

## BLACK SEA JELLYFISH: SHOCKING NEWCOMERS TO SUISUN MARSH

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Black Sea jellyfish love to travel. Far from their original home in the Black Sea of Southeastern Europe, Black Sea jellyfish have come to the San Francisco Estuary. Since these jellyfish first started regularly appearing in fishing nets in the early 1980s, scientists have been finding more and more of them in the San Francisco Estuary. Over the past 40 years, our lab has tracked the numbers of Black Sea jellyfish in a part of the Estuary called the Suisun Marsh. Over this time, we have observed increasing amounts of jellies, with the highest amount ever recorded caught in 2019. What does this mean for the San Francisco Estuary and its other current residents? This is a question we will explore in this article.

### INTRODUCING THE BLACK SEA JELLYFISH

Jellyfish on display in aquariums are charming. They casually swim around their tanks, awing on-lookers with their peaceful calmness.

**Figure 1**

A live Black Sea jellyfish resting on the bottom of a tank. Its many tentacles move around, searching for something to eat (Photo credit: Dave (Gio) Giordano).



Figure 1

**INVERTEBRATE**

Animal without vertebrae (spine bones).

**MARSH**

A wet and muddy grass-filled habitat near a river or coastline. Marshes are home to a lot of animals—birds, fishes, mammals, and more!

**TRAWL**

A method of collecting animals from the water by dragging a net behind a boat.

Jellyfish are beautiful and mysterious animals with big bell-shaped heads and long hair-like tentacles. Jellyfish do not just live in tanks though, they live out in the wild, too! We catch jellyfish in our nets, sometimes by the hundreds, when we are sampling fish in the San Francisco Estuary in California, United States, where freshwater from streams and rivers meets the salty Pacific Ocean water. The “jellies,” as we call them, look like soft, clear blobs of jelly, and are often only a little bigger than a golf ball in size (Figure 1). The jellies are not fish—they are **invertebrates** that drift with water currents.

Black Sea jellyfish are a relatively new, non-native species in the Estuary, and their role in the Estuary has only recently been studied. Their name is a give-away to their native home: they were once found only in the Black Sea, in Southern Europe. How does a weak-swimming invertebrate end up over 9,700 km (6,000 miles) away from home? They hitch a ride in the water that cargo ships take on in far-away ports to balance them as they cross the world’s oceans. When that water is released near the Estuary, the hitch-hiking creatures are released too, and the wind and tide move the Black Sea jellyfish upstream.

Suisun Marsh is one spot in the upper Estuary where these jellyfish are doing especially well. The **marsh** provides a safe refuge for many species. Since 1980, our team of researchers at University of California, Davis has been looking at what lives in the Estuary’s waters. Every month, we go to the Estuary to sample the animals that live there. We use nets called **trawls**, which are dragged behind a boat. Black Sea jellyfish first appeared in the trawls in the early 1980s. Since then, there has been an increase in Black Sea jellyfish populations in the Estuary (Figure 2).

**WHY ARE SCIENTISTS ALARMED BY SMALL JELLYFISH?**

Black Sea jellyfish look small and fragile, but they have four traits that may help them to cause a lot of damage to the Estuary. First, they have

### Figure 2

(A) The number of Black Sea jellyfish caught per minute of trawling, in Suisun marsh. (B) Total number of Black Sea jellyfish caught in these trawls. You can see that, ever since 1980, there have been increasing numbers of jellyfish in the Suisun Marsh, with a record 21,478 individuals caught in 2019.

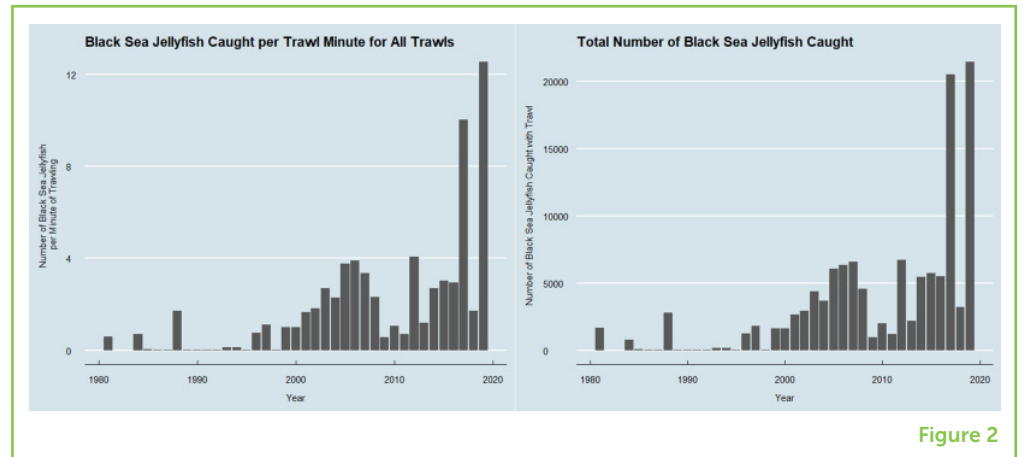


Figure 2

### Figure 3

Swimming behavior of a Black Sea jellyfish. Jellyfish swim to the surface of the water, flip over, and sink slowly to the bottom with their tentacles stretched out, searching for food as they descend. Once the jellyfish reach the bottom, they stay upside-down and twitch the ends of their tentacles, likely trying to lure bottom-dwelling zooplankton into their lethal trap (Image based on Wintzer et al. [1]).

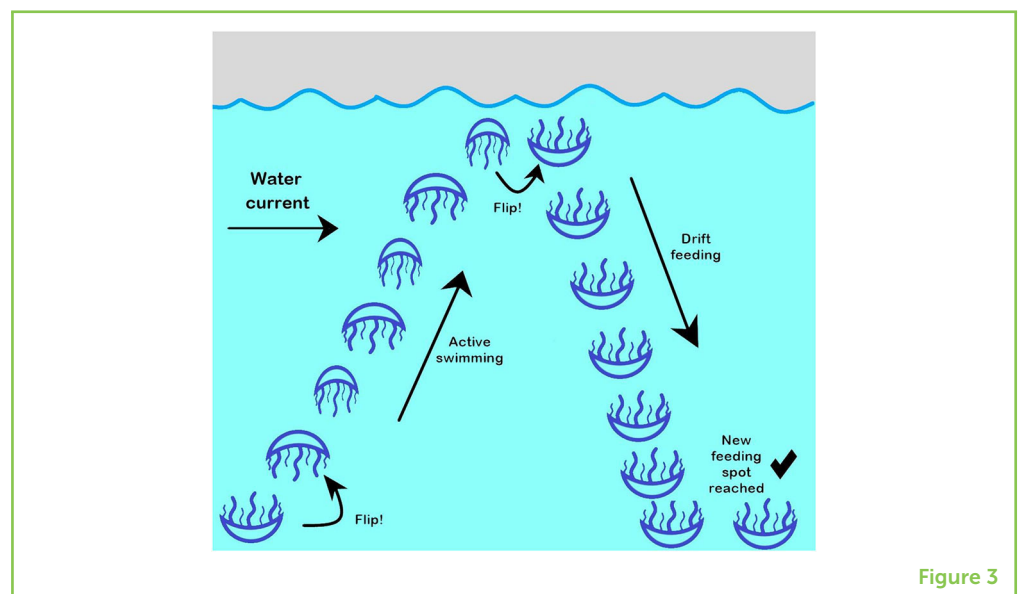


Figure 3

an effective hunting strategy that allows them to capture prey from the top to the bottom of the water. Most of their time is spent on the bottom, where they sit upside-down, wriggling their tentacles about and grasping for food. Every so often, they flip themselves bell-side up and swim to the surface. Once they reach the surface, they flip themselves upside-down again and float down to a new sitting spot [1]. As they go up and down, water currents carry them to new locations, allowing them to spread and find new patches of food (Figure 3).

Second, the bell-shaped bodies of Black Sea jellyfish are lined with hundreds of stinging tentacles. They use these stingers to catch and kill their prey. Scientists and managers are concerned that small fish in the Estuary are being killed by these stingers, and that the jellyfish are consuming small invertebrates that fish rely upon for food.

Third, Black Sea jellyfish quickly reproduce, thanks to a unique style of reproduction. Their life cycle is divided in two parts. Jellyfish in the

## MEDUSA

The adult stage of a jellyfish's life cycle. Medusa swim freely through water.

## POLYP

The juvenile stage of a jellyfish's life cycle. Polyps do not move and are attached to hard surfaces underwater.

## BLOOM

A sudden large increase in numbers of jellyfish.

## ZOOPLANKTON

Small aquatic invertebrates that drift with water currents.

## AMPHIPOD

A type of zooplankton with hard shells that have both swimming and walking feet.

adult phase are called **medusae**, and they can swim freely in the water. When jellyfish are young, they are called **polyps**. The polyps cannot move and live attached to hard surfaces, such as rocks, docks, ropes, and even empty shells. As polyps develop, they can release dozens or hundreds of small medusae.

Fourth, Black Sea jellyfish do not have natural predators in the Estuary. Consequently, since they eat a lot, reproduce quickly and in great numbers, and have no natural enemies, the number of Black Sea jellyfish can increase massively. Scientists call this rapid population increase a **bloom**. Blooms happen when water conditions favor the jellyfish, usually during the summer and fall when the water is warm and salty [2, 3]. At times, the jellyfish are so densely packed in the water that it may be hard for small fish and invertebrates to avoid getting stung by their tentacles. Together, these four traits make the jellyfish a potential threat to the San Francisco Estuary ecosystem.

## A STUDY OF BLACK SEA JELLYFISH IN THE SAN FRANCISCO ESTUARY

To evaluate whether the four traits of Black Sea jellyfish described above truly have a negative impact on fish in the San Francisco Estuary, our team studied the population size and behaviors of Black Sea jellyfish in Suisun Marsh. We asked three questions: (1) What do Black Sea jellyfish eat? (2) Do jellyfish eat larval (baby) fish? And, (3) Do jellyfish compete with fishes for food? [1].

To answer the first two questions, we examined the diets of Black Sea jellyfish in Suisun Marsh, by catching jellyfish in nets and using microscopes to look at what was in their stomachs. We found that jellyfish mostly feed on tiny **zooplankton** with hard shells, called **amphipods**. We found that Black Sea jellyfish *do* eat larval fish, but they were not common in the diet of jellies: only 4% of jellies' overall diet was larval fish. But this does not mean that larval fish are necessarily safe from the jellies—the lack of predation on larval fishes might simply be due to timing. When the jellyfish bloom and are on the hunt, most fishes have passed their larval stage. Many fishes hatch early in the spring and are too big for the jellyfish to kill by the time the summer blooms come [1].

To measure competition for food between jellies and fish, we looked at stomach fullness in threadfin shad, a fish that also eats zooplankton. If there was high competition for zooplankton between jellies and threadfin shad, the fish stomachs would be less full when the jellies were around. However, we found that the presence of Black Sea jellyfish made no difference in the fullness of threadfin shad; fish could eat just as much as they did when the jellies were not present. Were the shad switching what they ate to get full? Nope! Threadfin



shad and jellyfish stomachs were found to contain mostly the same thing—amphipods [1].

This tells us that, at least right now, competition does not appear to be a problem. However, the study *did* confirm that there is overlap in food resources, which means that zooplankton-eating fishes would have to compete with jellies if their common food source (amphipods) ever became in short supply [4]. This is of some concern to scientists in the San Francisco Estuary because zooplankton-eating fish have already been declining for decades, and more competition for food could make that decline even worse.

## IS THE FUTURE FULL OF JELLY?

It is difficult to predict the future of Black Sea jellyfish in Suisun Marsh. However, scientists think that climate change will cause summers to start earlier, be warmer, and last longer. If this happens, the Black Sea jellyfish could bloom sooner and stay longer. If jellies bloom earlier, fish that are born in the spring will still be small and vulnerable when the jellyfish bloom. Also, blooms could become even bigger. If the jelly population keeps rising, there may be more pressure on food resources for all the animals that eat zooplankton. So, it is possible that climate change could improve conditions for jellyfish, which could spell trouble for Estuary fish.

While it is difficult to predict the future, by looking at the past we can see that Suisun Marsh is certainly getting fuller with jellies. The Black Sea jellyfish population in Suisun Marsh has been increasing since the 1980s and in 2019, we saw the highest number of jellyfish ever: 21,478 jellies (Figure 2). So, how do we manage this species to prevent it from affecting fishes that we care about? One solution might be to change water conditions. Since the jellyfish prefer salty water, their numbers might be controlled by increasing the amount of fresh water flowing through the rivers that feed into the Marsh. A new experiment is being planned, which will allow more fresh water to flow through Suisun Marsh. Scientists hope that lowering the saltiness will benefit native fishes, while reducing the number of jellyfish by killing polyps with freshwater.

Black Sea jellyfish are here to stay, but their impacts can be reduced with good science and management. Scientists must continue to conduct experiments and monitor population trends. By studying the jellyfish, we can tell how changing conditions affect them and then pursue strategies to protect the Suisun Marsh ecosystem, by controlling the population of potentially deadly Black Sea jellyfish.

## ORIGINAL SOURCE ARTICLE

Wintzer, A., Meek, M., and Moyle, P. 2011. Trophic ecology of two non-native hydrozoan medusae in the upper San Francisco estuary. *Mar Freshw Res.* 62:952–61. doi: 10.1071/MF10221

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**SUBMITTED:** 23 September 2020; **ACCEPTED:** 19 August 2021;

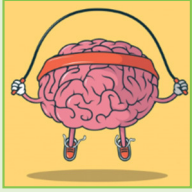
**PUBLISHED ONLINE:** 14 September 2021.

**EDITED BY:** Pedro Morais, University of Algarve, Portugal

**CITATION:** Newell CL, Durand JR, Meek MH and Moyle PB (2021) Black Sea Jellyfish: Shocking Newcomers to Suisun Marsh. *Front. Young Minds* 9:609315. doi: 10.3389/frym.2021.609315

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John R. Durand studies the ecology of food webs and fish in estuarine environments as a senior researcher at U.C. Davis’ Center for Watershed Sciences. He currently has several funded studies in the California Estuary, with projects including the ecological function of restored and managed wetland habitats, fish community composition across marginal habitats, and the effects of drought on the Delta.



### MARIAH H. MEEK

Mariah H. Meek is an assistant professor at Michigan State University, where her lab uses genetic studies to better understand how to conserve and manage aquatic species. She got her Ph.D. at U.C. Davis where she spent much of her time on Suisun Marsh, catching jellies, and counting fish.



### PETER B. MOYLE

Peter B. Moyle is Distinguished Professor Emeritus at U.C. Davis. He is a fish biologist and started the long-term research program on Suisun Marsh fishes and invertebrates in 1979.

