoration project was based at the former Wayne Golf Course in Bothell Washington. The Sammamish River flows through the Wayne Golf Course and is a migratory corridor for chinook salmon which is the main fish SRKW's prey on. By controlling invasive species and protecting the native species, we can improve water quality and potentially provide more prey for SRKW's in the Salish Sea (Whale Scout).

During this restoration project I successfully extracted invasive blackberry bushes by cutting the branches down to the ground and using a shovel to dig under the roots to pull them up. We also dumped many pounds of mulch on the area we extracted. Along with the help of

many other volunteers, we dug and piled up hundreds of bushes to clear out space for native trees to grow and provide canopy for the salmon in the Sammamish River. For the Sammamish River to be a potential habitat for more salmon and more prey for the orca whales, there needs to be more shade to cool the water down. If the fish survive and thrive, then there is a potential for SRKW to survive and thrive. By contributing to this restoration project, I completed my learning objective of detecting and using correct elimination techniques to remove invasive species. I also completed my learning objective of applying the knowledge I gained from my Invasive Species class. It is amazing invasive species can affect how well a killer whale can survive. After completing this restoration project, I realize how everything in the world is connected. I also learned that planting native plant species can play a role in filtering out pollution that is increasing as the years go on.

Whale Calls

The main part of my internship this summer was to learn a new language, and that language is orca whale. Orca Conservancy has three AI hydrophone sites within the Salish Sea located at Bush Point, Haro Strait, and Port Townsend. The hydrophones are connected to AI technology to detect whale calls and then are confirmed by a user if it is a true whale call or not. My job this summer was to go through all the confirmed whale calls and identify what call is being phonated. I strongly recommend visiting https://aifororcas.azurewebsites.net to understand what whale calls look like and listen to how harsh the background noise is.

I first had to learn the calls by seeing them and hearing them which took up most of my internship. I was provided with a website that has all the known calls of the SRKW's that included a picture of the call and a short 3-6 second audio clip of what it sounds like. Figure 1 shows my favorite call to identify which is S19 and is used by the L pod. It also shows another call, S9, for comparison. I was also given a Canadian Data Report of Fisheries and Aquatic Sciences paper by John K. B. Ford that includes not only a visual representation of the call but data on what pod uses the call the most, and the mean, min and max duration and frequency of a call (Figure 2). Some calls are broken into parts to further identify what call it is such as S3 in Figure 2. There was a total of 46 calls I had to memorize and understand. It seemed like it wouldn't be too hard at first but after getting into it, it is a lot harder than it looks. Some calls are wildly different, but some calls are very similar. For example, it was hard to differentiate between a S33 and a S10 call.

I focused on 6-8 calls per day until I got comfortable with them. After I was comfortable with all the calls, I was taught how to transcribe the calls using a software called Raven Lite. Raven Lite is a program that lets me upload a spectrograph of the confirmed calls captured by one of the hydrophones so I can see and hear a 60 second clip. This software was great because I could zoom in and out to closely look at the call, select a call I wanted to hear, and increase the sound to hear the call better. During each 60 second clip, every call that u heard, I would record in an excel file. Figure 3 shows a snip of the excel file I used. I completed 280 calls during my internship with some having a call every second and some having only 5-6 calls per 60 seconds. The most common calls I heard was S1, S4, S10 and S19. There were also a lot of faint calls that are too subtle to identify, so I would mark the call down as a "f" for faint. The most updated catalogue of underwater calls produced by killer whales was produced in 1987 by John K. B. Ford, so there is a 35-year gap of undocumented whale calls. Due to that huge gap, there were many calls that were unlike any of the calls I studied, so I would write down a "o" for other. Killer whales also make whistles, so there was a "w" for whistle. The worst thing to hear while listening to the audio files was hearing how loud the vessel noise is.

Why Study Whale Calls?

There are many things that people can find out by using my data. The main reason is to determine the effectiveness and reliability of the automated detection and another reason is so they can use all the calls I have identified to train the machine to recognize specific calls (Orca Conservancy). The main reason they have the hydrophones in the first place is so that when there is a confirmed detection of a whale, they can report their locations to people who need to know such as the military, ferries, shipping companies, and government enforcement so they can re-route, slow down or cease dangerous activities. Dangerously loud noise has been increasing making it hard for SRKW's to find food. The last way they will use my data is to compare the structure of the calls to what they were in 1987 and see how much they have changed and possibly identifying new calls. My dad, Quentin Miler works in language AI at Microsoft, and he thinks this labeled data could one day help train neural networks that will permit us to speak Orca. By learning this new language, I have completed my objectives of learning the process of how to identify different whale calls, learning how to record observations into a database, understanding what scientific data needs to be recorded, and real-world experience at monitoring a marine mammal.

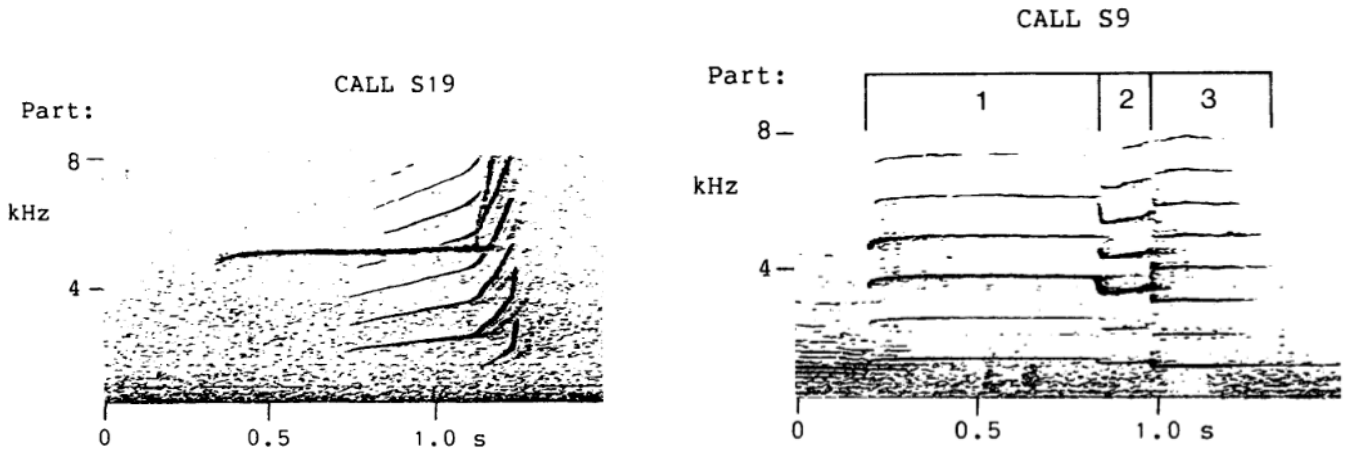
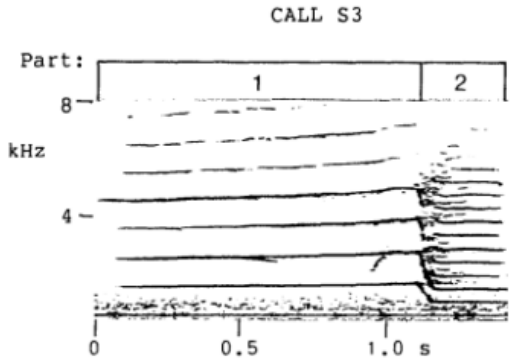


Figure 1: Examples of two calls I had to learn by visualizing it and hearing it as well. Frequency (kHz) on the y-axis and time on the x-axis (Ford 1987).



Measurement	Pod	Mean	C.V.	Min	Max	n
Duration (ms)	J	1195	24.3	598	1649	21
	MD	1079	3.6	1025	1135	10
Part 1:						
Dur (ms)	J	964	30.4	433	1449	21
	MD	909	3.8	872	952	10
SBI, start (Hz)	J	1068	4.0	994	1166	21
	MD	955	4.6	868	1028	10
SBI, end (Hz)	J	1068	6.6	972	1245	21
	MD	898	5.6	831	982	10
Part 2:						
Dur (ms)	J	231	17.5	165	313	21
	MD	169	6.8	153	189	10
SBI, start (Hz)	J	453	6.3	395	500	21
	MD	408	5.0	377	431	10
SBI, end (Hz)	J	455	6.8	396	516	21
	MD	400	6.7	356	435	10

Figure 2: Example of call descriptions from the Ford pdf that goes further in-depth (Ford 1987 pg. 129).

						Start Time						
	0	1	2	3	4	5	6	7	8	9	10	11
rpi_orcasound_lab_2021_09_30_18_07_11_PDT.wav					w	6?	1	f		f		
rpi_orcasound_lab_2021_09_30_18_06_32_PDT.wav			40?			40?	o, o	o	o	o	o, 4	
rpi_orcasound_lab_2021_09_30_18_06_11_PDT.wav	f,4	10	o									
rpi_orcasound_lab_2021_09_30_18_05_19_PDT.wav	o,o	10	10	o	40?	40?		40?		w, 10	40?	
rpi_orcasound_lab_2021_09_30_18_05_10_PDT.wav	f	o		40?	o,o	1	o		40?		o	o
rpi_orcasound_lab_2021_09_30_18_04_09_PDT.wav	f	1	4		o			w	1	1	buzz, 10	w
rpi_orcasound_lab_2021_09_30_18_03_09_PDT.wav	1		w	1		buzz, 1	1				1, 42	1
rpi_orcasound_lab_2021_09_30_18_02_46_PDT.wav	f	f		buzz	o				1	1	f, buzz	w
rpi_orcasound_lab_2021_09_30_18_02_09_PDT.wav	f			o		o			o	4,4	w, 16	4
rpi_orcasound_lab_2021_09_30_18_01_25_PDT.wav	f	f	o		o		o		f	f	1, o, o	1, o
rpi_orcasound_lab_2021_09_30_18_01_07_PDT.wav	10		40?								f	f
rpi_orcasound_lab_2021_09_30_18_00_05_PDT.wav	o		1			o		buzz	1			f
rpi_orcasound_lab_2021_09_30_17_59_58_PDT.wav				w					w	f	o	
rpi_orcasound_lab_2021_09_30_17_59_05_PDT.wav	f	o	o	o,o	o	buzz, 1			f		1	
rpi_orcasound_lab_2021_09_30_17_58_39_PDT.wav		1	f			10, 4			f	f		
rpi_orcasound_lab_2021_09_30_17_58_05_PDT.wav							f		buzz	1, o		
rpi_orcasound_lab_2021_09_30_17_54_44_PDT.wav	buzz			f					1		o	

Figure 3: Snippet of the excel file I recorded my data in. On the left if the link to the audio file, and on the right is where I would put what call I heard and at what second.

Theodolite

I got an opportunity to learn what a theodolite is, how to use it, and even practiced using it. Dr. Bain and I traveled to a beautiful outlook in Shoreline to set up the theodolite. A theodolite is a land-based measuring tool to estimate distances and fixed positions of objects on the ocean's surface (Mastick). In our case, we used a theodolite to measure how far a whale is from a ship/boat and to recreate the path the orca is traveling. This is important because if we see a whale and a vessel that are too close to each other, we can inform boats via radio to slow down or turn off the engine. If the vessel(s) do not slow down of turn off the engine, it is our job to get the description or number of the vessel and report it to the authorities so they can be fined. I was taught how to set the theodolite up by putting it together and collaborating the scope which is very sensitive and took me a while to get used to. Unfortunately, there were no whales spotted but that was not a surprise. It is very important for recreational boaters and other vessels to be aware of their surroundings and operate responsibly around any type of marine animal so we can ensure their safety and the boaters as well. During this experience I got to further complete my learning objectives of getting real world experience at monitoring a marine mammal and understanding what scientific data must be recorded while using a theodolite.

Whale Identifications

There was one other topic I wanted to focus on which was whale identifications. I have always wanted to know everything about whales, so getting to know all the SRKW's physically

would be something interesting for me to learn. I did not put this down as one of my learning objectives, but I thought it would be a fun, interesting thing to do. When I asked Dr. Bain, he gladly sent me a pdf of pictures of all the known SRKW's and how to identify them. There are three pods they are grouped in, and they are J, K, and L pods. This was more of a fun thing to do as I was focusing on whale calls the most, so I decided to focus on one pod only which was K pod. Figure 4 shows the K pod family tree on the left and shows two of the orcas on the right. You identify each orca mostly by their saddle which is the white/ grey part behind their dorsal fin. It can be extremely difficult as the pigmentation pattern on each whale can be very similar. I had a lot of fun getting to know the K pod and it was an important thing to do because then we can keep and maintain a population census up to date and make sure they all are well.

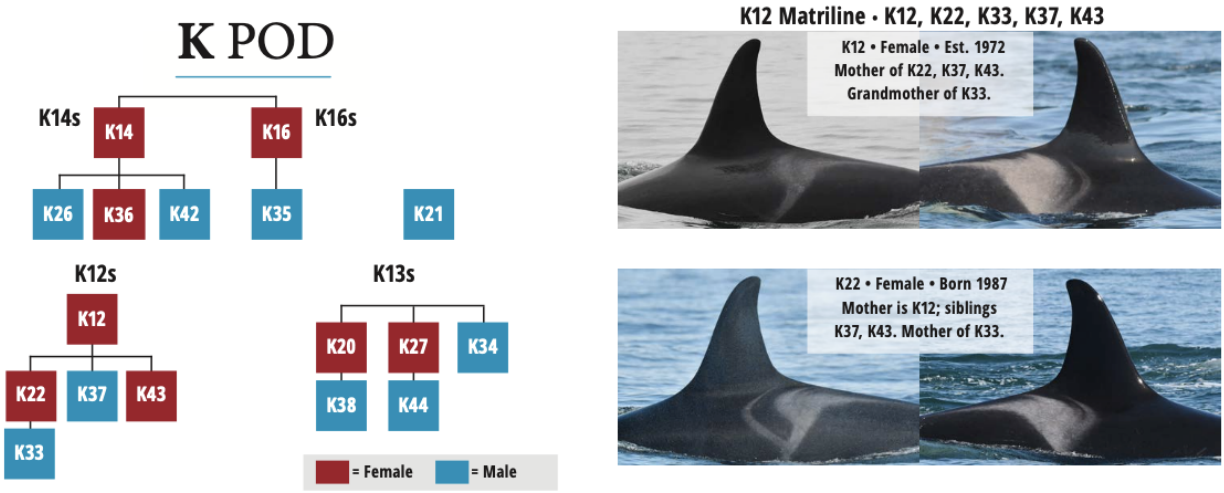


Figure 4: The K pod family tree (left) and a closer look at two of the orca's saddles (right).

Sealife Response, Rehabilitation, and Research

I had a last-minute opportunity to tour Sealife Response, Rehabilitation, and Research (SR3) in Des Moines Washington. Their main goal is to advance the health and welfare of marine life in the pacific northwest. At this moment they are mostly rehabilitating harbor seals. I was excited to go here because I have always wanted to work in rehabilitation but have never had the opportunity to experience it. Rehabilitation is very important because you can monitor environmental health while also saving the species whether it is endangered or not (SR3). I learned that disease in harbor seal populations can also signal upcoming risks for SRKW's. I have loved animals my whole life and having this experience not only increased my passion for animals but increased my passion for saving the environment. Their facility was small, but it had

everything they needed including pools, heater/chillers, good filter system, a surgery room stocked with all the equipment, fridges full of formula and fish, an excellent staff of volunteers, veterinarians and more. I also already work at an emergency veterinary hospital, so it was interesting to see how much of the equipment is similar, but they work very differently than a hospital. I would love to have the opportunity to work there because working with animals, saving their lives, and saving the environment all at once is something I have always dreamed of doing. By having this experience, I have further completed my learning objective of seeing real world experiences of monitoring a marine mammal.

Conclusion

There were three classes that I utilized the most while going through my internship and the classes were Water Quality, Invasive Species, and my capstone, Oceanography of the Salish Sea. In my capstone class, I researched how increased vessel noise is affecting the Southern Resident Killer Whales which goes along well with my internship as my focus was whales and how we can help conserve them. Due to increasing vessel noises, SKRW's are experiencing increased masking of their communication, which is consequently changing their behavior and is making it hard for them to catch food. Masking of communication means that one sound is overlapping or interfering with their sound, so they must increase their sound threshold and that makes them more tired and stressed out. The increased noise is also causing the SRKW to work harder for their prey. A noisier environment will decrease the distance an orca can detect prey using its echolocation causing them to work harder and not catch as much fish as they used to. There is already scarce population of salmon for them to eat so it is crucial to find ways to decrease large vessel noises. The next class I utilized during my internship was Water Quality because salmon need good water quality to survive and become prey for the orcas. Water Quality also helps us detect which areas need most protecting. At the restoration site I volunteered at, our main goal was to increase the river canopy by planting native trees, so the water can cool down and salmon can survive. The last class I utilized was my Invasive Species class because at the restoration site I was pulling out invasive blackberry bushes. It is important to get all of the root, so they do not grow back. Understanding that from the class prepared me in the process.

My internship taught me how everything is connected, how to organize my time well, how to address the major threats regarding orca survival and has increased my passion for loving and caring for all animals. I would not have believed that trees shading a river could have

a huge impact on orca survival, but the little things do matter, and they are all connected. For an orca to survive they need salmon, for the salmon to survive they need to have the right water temperature, and to get the right temperature you may need to plant trees for shading. I learned how to better organize my time well with the time I had for my internship. I did roughly on average 4 hours a day Monday-Sunday of either studying whale calls or transcribing them. I helped address the threat of prey scarcity by volunteering at restoration projects, and I helped address the threat of vessel disturbance by participating in the AI hydrophone project. Finally, my internship increased my love of animals because I got to learn more about them and that makes you want to save them and love them even more. Dr. Bain was an excellent intern site supervisor because he could answer any question I had, is passionate in what he does, and is always available by phone or email. If you have a passion for animals, especially orcas, Dr. Bain would be a great fit because he will make you love them more.

Appendices

Appendix A: Daily Log

6/18/22- Whale Scout Restoration 3.5 Hours

Pulled out invasive blackberry bushes to clear out areas for trees to grow for canopy of the Sammamish River. By doing this, there will be more shade leading to cooler water for salmon to live. Orcas need salmon to survive. David also gave a presentation on orcas and why they are in trouble.

6/23/22 Learning Whale Calls 6 Hours

Spent the day downloading software for analyzing and interpreting whale calls. I also listened to whale calls S1-30 and tried to familiarize myself and find key differences. David said, “I have to learn a new language”. I also looked at call patterns.

6/25/22 Studying Whale Calls 4 Hours

Played with calls S1-6 to get familiarized with them and recognize the sound on a spectrograph. I started to make notes of sounds like “it sounds like an owl” or “sounds like a cat meow”. I also played the sounds in my head several times to start remembering them. I feel 60% confident on calls S1-6.

6/26/22 Study Whale Calls 3 Hours

Studied S7-14 and then when I was comfortable, I studied S1-14. My dad would play a sound and then I would say what call It was. He would also do the opposite by showing me a call visually and me saying what call it was. I feel 65% confident on calls S1-14.

6/29/22 Study Whale Calls 4.5 Hours

Studied S14-30 along with S1-14 when I was comfortable. I printed out spectrographs so I can see them all together in my hands. Feeling 65% confident on calls S1-30.

6/30/22 Learning Rest of the Calls 3 Hours

Studied S30-46 by myself and then had my dad play back the call and have him show me a picture of the call. S30-46 was the hardest in my opinion. I am feeling 60% confident on S30-46.

7/1/22 Theodolite 7 Hours

Went to an outlook in Shoreline to work and learn how to use a theodolite. It is a machine that measures distance and location of an object (Boats, and whales). You can see how far away an orca is to a boat. I practiced using it by saying “mark” when I see a boat and saying “ready” when it crossed my point. I spend the rest of the day studying whale calls S1-46.

7/2/22 Whale Call Study 4 Hours

Spent my time studying calls S1-46 so I can master them before transcribing. I am feeling 70% confident on S1-46. I am learning more patterns and recognizing calls more easily. I also started to download some audio files so I can see how easy it is for me to recognize calls.

7/3- 7/9/22 Whale Call Study 24 Hours

Spent the hours studying calls S1-46 more in depth. Mom and dad quizzed me every day and I got better and better each day. On the spectrographs I printed out of each call, I put the number of the call on the

back and quizzed myself. On the spectrograph side I would say the call by looking at it visually. On the number side, I would think or speak the call. I would download audio files and test myself to see if I feel confident enough to start transcribing. By 7/9 I was 95% confident and ready to transcribe.

7/10/22 – Learning how to Transcribe 3 Hours
Used RavenLite 2 to learn the ropes of transcribing and how I am going to be recording my data. Started an excel file. I studied calls for the rest of the time.

7/11/22- Transcribing 4 Hours
Began transcribing audio files that are 60 seconds long. Some files have only a few calls in them, but some also have more than 50. I would write down the call I heard at the specific second it started it and recorded it in the excel file. I only did a few as I was not 100% confident yet. I studied the rest of the time.

7/12-7/28/22- Transcribing and Studying 62 Hours
Spent the time transcribing audio files that took from 5-25 minutes each to do. Some have many calls that take a while to transcribe and some only have a few that only takes about 5 minutes. I also did more studying and there were a lot that I did not know. I realized that S1-46 were documented in 1987 so there is a 35-year age gap for orcas to create more calls or create a spin off/look alike of an original call. After 7/28 I finished about 200 audio files.

7/29- 8/1/22- Studying and Identifying 20 Hours
Along with studying whale calls to make sure I am refreshed; this was also when I started studying the K pod physically. I learned that they are identified by their saddle pattern on the back side of their dorsal fin. It is very hard to tell them apart because some of the saddles are very similar to each other. By the end of the day 8/1 I was quizzed on J Pod, and I got MOST of them correct which I was proud of.

8/2- 8/5/22 Transcribing 13 Hours
Finished transcribing for David. I finished with 285 audio files completed which does not seem like a lot, but it took up a lot of time and I was slow at the start when I started learning. I am still about 98% confident in all the calls and I hope that I will remember them in the future. I am very aware of their call patterns visually and have little tricks to know what each call is.

8/15/22 SR3 2 Hours
Had a tour at Sealife Response, Rehabilitation, and Research in Des Moines Washington. It was a great facility and I loved to see all the baby harbor seals being treated back to health for the wild. David suggested I go here because I am passionate about animal recovery and is something I want to do in the future. The surgery suite is amazing as all their equipment is portable to take to the field. I got to see hands on about how to rehabilitate a harbor seal.

TOTAL: **163 Hours**

Appendix B: Internship Site Advisor Letter

Pending

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