# Olfactory orientation to salt marsh odors by Atlantic silverside in coastal Long Island Sound

Valeriay Dion and John Kelly, Ph.D.
Department of Biology and Environmental Science, Marine Biology Program
University of New Haven

## Introduction

Salt marshes are important ecosystems for many estuarine species. These organisms use these habitats as feeding grounds and, sometimes, breeding grounds. Many species, like *Menidia menidia,* Atlantic silverside (Fig. 1), use salt marshes as breeding grounds in the spring and summer months, moving offshore into the open estuary during the winter months (Cadigan and Fell 1985). Silverside not only use salt marshes as breeding grounds, but also for feeding. Gut content of Atlantic silverside consists of approximately 80% grasses, including *Spartina alterniflora*, cordgrass, a species that thrives in the salt marsh (Cadigan and Fell 1985).

The need for food and habitat raises the question of how these species find their way to salt marshes. Different cues that allow various species of fish to orient are tides, sound, light, and olfaction. Species such as the *Fundulus heteroclitus*, mummichug and *Morone americana*, white bass, have been show to use tidal migration to find their way to the salt marsh; however, Atlantic silverside showed no such pattern (Kimball and Able 2012). If silverside do not use tidal cues to orient, the question remains, how do they make their way to a salt marsh?

One form of sensory modality that fish use to orient is olfaction, or smell. Olfaction is the ability to detect a chemical cue dissolved in a medium, such as water. This behavior is found in many different types of fishes, with functions ranging from locating food to settling in habitat after a pelagic larval stage.

**Figure 1.** *Menidia menidia,* Atlantic silverside.

Olfaction would be beneficial for navigation to the marshes, allowing fish to forage, breed, and locate habitat. The goal of this experiment is to determine if fish use olfaction to orient to salt marshes.

## Objectives

- Further understand how fish orient to salt marshes.
- Determine if fish use amino acids such as Alanine and Leucine, found in *Spartina alterniflora*, to orient.

**Figure 2.** Collection of fish by seine in New Haven Harbor Estuary.


**Figure 3.** Y-maze with the treatment and control in each arm.

## Results

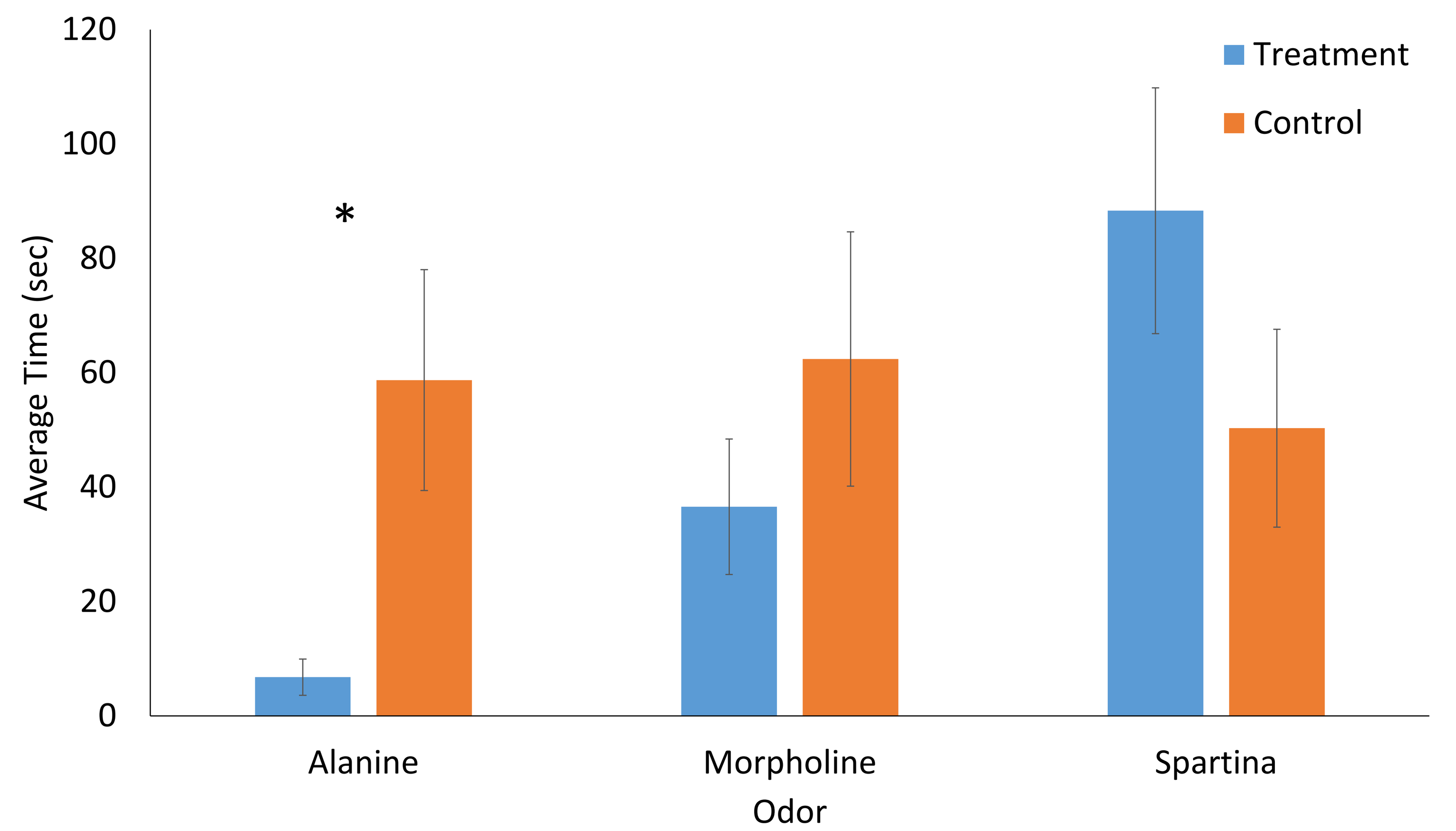


**Figure 4.** Average time Atlantic silverside spent in treatment and control for all odors in set 1, alanine is significant with a p-value of 0.019.

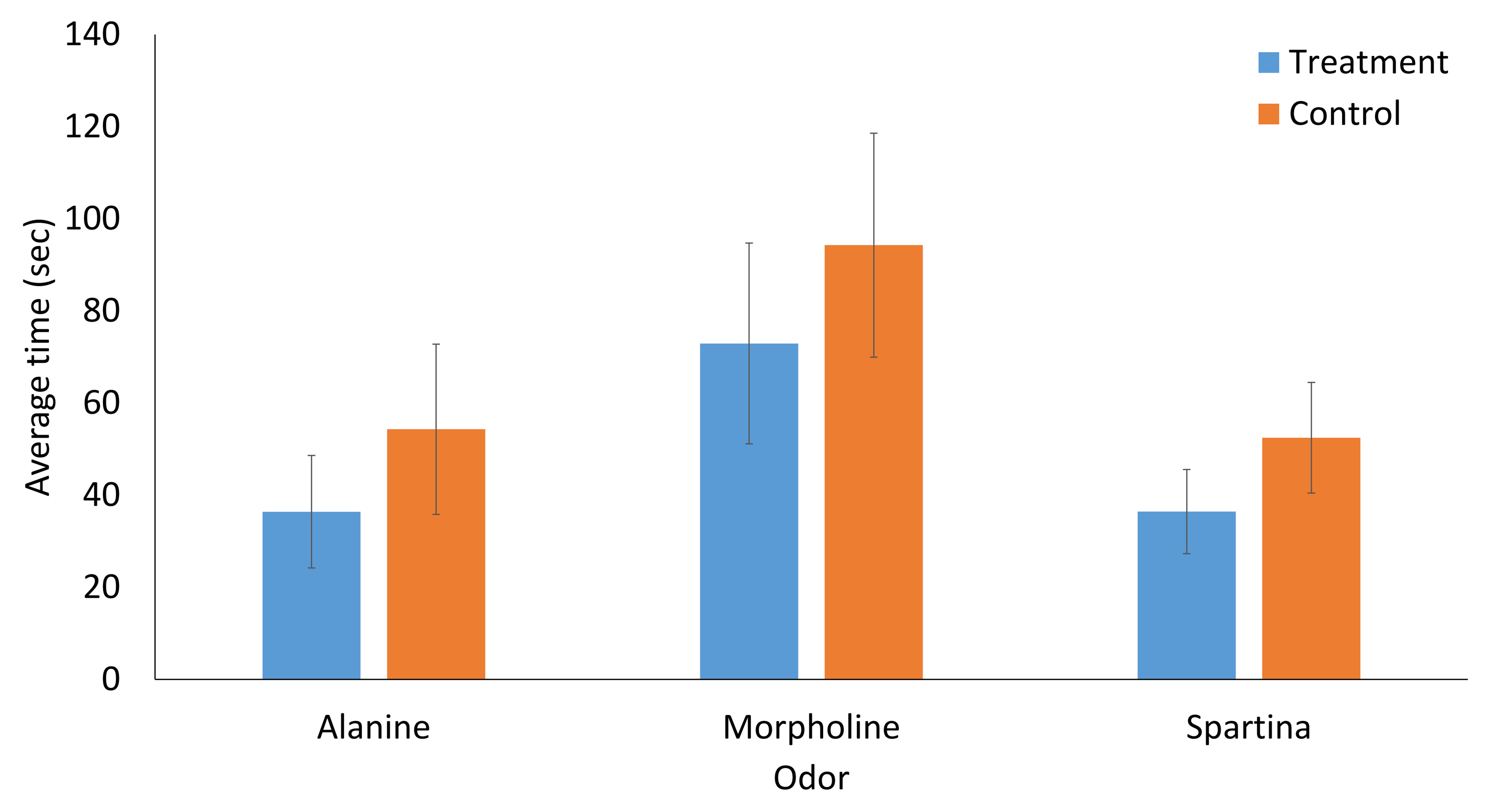


**Figure 5.** Average time Atlantic silverside spent in treatment and control for all odors in set 2, results were not significant p>0.05.

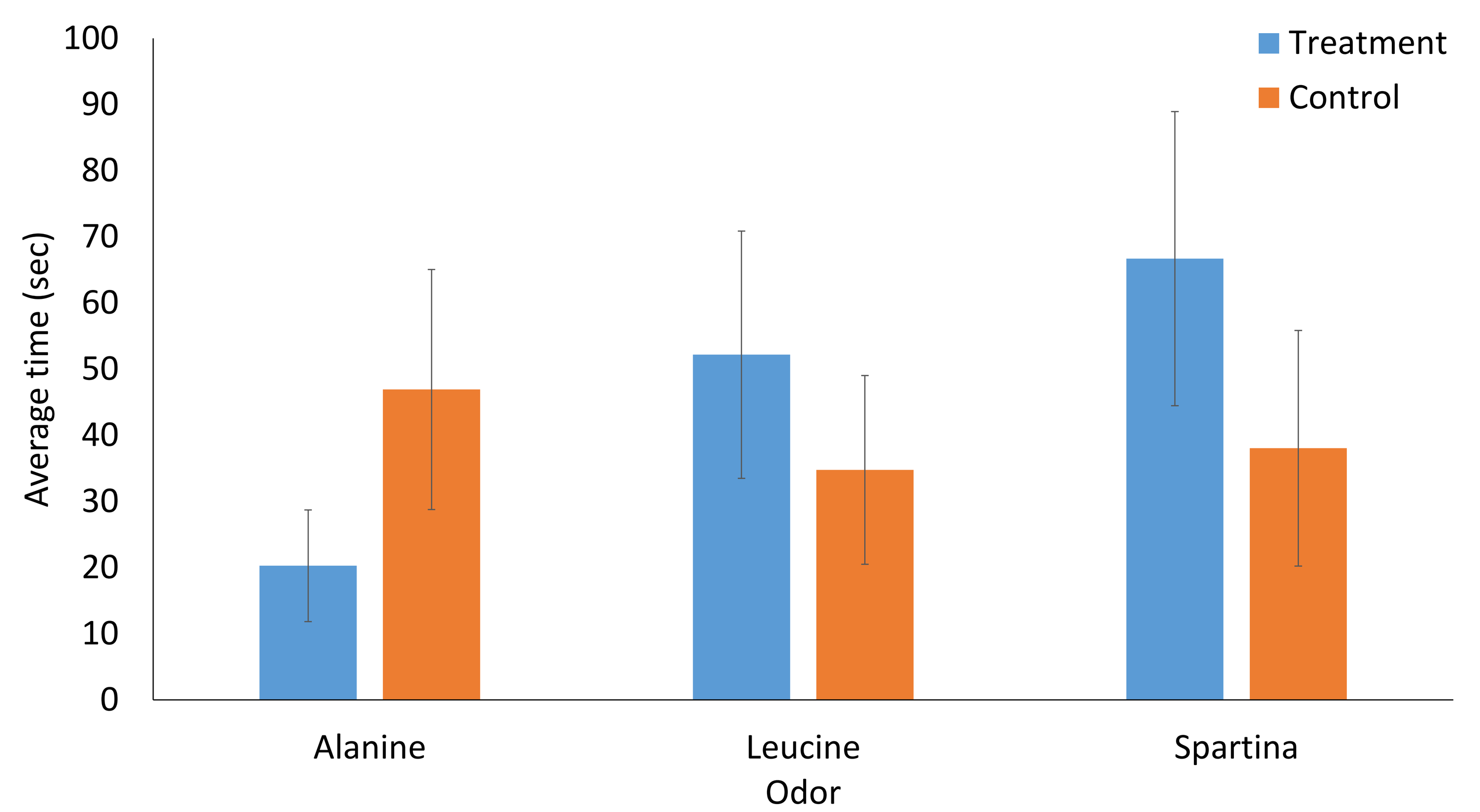


**Figure 6.** Average time Atlantic silverside spent in treatment and control for all odors in set 3, results were not significant p>0.05.

## Materials and Methods

Sixty fish were collected from West Haven Beach in Connecticut (Fig. 2) and acclimated for 24 hours before trials started. Fish were placed individually in a Y-maze (Fig. 3) and acclimated for 10 minutes. Odorants were dissolved in 25 ppt salinity water and dripped into one arm of the maze for 2 minutes. Control water at 25 ppt salinity with no added odorant was dripped into the other arm. The fish were observed for 5 minutes and their locations were recorded. Three sets of trials were conducted consisting of 60 trials each. Odorants in set one consisted of $10^{-2}$ M alanine, $10^{-5}$ M morpholine, salt water at 25 ppt, and 40 grams of cordgrass infused in salt water of 25 ppt. Set two consisted of $10^{-5}$ M alanine, $10^{-3}$ M morpholine, salt water at 25 ppt, and 40 grams of cordgrass infused in salt water. Set three consisted of $10^{-2}$ M alanine, $10^{-2}$ M leucine, salt water at 25 ppt, and 40 grams of cordgrass infused into salt water. The order and side from which odorants were presented varied according to a Latin Square design. Results were analyzed through one-way ANOVAs and paired sample t-tests, with significance set at a p-value of 0.05.

## Discussion

The significance difference noted in the alanine trials in set 1 (Fig. 4) suggests that the fish may actually have been avoiding alanine. Based on this, alanine may not be used by fish for orientation and navigation. In set 2 (Fig. 5) alanine concentrations were decreased to see if this aversion was due to the intensity of the odorant. Amino acids dissolved in water may occur as a result of decomposition, so the fish were potentially avoiding this odor because they perceived it indicitave of a high concentration of dead cordgrass. However, similarly significance results were not observed at lower concentrations or when the higher concentration was tested again in set 3. It is unclear if these results indicate choice by the fish or are simply due to natural variation. Leucine in set 3 (Fig. 6) was not significant different from control water, which suggests that this amino acid is also not used to orient. The results to date, therefore, do not support the hypotheses. This study found that the fish may have detected some of the amino acids present, but were not attracted to it. It si possible that the odor cue presented to the fish are not appropriate for orientation, and that the fish may use a combination of amino acids or other chemicals that are produced by different plants or organisms in the salt marsh. Additional studies are under way to determine if Atlantic silverside use olfaction to orient, and what chemicals are important.

## References

Cadigan K. Fell P. 1985. Reproduction, Growth and Feeding Habits of *Menidia menidia.* (Atherinidae) in a Tidal Marsh-Estuary System in Southern New England. *Copeia.* 1985(1): 21-26.

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