



## SAVING THE INCREDIBLE SALT MARSH HARVEST MOUSE!

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### YOUNG REVIEWERS



CORTE  
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AGES: 10–11

Did you know that one of the most unique and incredible mammals in the world is found only in the San Francisco Bay-Estuary? The salt marsh harvest mouse is an endangered species because over 90% of its coastal marsh habitat has been lost due to human development. This species can swim for over 2h, can climb using its tail like a fifth limb, can eat salty foods, and can even drink water saltier than the ocean! For decades, people thought this animal could live only in tidal marshes dominated by salt-loving plants. However, in the past few years, we have learned many new things about the salt marsh harvest mouse. For example, we now know it can live in non-tidal marshes and forage on freshwater plants. Unfortunately, the superhero abilities of this mouse will not protect it from all the threats it faces in the future, such as sea-level rise.

### Figure 1

A salt marsh harvest mouse in a biologist's hand. The marsh and bay can be seen in the background.



Figure 1

### ENDEMIC

Living only in a certain place.

### TIDAL MARSHES

Marshes that have a regular rise and fall in water level due to the movement of the ocean tides.

## AN UNUSUAL MOUSE

The salt marsh harvest mouse (let us call them Salties for short) is the only mammal in the world that lives only in marshes near the ocean. Salties are about the size of a big thumb and weigh about as much as two nickels. They range in color from blond to black, but are usually the color of cinnamon, and sometimes have a bright orange belly (Figure 1). The species is **endemic** to the San Francisco Estuary, which means Salties do not live anywhere else in the world. Humans have changed the Estuary a lot. Over 90% of the **tidal marshes** (areas where waters get higher or lower depending on the ocean tides) where Salties used to live have been converted for housing, business, farming, or other human uses [1]. This huge loss of habitat led both the United States Fish and Wildlife Service and the California Department of Fish and Wildlife to list Salties as endangered in the early 1970's [1]. Since then, biologists have worked hard to understand how Salties are influenced by their physical surroundings and by other organisms, with the goal of protecting their remaining habitat and creating new habitat through tidal marsh restoration.

Even though Salties were discovered in 1908 [1], researchers did not pay much attention to them until the 1960s. Some pretty amazing things have been discovered about Salties. They can swim for more than 2 h without getting tired, use their tails like an extra hand for climbing in vegetation above tidal waters, eat very salty foods, and drink sea water [2]! Biologists thought that the species needed tidal marshes almost completely covered by a short, fleshy plant called pickleweed. However, there was a lot that biologists did not fully understand about Salties at that time. Most biologists only looked for Salties in tidal marshes, and did not look for or find them in areas where tidal waters did not reach. This meant that biologists focused mainly on protecting and improving tidal marshes.

## Figure 2

A salt marsh harvest mouse standing inside of a trap before the door closes. This trap was in a non-tidal marsh, so it could be placed directly on the ground without risk of flooding by tidal waters.



Figure 2

## NON-TIDAL MARSHES

Marshes where tidal waters cannot reach and water levels usually do not change on a daily basis. Non-tidal marshes may be marshes near the ocean with **levees** around them, but they can also be far from the ocean.

## LEVEE

A barrier, usually made of soil or rock, that prevents the movement of water.

## LONG-TERM STUDY

A study where repeated observations or measurements are made over a long period, usually months or years.

## MICE IN UNEXPECTED PLACES

In the late 1990s, some curious biologists started looking for Salties in **non-tidal marshes**, where big dirt walls called **levees** kept out the water moved by tides, and they discovered there were many Salties in these marshes [3]! These biologists also learned that Salties like areas with various kinds of plants, not just areas where there is a lot of pickleweed. This came as a surprise to many scientists who thought that Salties could not live in habitats without pickleweed. The new information generated a lot of questions! Are there more Salties in tidal marshes or in non-tidal marshes? Do Salties really require pickleweed for food and nesting? Can Salties live in areas where there is no pickleweed at all? Do these mice use tidal and non-tidal habitats differently when searching for food and nesting?

The answers to these questions are important for deciding which habitats to protect for Salties. There are plans to change some of the non-tidal marshes in the Estuary into tidal marshes, because people think it will benefit Salties. This new information will also help us deal with new challenges, like sea-level rise caused by climate change. For example, biologists need to know whether tidal marshes or non-tidal marshes will be better places for Salties to live as sea levels get higher and higher.

## TESTING OUR NEW IDEAS

With this new knowledge and a new set of research questions, biologists designed a bunch of new experiments to study Salties. To understand whether tidal or non-tidal marshes were better for Salties, scientists designed a **long-term study** in both marsh types. Box-like traps containing seeds that the mice like to eat, and a fluffy ball of cotton for them to cuddle in, were used to lure the mice into the traps (Figure 2). These traps were placed in the marsh and opened

### Figure 3

A salt marsh harvest mouse standing on top of a datasheet with the tracking collar that was just taken off him, to his left. Check out the frayed antenna wires where the mouse chewed on the collar! Also pictured are the various tools that we use to measure Salties and to put on/take off their collars.



Figure 3

at sunset. During the night, if a mouse walked into the trap, a door closed behind it. While inside, the Salty got to feast on a yummy meal and sleep in a comfortable, warm bed until the morning, when biologists returned. First, the biologists gently removed the mice from the traps and measured them. Like all wild mice, Salties sometimes bite biologists, but they are mostly friendly, with soft fur, grippy foot pads, long whiskers, and big eyes and ears. Once the mice were measured, the biologists gave each one a tiny tag on its ear (like an earring!) with a unique number. Then they returned the mice to their nesting areas. By continuing to trap and tag mice in the same marshes, biologists could estimate how many Salties were in each marsh area.

To find out what types of foods Salties like to eat, some of the captured mice were placed into buckets with different jars of food found in tidal and non-tidal marshes, like seeds, leaves, flowers, and even beetles and tiny shrimps! Those mice were video recorded while they ate the different foods, to see which foods they spent the most time eating.

Finally, some of the Salties that were captured were given tiny collars with tracking devices on them before they were set free (Figure 3). For the next 2 weeks, biologists followed the mice around and recorded where they ate at night and slept during the day.

### OUR INTUITIONS WERE RIGHT!

Through these studies, biologists found a similar number of Salties in tidal and non-tidal marshes. This means that non-tidal marshes are also good habitat for the species [4]. Results of the food preference study showed that Salties will eat many different types of plants and bugs from both marsh types. They did like pickleweed—the food everyone thought was their favorite—a lot, but there were other plants

## UPLAND

Habitats that are elevated above water level. In the San Francisco Estuary these are often dry and grassy, and near tidal marshes.

they liked just as much, like fat hen and rabbitsfoot grass, both of which are commonly found in non-tidal marshes [5]. Finally, Salties in the tracking study moved around a lot in their habitats, crossing over levees between tidal and non-tidal marshes, and even sometimes moving into **upland** areas. Some mice moved just a few meters each night, while some ran hundreds of meters from one side of the marsh to the other, several times a night. Salties also built nests in many different types of plants, not just pickleweed, and used old bird nests and burrows dug by other animals, like crayfish. This showed that Salties have a lot of flexibility in how they use their habitat. They do not need to live their entire lives in tidal marshes with lots of pickleweed, as biologists believed for many decades [4, 6].

While in some ways this is good news, it also makes conserving Salties more complicated. There are plans to convert non-tidal marshes to tidal marshes throughout the Estuary, in part to benefit Salties. But will this restoration benefit the species if there are similar numbers of Salties in both types of marshes? Biologists are now more carefully considering the value of non-tidal marshes. As before, this new information has opened the door to a whole new set of research questions. One of those questions is: if Salties are flexible in their habitat and food requirements, why do they live only in marsh areas? With their ability to swim and drink saltwater, Salties can live in marsh habitats more easily than other rodents can. In upland areas, other rodents probably bully the Salties, and there are a lot more predators. New research supports the possibility that Salties avoid moving out of flooded marshes into uplands where there are lots of other rodents. So how do other species affect Salties?

## SALTIES ARE PART OF A COMMUNITY

For decades, researchers have studied Salties without considering the larger wildlife community, including other rodents (competitors) and animals that eat mice for food (predators). We still have many questions about how other species might affect our efforts to protect Salties. For example, if we build islands so that Salties can move to high ground during floods, will the dry soil on the islands allow competitors like deer mice to dig burrows and take over? Or, will building more uplands near marshes for Salties to use during flood events create a path for predators like gray foxes, coyotes, and even cats to access marsh habitat and eat Salties? No conservation action should be taken without considering how all animals in the marsh community might affect outcomes.

Though biologists have learned a lot about Salties over the years, you can see that there are still a lot of unknowns when it comes to habitat protection, enhancement, and restoration. These unanswered questions stand in the way of increasing populations of Salties to levels where they can be taken off the endangered species list. As the risks of

climate change and sea-level rise grow, it is even more important to keep researching this species. It will take a new generation of biologists to keep searching for answers to the many questions about Salties that still remain; and answering one question often leads to infinite new ones! Will YOU be the next champion for this awesome creature and help make sure they stay in our marshes forever?

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## YOUNG REVIEWERS

### CORTE MADERA SCHOOL, AGES: 10–11

We are a fifth grade class, excited about all things science. Since we live in the San Francisco Bay Area, we love to learn about the amazing wildlife and the natural environment around us.



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Dr. Smith has been studying the salt marsh harvest mouse for over a decade and devoted her master's and Ph.D., work to improving conservation of the species. She loves all rodents, and especially likes to study their behavior to better understand how they use their habitats. Dr. Smith worked for California Department of Fish and Wildlife for about 10 years while she was doing her graduate school research. She is now a wildlife biologist at WRA, Inc. an environmental consulting firm, and helps her old lab at University of California, Davis with mouse research. Most nights you can find her lurking in the marshes around the bay. \*ratsmith@ucdavis.edu; ksmith@wra-ca.com

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Melissa Riley is an environmental scientist at the California Department of Fish and Wildlife. She received her bachelor's degree from University of California, Berkeley, where she first started researching land use change and its effect on wildlife. Since 2012, Melissa has worked at California Department of Fish and Wildlife on a team researching wildlife species like western pond turtles and salt marsh harvest mice. She is also pursuing her doctorate degree in ecology at University of California, Davis, focusing on western pond turtle habitat use. She is interested in studying the effects of tidal restoration and land management on turtle and mouse populations.

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