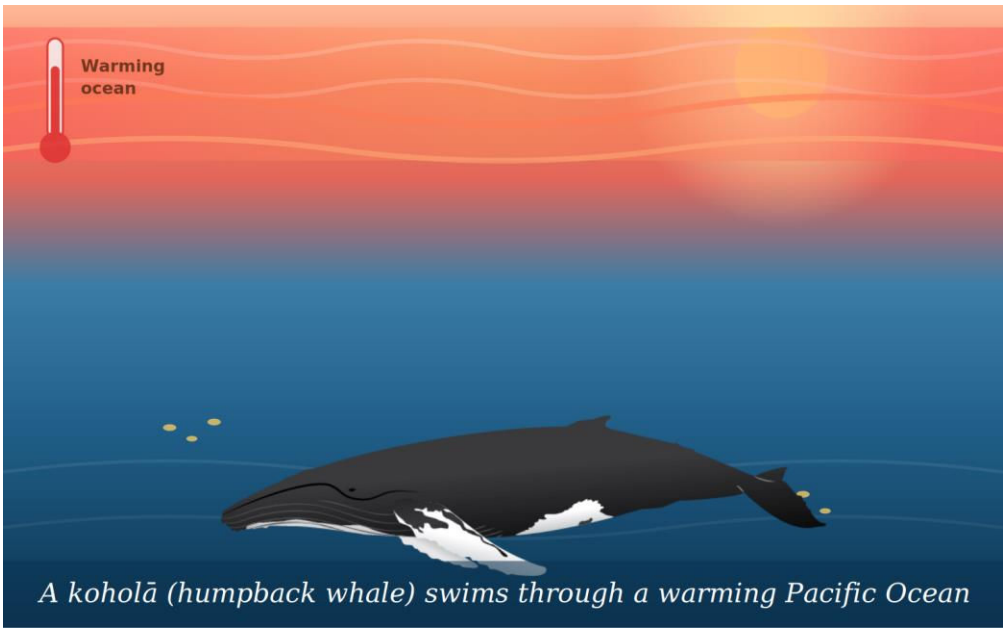
Why Did Hawai‘i's Humpback Whales Stop Growing?

For decades, humpback whales that visit Hawai‘i bounced back from near disaster, growing in number year after year. Then, between 2013 and 2016, a giant patch of unusually warm water spread across the North Pacific Ocean. Scientists wanted to know what this “marine heatwave” did to the whales. Using twenty-one years of tail photos taken by researchers and everyday ocean-goers, we tracked how many whales survived each year and how many were using Hawai‘i's waters. We found that whale survival crashed during the heatwave, and the population dropped by more than a third in the years that followed. It has not fully bounced back. This matters because even a conservation success story can be knocked backward by a warming ocean, and it shows why we still need to keep watching these whales closely.



Marine heatwaves warm the ocean surface where whales feed and migrate, the change at the center of this study.

What Are Koholā, and Why Do They Come to Hawai‘i?

Every winter, thousands of humpback whales swim from cold feeding grounds near Alaska all the way to the warm, calm waters around the Hawaiian Islands. In Hawaiian, they are called koholā.

They come to **breeding grounds**, the warm shallow areas where they mate, give birth, and raise their new calves before the long swim back north.

Humpback whales almost disappeared because of commercial whaling last century. Hunting knocked that number down to as few as 1,200 to 1,600 whales. After whaling stopped in the 1970s, the population grew back, and it was one of the great comeback stories in ocean conservation. In 2016, the Hawai‘i group of whales, called a **distinct population segment (DPS)**, was even removed from the U.S. Endangered Species List because it had recovered so well.

What Happened to the Ocean Between 2013 and 2016?

Recovery does not mean a species is safe forever. From late 2013 through 2016, an enormous **marine heatwave** hit the northeastern Pacific Ocean. Water temperatures stayed abnormally warm for years, and in some places the warmth lingered in deeper water even after the surface cooled back down.

This mattered enormously for whales, because the heatwave disrupted the ocean food web in exactly the areas where humpback whales go to feed. Fish and tiny shrimp-like animals called krill, the food whales depend on to build up fat for their long migration, became much less available. Scientists in Alaska reported thinner whales, fewer calves, and even a spike in whale deaths during this period [1]. But nobody had measured, in one careful study spanning the whole time before, during, and after the heatwave, exactly how much this event affected the Hawai‘i whale population. That is the mystery we set out to solve.

How Do You Count Whales You Can Never Hold Still?

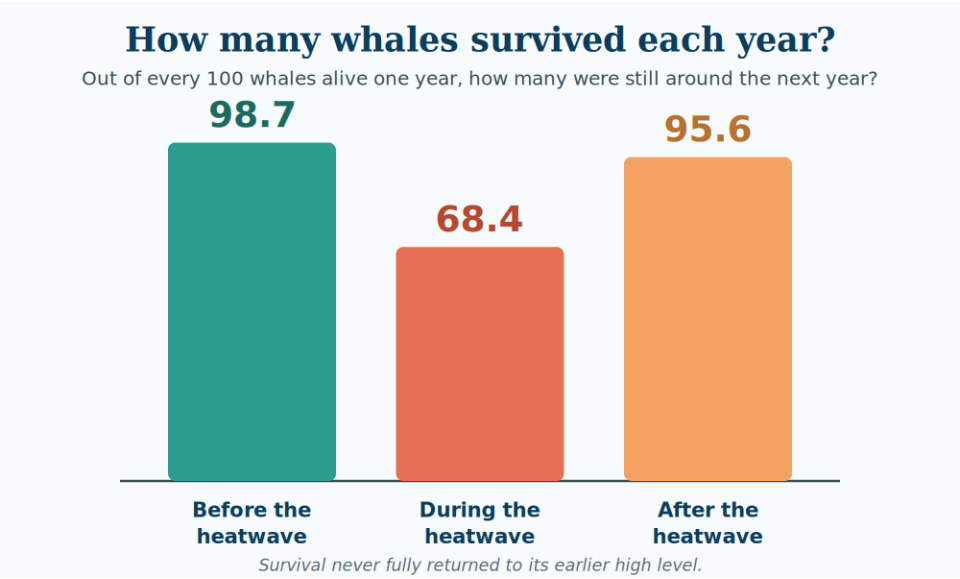
To figure out how many whales were surviving and returning to Hawai‘i each year, scientists cannot just line them up and count. Instead, they rely on **photo-identification**: every humpback whale has a uniquely shaped and patterned tail, called a **fluke**, as individual as a fingerprint.

Collecting the photos. Researchers on boats, and everyday whale watchers on tour boats and private vessels, photographed the undersides of whale tails whenever a whale dove and showed its fluke. Over 21 years, more than 37,000 of these photos were collected and uploaded to a website called **Happywhale**, which uses computer image-matching to recognize the same individual whale in different photos, even years apart.

Turning photos into numbers. By tracking which whales showed up in which years, scientists used a statistical method called **capture-recapture** to estimate, each year, roughly how many whales were alive and using Hawai‘i's waters, and what fraction of them survived from one year to the next. Newborn calves were left out of the count because their tails do not yet have enough unique markings to track reliably. In total, the team identified 10,371 individual whales, not counting calves, making this the largest and most complete study of its kind ever done for Hawai‘i's whales.

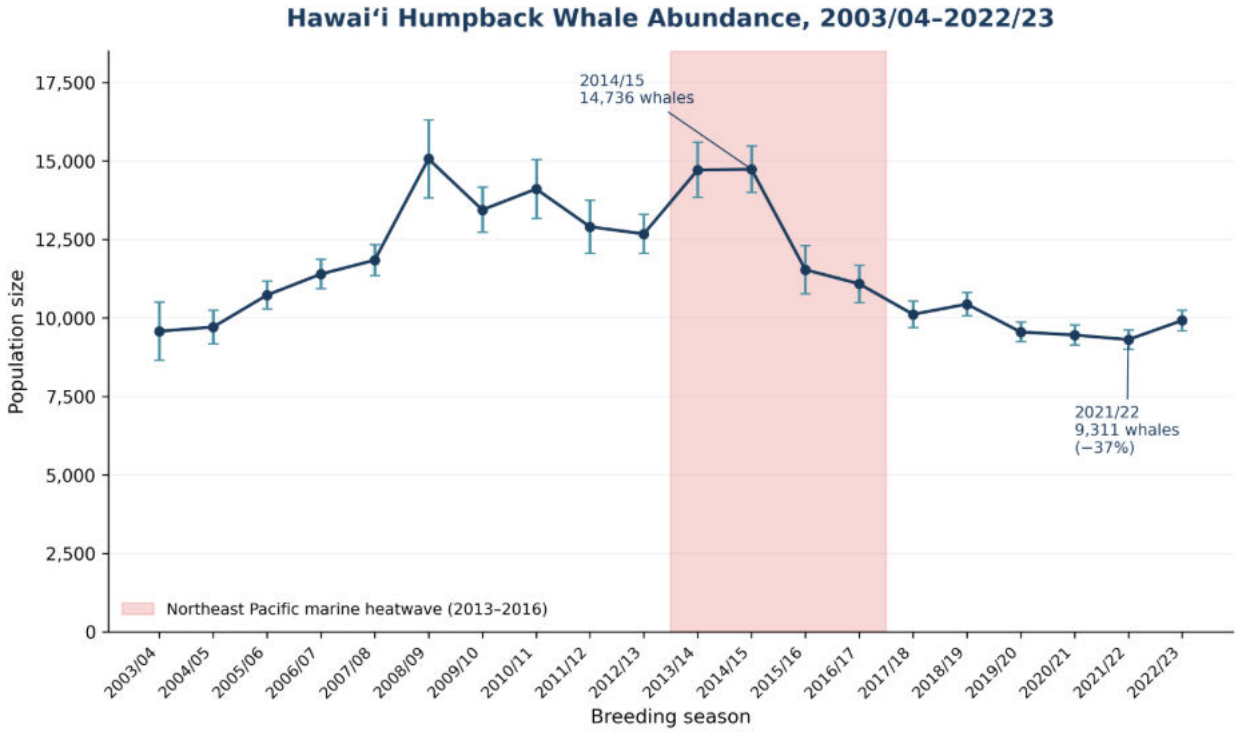
A Sudden Crash, Then a Slow, Incomplete Recovery

Before the marine heatwave, whale **survival** was remarkably high: about 98.7 out of every 100 whales survived from one year to the next, a number typical for a long-lived animal with few natural threats. Then, in the single year spanning the heart of the heatwave, survival plunged to just 68.4 out of 100. That means roughly one in three whales that had been alive the year before did not show up again, whether because they died or left the region entirely.



Survival dropped sharply during the heatwave and only partly recovered afterward.

Survival partly recovered after the heatwave ended, climbing back to about 95.6 out of 100, but it never returned to the sky-high levels seen before. The number of whales using Hawai‘i, called their **abundance**, followed a similar pattern: after growing for years and peaking at roughly 15,000 whales around 2008 to 2009, the population fell by 37% between 2014/15 and 2021/22. The single steepest one-year drop, a 21.7% decline, happened in the very interval the heatwave hit hardest.



The whale population peaked, then fell sharply during and after the heatwave.

Why a "Stable" 20-Year Average Hides a Dramatic Story

If you only compared the whale count at the very start of the study to the count at the very end, you might conclude nothing had changed. Averaged across all 20 breeding seasons, the population's growth rate was almost perfectly flat, meaning the DPS neither grew nor shrank overall.

But that average erases the real story. Whales grew by about 9% a year in the early 2000s, a healthy, thriving trajectory. Then the heatwave hit, and the population entered a decline that lasted years. Only in the final few seasons of the study did numbers start to stabilize, with a hint of slight growth. A species can look "fine" in a 20-year snapshot while having actually gone through a severe, multi-year crash and only partly climbed back out of it. This is why long-term, continuous monitoring matters so much: a single before-and-after comparison would have completely missed what really happened to Hawai‘i's whales.

What If Warming Oceans Like This Become More Common?

Climate scientists expect marine heatwaves to become more frequent, more intense, and longer-lasting as the planet continues to warm [2]. If Hawai‘i's humpback whales have not fully recovered from one heatwave by the time the next one arrives, each successive event could push the population lower, without enough time in between to bounce back.

That is a serious concern for a species that reproduces slowly. Whales do not have large numbers of babies the way fish or insects do. A mother humpback typically has one calf every few years, so a population that loses a big chunk of its members in one bad year may need a decade or more to rebuild, if conditions even allow it to.

What You Can Do for Hawai‘i's Whales

This whole study was only possible because thousands of ordinary people, whale watchers, tour boat crews, and researchers, all photographed whale tails and uploaded them to the same shared database. If you are ever lucky enough to see a humpback whale breach or dive in Hawai‘i or anywhere else in the world, take a clear photo of its tail flukes and share it with Pacific Whale Foundation here. Your single photo could help scientists track that whale's survival, its travels, and its story for years to come, and could add one more data point to the ongoing effort to understand how these remarkable animals are weathering a changing ocean.

Glossary

KOHOLĀ: The Hawaiian word for humpback whale.

BREEDING GROUNDS: The warm, shallow ocean areas where humpback whales mate, give birth, and raise young calves.

DISTINCT POPULATION SEGMENT (DPS): A group of animals from the same species that is managed separately because it uses a specific area, like the humpback whales that breed in Hawai‘i.

MARINE HEATWAVE: A period of unusually warm ocean temperatures that can last months or years and disrupt the food web.

FLUKE: The tail of a whale; each humpback whale's fluke has a unique shape and pattern, like a fingerprint.

PHOTO-IDENTIFICATION: A research method that identifies individual animals by photographing unique natural markings, such as a whale's fluke.

HAPPYWHALE: An online platform where researchers and the public upload whale photos, which computer software matches to recognize individual whales over time.

CAPTURE-RECAPTURE: A statistical method scientists use to estimate how many animals are in a population and how many survive over time, based on repeatedly spotting the same marked individuals.

ABUNDANCE: The estimated number of animals, such as whales, present in an area at a given time.

SURVIVAL: The proportion of animals alive in one year that are still alive the following year.

References

[1] Gabriele, C. M., Amundson, C. L., Neilson, J. L., et al. 2022. “Sharp Decline in Humpback Whale Survival and Reproductive Success in Southeastern Alaska During and After the 2014-2016 Northeast Pacific Marine Heatwave.” Mammalian Biology 102(4):1113-1131.

[2] Cheeseman, T., Barlow, J., Acebes, J. M., et al. 2024. “Bellwethers of Change: Population Modelling of North Pacific Humpback Whales From 2002 Through 2021 Reveals Shift From Recovery to Climate Response.” Royal Society Open Science 11(2):231462.

This material was prepared with assistance from AI tools and reviewed by staff for accuracy and alignment with our mission.