

Orca Communication and Behavior

A little about orcas

Orcas are mammals, a type of dolphin to be specific. They live in a rather complex matriarchal family structure which consists of pods of closely related individuals. For a variety of reasons, orcas extensively use vocal communication consisting of three distinct sound types for a variety of reasons, including food processing after a successful hunt (aka butchering whale carcass). Groups (e.g., pods) of orcas have even been known to develop dialects distinct from that of other groups, and it is for this reason that I am interested in orca behavior and communication.

Literature Review / Annotated Bibliography

1. Whitney B. Musser, Ann E. Bowles, Dawn M. Grebner, and Jessica L. Crance. *Differences in acoustic features of vocalizations produced by killer whales cross-socialized with bottlenose dolphins*. The Journal of the Acoustical Society of America, 2014 DOI: [10.1121/1.4893906](https://doi.org/10.1121/1.4893906).

This is just a little bit of extra information about orca communication and adaptability. Although orcas sometimes eat their fellow dolphins, the former sometimes befriend the latter in some situations. This article goes to show that killer whales are capable of adapting their communication patterns to accommodate certain aspects of their environment.

2. Christensen, V. and C. J. Walters. 2004. *Ecopath with Ecosim: methods, capabilities and limitations*. Ecological modelling, 172(2), 109-139. <http://www.ecopath.org/about>.

Ecopath with Ecosim (EwE) is a simulation framework for ecological systems, particularly marine ecosystems and fisheries. As one could easily imagine, an agent-based simulation could easily become far too complicated and computationally intensive to run. Consequently, this simulation framework approaches species populations as biomasses and uses ordinary differential equations to model the interactions among these populations. The mathematical approach is interesting, but the granularity is not appropriate for my project at this point. I am interested in the individual interactions among orcas and between the orca population and its prey.

3. Gerum, R. C., Fabry, B., Metzner, C., Beaulieu, M., Ancel, A., & Zitterbart, D. P. (2013). The origin of traveling waves in an emperor penguin huddle. *New Journal of Physics*, 15(12), 125022.

In this study, the behavior of chilly Emperor penguins is simulated. The goal is to reproduce the cascading patterns of penguin movement as the penguins try to huddle away from the cold as seen in video footage from previous studies. To reproduce this behavior, the authors designed an agent-based model in which 1) every penguin seeks to

stay warm given a threshold for cold-tolerance and 2) an individual penguin's movement could influence the movements of their neighbors. The authors compared the behavior to a traffic jam, except in this case multiple directions were involved because penguins could have up to six neighbors. The simplicity of this model is to be admired. However, the behavior of orcas complicates my model because the orcas are adapting their *behavior* over time, not just their *state* as in the penguin huddle model.

4. Mock, K. J. and J. W. Testa. 2007. *An agent-based model of predator-prey relationships between transient killer whales and other marine mammals*, University of Alaska Anchorage, Anchorage, AK, May 31, 2007, Available online at <http://www.math.uaa.alaska.edu/~orca/>.

The authors here sought to model orca behavior and movement with great detail. Like my project will be, their simulation is agent-based. However, I am not interested in this level of detail (at least not yet) and I am more interested in the language aspect.

5. Riesch, R. and V.B. Deecke. 2011. *Whistle communication in mammal-eating killer whales (Orcinus orca): further evidence for acoustic divergence between ecotypes*. Behavioral Ecology and Sociobiology, 65(7), 1377-1387. <http://www.marinemammal.org/wp-content/pdfs/riesch.pdf>.

This paper discusses how two types of orcas (pescatarian orcas and mammal-eating transient orcas) differ in language patterns. To be specific, mammal-eating orcas tend spend more of their time silent when compared to fish-eating orcas. This is believed to be the result of differences in diet; mammal-eating orcas must contend with the fact that their prey is capable of hearing the orca's verbal communications since the predator and prey share the same hearing range. Prey could eavesdrop on orca conversation and take the necessary evasive maneuvers. These transient orcas would go hungry if they kept chitchatting while hunting. I wish to explore the development of this difference; thus this paper is the foundation of this project.

Project goals/Conceptual Model

I would like to reproduce the behavior described in (Riesch & Deecke, 2011). Following the example of (Gerum et al., 2013), evaluation will be more qualitative in that I am trying to reproduce a specific type of behavior. Like (Mock & Testa, 2007), my simulation will be agent-based, but I do not intend to model the same level of detail as this group. Furthermore, I am interested in observing a specific phenomenon related to language.