

Shifting Habitat Conditions at the Salton Sea Create New Opportunities for Conservation:

SURPRISING INCREASE IN WETLANDS
PROVIDES HABITAT FOR SHOREBIRDS

June 2025



Western Sandpiper walks along the Salton Sea shoreline.
Photo: Alecia Smith/Audubon

Report at a Glance

This report highlights findings from seven years of bird surveys and habitat assessments from 2016 to 2023 at the Salton Sea—California's largest and most imperiled lake—and reveals how bird populations and their habitats are responding to rapid environmental change. While deep-water habitats and fish-eating birds face sharp declines, shorebirds are thriving, relying on the Sea's expanding wetlands and shallow-water habitats.

Our findings reveal that the Sea remains a refuge amid widespread bird declines across North America. We provide targeted recommendations—including prioritizing shorebird conservation, stabilizing critical wetlands, advancing biofilm research, understanding water needs, and diversifying habitat types—to secure the Sea's future as an essential oasis for migratory birds in the West.

ADDITIONAL RESOURCES

For more information, please visit the Salton Sea projects [webpage](#) or scan the QR Code:

Surveyors on the playa near Bombay Beach Wetlands during the Intermountain West Shorebird Survey. Photo: Sydney Walsh/Audubon



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Foreword

As human populations grow and prolonged droughts impact water availability, lakes and wetlands have disappeared globally and throughout the Western United States. California alone has lost an estimated 90% of its wetlands over the past two centuries. Millions of migratory birds along the Pacific and Central flyways rely on the persistence of open water and wetland habitats for breeding, stopover and wintering sites. However, development, water availability, and climate change threaten many of the remaining habitats. The Salton Sea (Sea) is among the most critical remaining saline lake ecosystems for birds along the Pacific Flyway. It provides essential habitats for migratory birds, including species with life histories closely tied to saline lakes and species that may travel from as far as Alaska's Northern Slope to as far south as Central America. However, the Sea is shrinking, driving changes in the availability of habitat and food resources that likely impact migratory and resident bird populations.

The Salton Sea, located in the Imperial Valley, is part of the Colorado River Basin, which encompasses 240,000 square miles in the Interior West. The Colorado River and its tributaries have been developed over a century with infrastructure including reservoirs and irrigation projects that today support more than 40 million people. The Colorado River and its tributaries also support 400 species of birds. As California's largest lake, the Salton Sea hosts over 300 bird species and millions of migratory birds annually, making it one of the most ecologically productive wetlands in the interior West (Barnum and Johnson 2004, Shuford 2014).

Historically, Colorado River floods periodically filled and evaporated from the Imperial Valley, most recently when an irrigation canal broke in 1906. Since then, the modern-day Salton Sea has been replenished only by agricultural runoff from Imperial Valley farms, and 21st century changes in those farms' water use have caused it to shrink rapidly. Inflows from Imperial Valley agricultural runoff began to be reduced following the 2003 Quantification Settlement Agreement (QSA), which transferred Colorado River water from use in the Imperial Valley to use in the Southern California urban coastal region. While mitigation flows were required through 2016, they ceased in 2017, accelerating the Sea's decline (Bradley et al. 2022). Since 2003, over 15,000 hectares of lakebed (playa) have been exposed, increasing airborne dust pollution, and reducing critical wetland habitat (U.S. Bureau of Reclamation 2020).

As the Sea continues to recede, salinity has increased to more than double the ocean's salinity, pushing tilapia, which are the primary fish species that support fish-eating birds, towards collapse (U.S. Bureau of Reclamation 2020; Bradley et al 2022; Jones et al. 2019). Macroinvertebrate populations, a key food source for migratory birds, have also shifted (Jones et. al 2019). The receding Sea has also led to the loss of nesting islands like Mullet Island, once home to 75% of the inland nesting Double-crested Cormorants (Shuford et al. 2020). These habitat and food web changes underscore the need for strategic conservation efforts.



Great Egret glides overhead at the Salton Sea.
Photo: Lindsay Rowe/Audubon

The California Natural Resources Agency initiated the Salton Sea Management Program (SSMP) 10-year Plan in 2018, committing to habitat restoration and dust mitigation on 29,800 acres of playa (California Department of Water Resources et al. 2018). As the State of California's SSMP habitat restoration and vegetation enhancement projects are designed and implemented, it is critical to address the shifting and emerging habitats and understand how bird populations are responding to these dynamic changes. While past studies have examined historical bird populations (Hurlbert et al. 2007, Shuford et al. 2002) and quantified habitats (Jones et al. 2016), no recent comprehensive assessment has been done.

Overview

As migratory birds confront widespread habitat loss—both globally and along the Pacific Flyway—the Salton Sea presents a critical opportunity to establish sustainable habitats that support bird populations now and into the future.

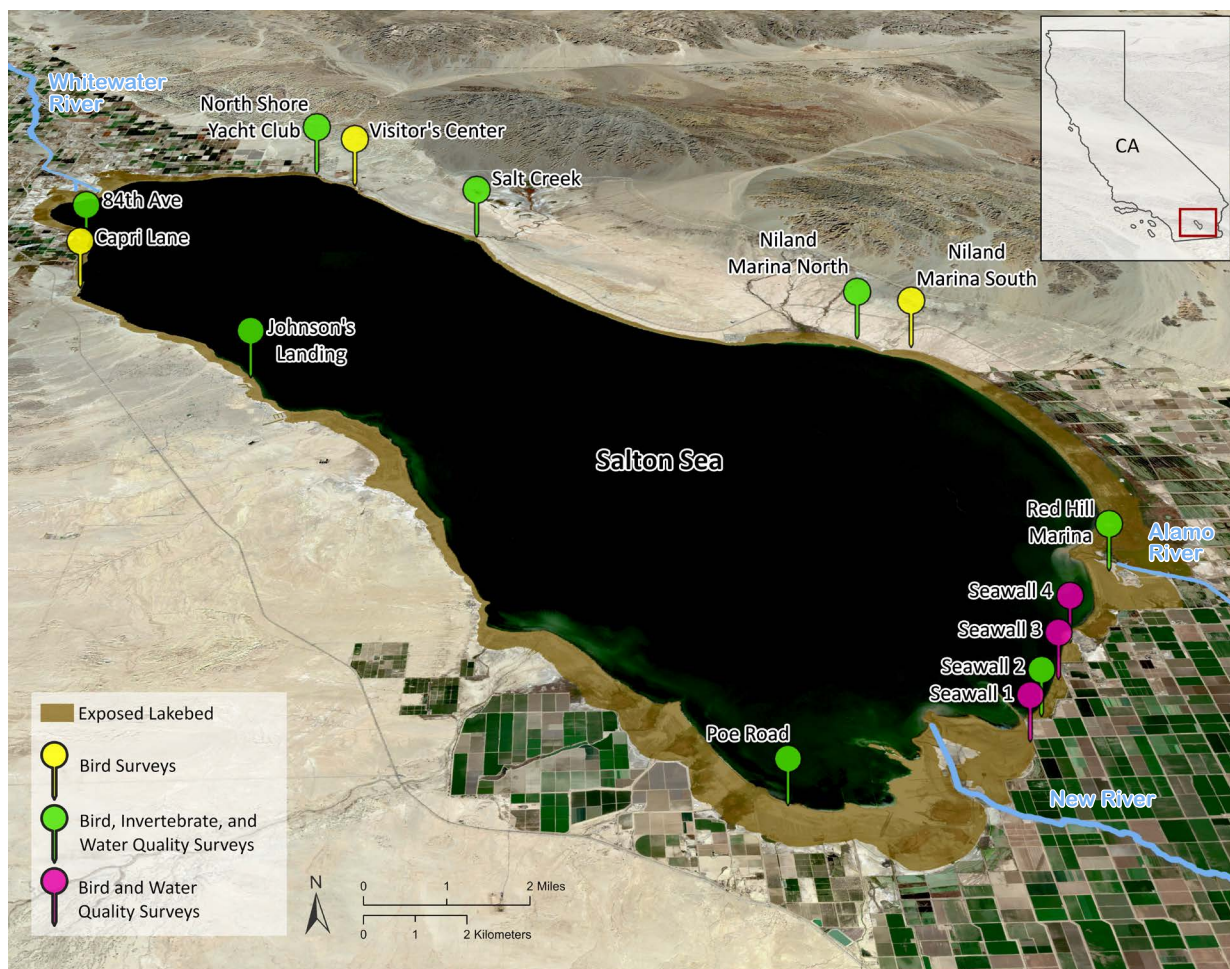
Shorebirds in particular, are among the most imperiled bird groups in North America (2025 State of the Birds Report), making the Sea's expanding wetlands especially significant. With the State's commitment to habitat restoration and dust suppression, there is a chance to create a resilient refuge where birds and other wildlife can thrive, even in the face of climate change and water reductions.

This report synthesizes seven years of National Audubon Society surveys, sampling, and analyses to evaluate current bird population trends and habitat conditions at the Salton Sea. Our findings offer insight into how bird populations are responding to dynamic habitat changes and will inform the State of California and its partners as they develop conservation and management strategies to protect birds and habitats at the Salton Sea into the future.

AUDUBON'S RESEARCH OBJECTIVES

1. Quantify key habitat types at the Salton Sea and their use by birds to evaluate habitat changes through time.
2. Monitor emerging wetlands on exposed lakebed (playa) using high-resolution imagery.
3. Assess habitat conditions and food availability through monitoring water quality and sampling macroinvertebrate populations.
4. Assess long-term waterbird population trends at the Salton Sea from 2016 to 2023 using representative species for dabbling ducks, diving ducks, fish-eating birds, shorebirds, and other saline lake-dependent species.
5. Link bird and habitat trends to gain a comprehensive understanding of how the Sea is changing at an ecosystem-wide scale.

FIGURE 1. Salton Sea bird, water, and invertebrate sampling sites overlaid on exposed playa from shoreline recession between 2003 and 2022.





Black-necked Stilts along the Salton Sea shoreline.
Photo: Ryan Llamas

Bird Habitat Trends

BACKGROUND

Quantifying bird habitat around the Salton Sea is critical to understanding if and how habitats shift over time as water allocations decline and the Sea recedes. The Sea supports a range of habitats for birds, including playa, mudflats, shallow to deep water, and vegetated wetlands, and these habitats are shifting in location and extent. As the Sea recedes, thousands of acres of playa are exposed each year. Runoff from streams, desert washes, and agricultural canals pool on exposed playa, creating new wetlands that provide critical habitat for migratory birds and other wildlife.

Increasing salinity levels have significantly changed the abundance and diversity of invertebrate and fish species in the Sea, impacting the integrity of the food web. As a result, fish-eating birds that rely on deep-water habitats have sharply declined. However, some waterbirds have been able to exploit other readily available

food resources. Water boatmen (Corixidae) have remained abundant in saline conditions and may serve as a dominant food resource for some bird species. Additionally, some shorebirds, such as Least and Western sandpipers, have adapted to these changes by feeding on biofilm, a mucus-covered slurry of microorganisms that are rich in lipids and carbohydrates that forms when freshwater from irrigation drains mixes with saline water in mudflat areas (Elner et al. 2005; Kuwae et al. 2008; Walters et al. 2024). Given these ecological changes, it is essential to assess habitat changes, conditions, and food availability as the State works to manage, create, and protect bird habitats. Here, we quantify changes in key habitat types, track the expansion of emerging wetlands using high-resolution imagery, evaluate changes in dissolved oxygen, and sample macroinvertebrate populations around the Salton Sea.

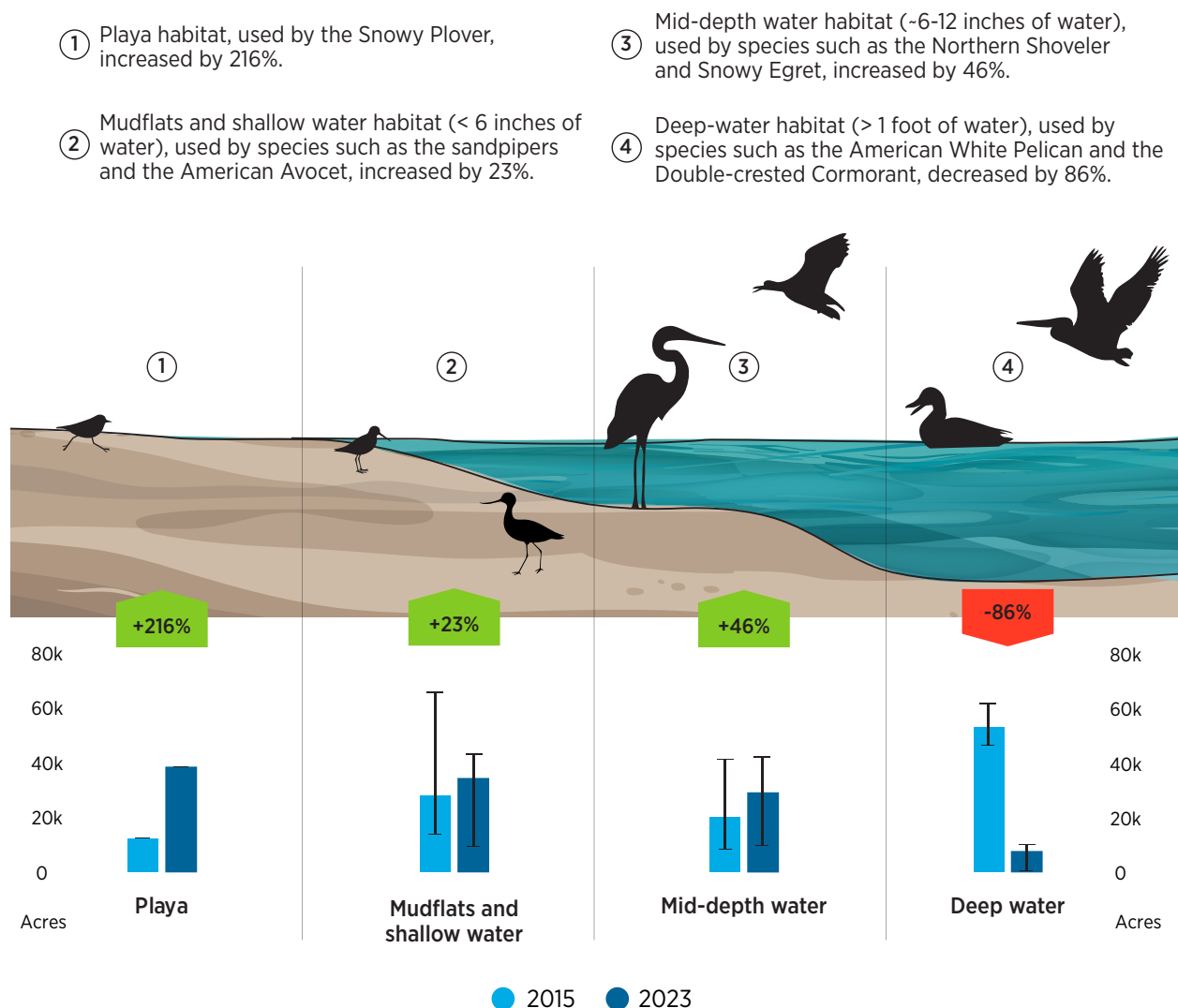
KEY FINDINGS

Shallow Water Habitats Increasing as Deepwater Declines

We identified four key habitats at the Sea and representative species for each habitat, and used statistical modeling to estimate changes in the different environmental variables that create preferred habitat for each species over time. We compared the estimated acres of each preferred bird habitat type

in 2023 to the estimates from 2015 (derived from Jones et al. 2016; Figure 2). Although vegetated wetlands are also a key habitat at the Sea, we assessed this habitat type using remote sensing techniques (Figure 4), rather than statistical modeling.

FIGURE 2. Change in acres of preferred bird habitat at the Salton Sea since 2015.



Desert Washes and Irrigation Flows Drive Rapid Wetland Growth

We used high-resolution satellite imagery to quantify emerging vegetated wetland habitats around the Salton Sea created by water from irrigation and other runoff onto exposed playa (Figures 3 and 4). There was a 23% increase in total vegetated wetlands, including plant and algal vegetation, around the Sea between 2019 and 2022 (Figure 3).

FIGURE 3. Total acres of emerging wetland vegetation, including algal mats, on exposed lakebed (playa) in 2019, 2020 and 2022.

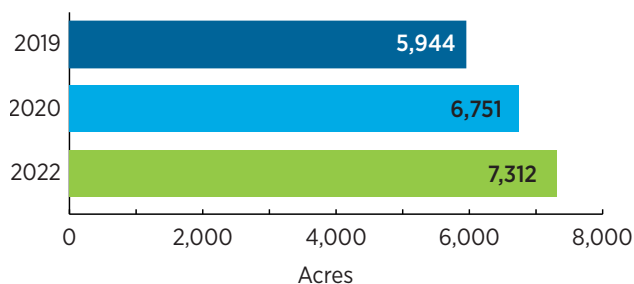
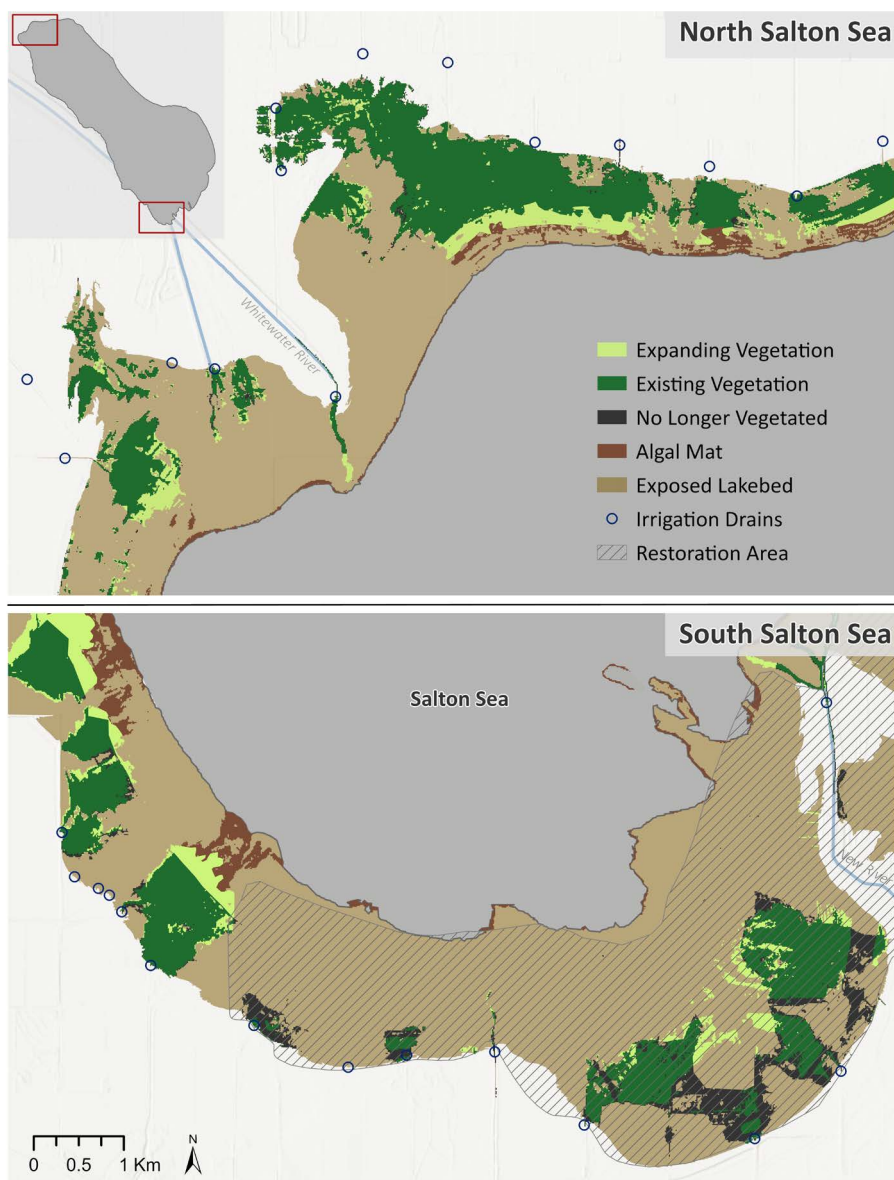


FIGURE 4. Vegetated wetlands in northern and southern Salton Sea that persisted (green), expanded (lime green), and were lost (black) between 2020 and 2022.



Questions Remain About Water Quality and Food Resources

We monitored dissolved oxygen at bird monitoring sites (Figure 1) and sampled macroinvertebrates at a subset of sites over two years to better understand physical conditions and food availability at monitoring sites.



Macroinvertebrate diversity was extremely low, with 97.5% of specimens identified as *Trichocorixa reticulata*.



Dissolved oxygen levels declined between 2020 and 2021.



Analyses suggest a preference for low-oxygen areas coinciding with areas where food resources such as biofilm are abundant.

Poor aquatic health and unstable food sources highlight the need to improve both habitat quantity and quality.

Bombay Beach Wetlands.
Photo: Mike Fernandez/Audubon

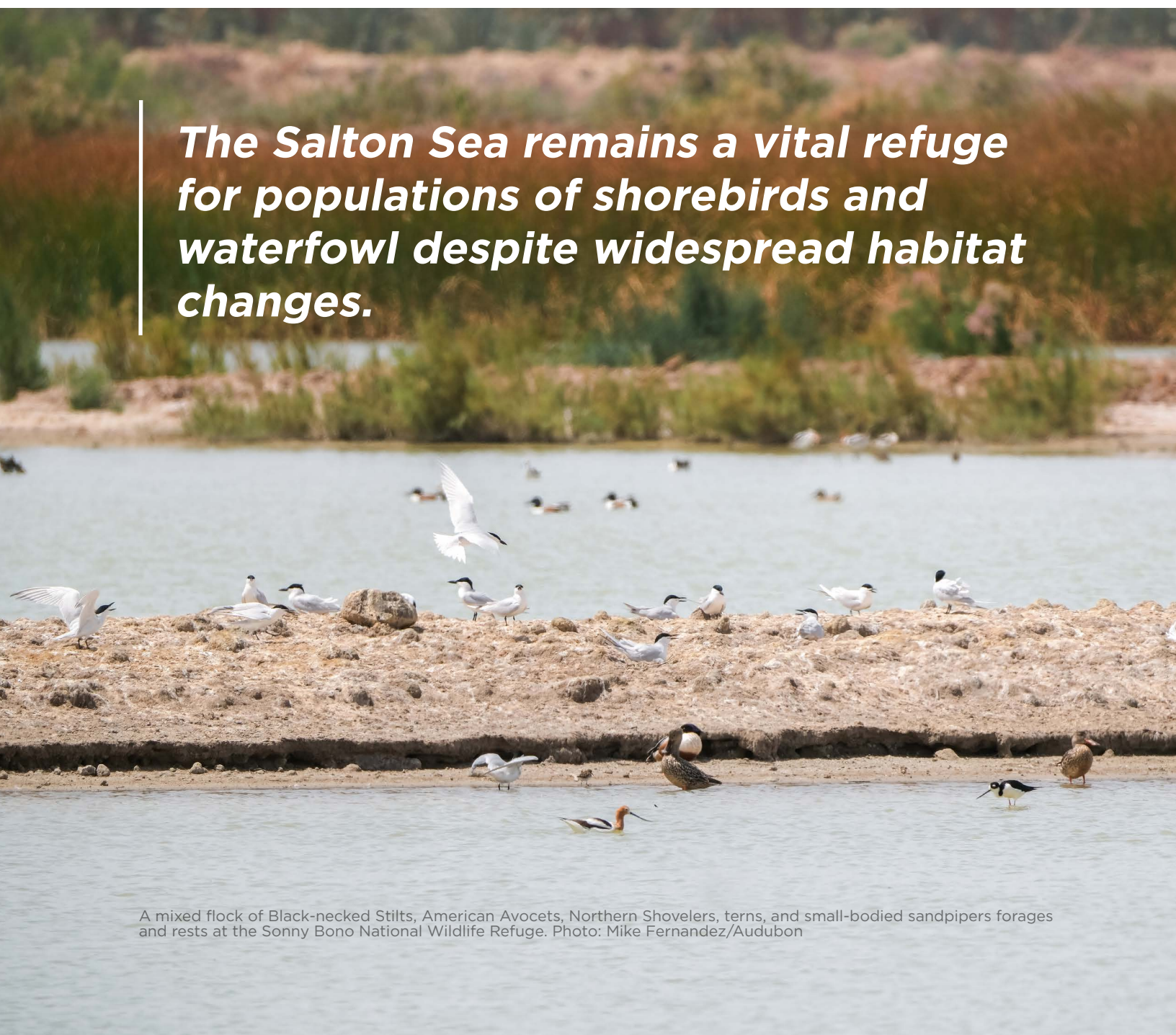
Bird Population Trends

BACKGROUND

Across the Salton Sea, decreases and changes in food resources and habitat availability could have negative or positive impacts on different waterbird species. To understand and document how waterbird populations are changing, Audubon conducted waterbird point

surveys at 14 sites from 2016 to 2023 ([Figure 1](#)). We used these survey data to model population trends for 9 waterbird species across all years ([Figure 5](#)). We also analyzed total waterbird counts to assess broader trends in waterbird abundance.

The Salton Sea remains a vital refuge for populations of shorebirds and waterfowl despite widespread habitat changes.



A mixed flock of Black-necked Stilts, American Avocets, Northern Shovelers, terns, and small-bodied sandpipers forages and rests at the Sonny Bono National Wildlife Refuge. Photo: Mike Fernandez/Audubon

KEY FINDINGS

Some Shorebirds, Waterfowl Increase; Fish-Eating birds in Decline

From 2016 to 2023, waterbird populations at the Salton Sea had an overall increasing trend, primarily driven by shorebirds, dabbling ducks, and grebes. However, deep-water-dependent species showed decreasing population trends.

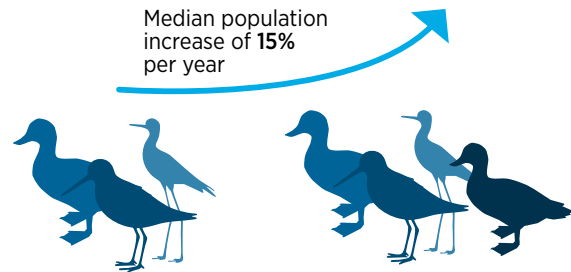
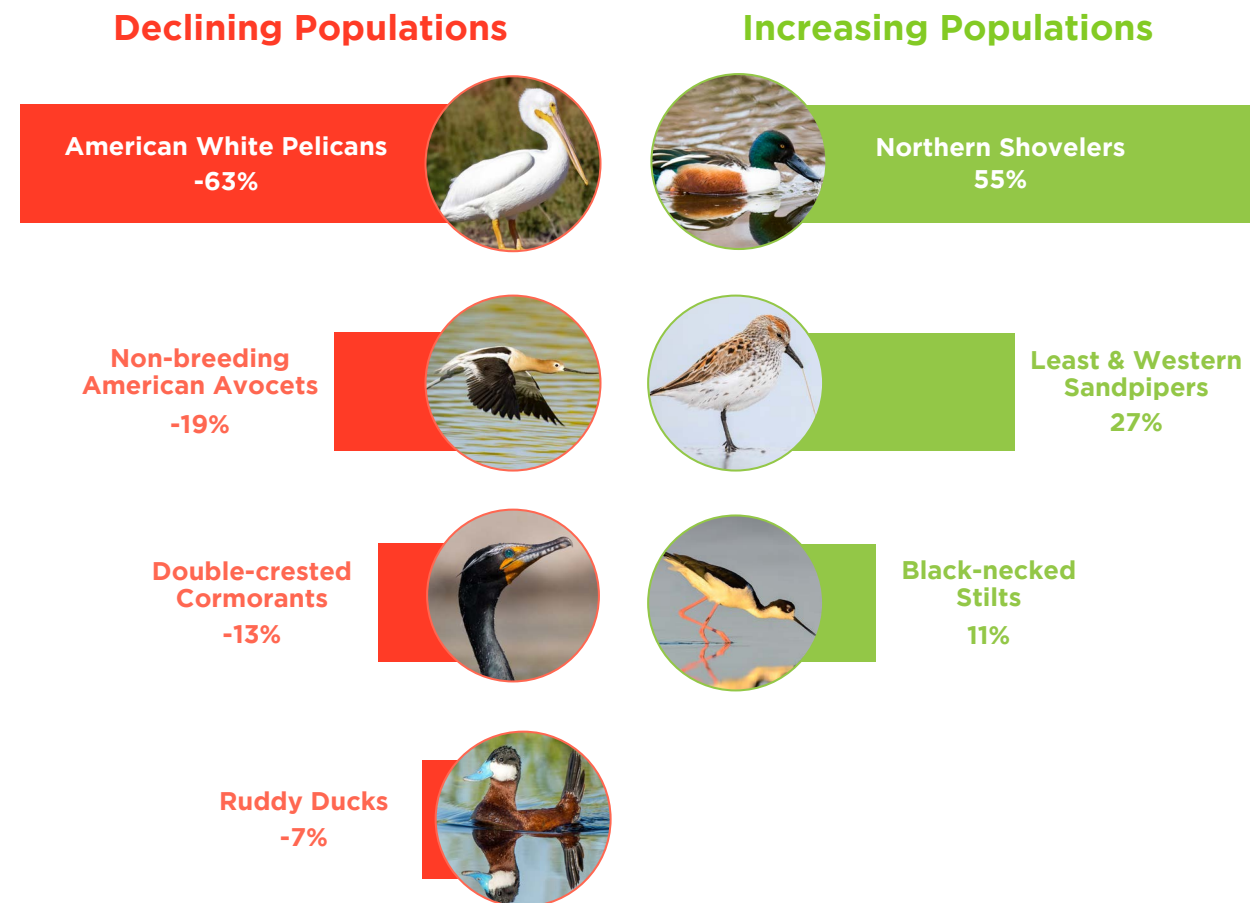


FIGURE 5. Salton Sea waterbird population trends derived from survey data between 2016 and 2023.



Shorebirds are thriving, relying on the Sea's expanding wetlands and shallow-water habitats.

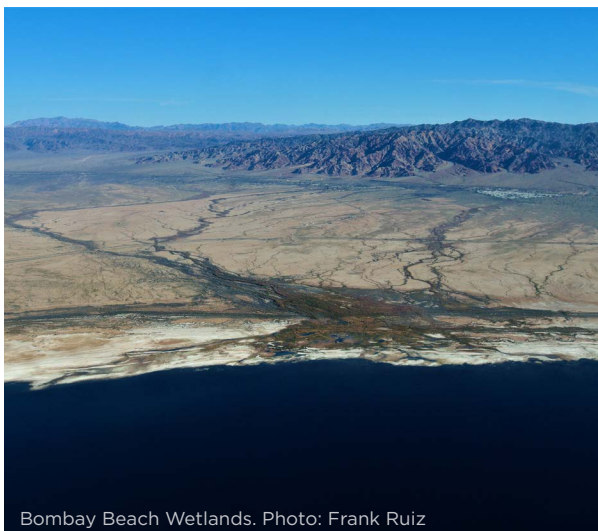


Snowy Plover stands at the Salton Sea shoreline.
Photo: Alecia Smith/Audubon

Recommendations

Our data show that the Salton Sea remains a vital refuge for populations of shorebirds and waterfowl despite widespread habitat changes. As migratory birds face habitat loss globally, and along the Pacific Flyway, the Sea presents a unique opportunity to sustain bird habitats through effective wildlife and resources management. With the State's commitment to habitat restoration and dust suppression, there

is potential to create a stable oasis of habitats for birds and wildlife into the future. Our study finds that shorebird populations are increasing at the Sea, underscoring the importance of prioritizing their conservation, especially given their low water requirements. We provide key recommendations to guide effective management and mitigate the impacts of future water reductions.



Bombay Beach Wetlands. Photo: Frank Ruiz

UNDERSTAND WATER NEEDS

Develop research on water requirements needed to sustain the five key habitat types into the future and create adaptive management strategies to ensure their persistence. Assess potential impacts from climate change and water allocation changes under different management scenarios to understand potential impacts from water availability, policy and/or management changes.



CONSERVE EMERGING WETLANDS

Protect, manage and/or enhance, and stabilize a mosaic of emerging wetland areas that support shorebird, marsh bird, wading bird and songbird populations, including threatened and endangered species, provide dust suppression benefits, and can enhance opportunities for outdoor recreation. Optimize the use of available water to sustain emerging wetland habitats and improve water quality in these areas.



DIVERSIFY HABITAT TYPES

Incorporate a mix of shallow, mid-depth, deep-water, and vegetated wetland habitats into existing or new restoration projects. Establish a target acreage number for each habitat type to inform future restoration projects. A future Salton Sea must include reliable habitats for a diverse group of resident and migratory birds that depend on a variety of habitats. While these habitats continue to disappear across the West and globally, we have an opportunity to secure vital habitats for waterbirds and other wildlife.



CONTINUE TO UTILIZE VEGETATION ENHANCEMENT IN DUST SUPPRESSION

Dust suppression through wildlife-friendly native vegetation enhancement can create habitat for birds and other wildlife while also suppressing dust emissions. This has been successfully carried out on the western portion of the Salton Sea playa and should continue where it is appropriate. State investments should seek multiple benefits when possible.



Western Sandpipers. Photo: Mike Fernandez/Audubon

EXPAND BIOFILM AND FOOD WEB RESEARCH EFFORTS

Expand research to better understand if and how shorebirds use biofilm as a resource as well as its spatial distribution at the Sea; implement studies on food web dynamics to better understand what resources birds are depending on and how changes in water quality and quantity may impact birds and other wildlife.

PRIORITIZE SHOREBIRDS

Despite declining shorebird trends throughout North America, the Salton Sea remains a stronghold, with expanding wetlands and increasing shorebird populations, including sandpipers, Black-necked Stilts, and American Avocets. Unlike deep-water species, shorebirds rely on shallow wetlands, mudflats, and shoreline habitats that require significantly less water, making them a strategic conservation focus as water allocations to the Sea continue to decline. By stabilizing these priority habitats, advancing research on food resources like biofilm, and implementing stronger conservation measures, the State can ensure the Salton Sea remains a vital refuge for both breeding and migratory shorebirds well into the future.



Least Sandpiper. Photo: Ryan Llamas

IMPLEMENT EARLY INTERVENTION WITH RESTORATION

Implement habitat restoration projects before major water reductions occur to prevent further bird population declines. Prioritize restoration projects with co-benefits of creating and sustaining habitat, controlling dust, and providing public access, along with efficient use of water.



Tamarisk thicket near Poe Road, Salton Sea. Photo: Hans Baumann



LEAN ON THE SALTON SEA SCIENCE COMMITTEE

Engage the Salton Sea Management Program's Science Committee, share State plans and identified science needs with the committee, and obtain feedback and advice on gaps and future science that is needed. Leverage science committee expertise and networks to seek out collaborations and partnerships with academic and other scientists conducting studies at and around the Salton Sea.



SEEK PUBLIC INPUT EARLY AND OFTEN

Building local public support and investment is essential for conservation and land protection. Projects at the Salton Sea cannot be implemented in isolation. Early, transparent engagement with local communities builds trust and long-term support. From the initial planning stages, agencies should engage the public, addressing concerns, answering questions, and incorporating feedback where feasible. Meaningful participation strengthens community investment in project outcomes, including the long-term management needed for the Sea.



MAKE PUBLIC ACCESS A PRIORITY

Ensuring public access fosters community investment and long-term land stewardship. Restoration projects should incorporate passive recreation, education, and cultural engagement opportunities, particularly for underserved communities. This includes accessible entry points, multi-lingual interpretive programs, and nature-based activities to help the public connect with and support the Sea's restoration. A stronger community connection will help sustain the State's efforts into the future.



Killdeer walking along Salton Sea shoreline.
Photo: Ryan Llamas

Conclusion

The Salton Sea presents an opportunity to establish sustained and reliable habitats for birds in the desert. As wetlands and saline lakes decline due to development, land use, and climate change, this habitat is increasingly essential for millions of migratory birds. Shorebirds are experiencing some of the steepest population declines in North America, so protecting their habitat at the Sea is more urgent than ever. Expanding wetlands and increasing shorebird trends at the Sea underscore the Sea's potential to serve as a critical refuge for these imperiled species.

How this ecosystem is managed will determine whether these vital habitats within the Pacific Flyway are lost or transformed into a sustainable oasis for migratory birds in the West. With effective management, the Salton Sea could serve as a global model for sustaining other threatened saline lake systems. As the State of California implements the Salton Sea Management Plan, there is a critical opportunity to build a resilient mosaic of habitats that support wildlife and benefit surrounding communities.

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critical in advancing our understanding of how habitats and bird populations are changing at the Salton Sea.

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ADDITIONAL PHOTO CAPTIONS FROM PAGE 12

Pictured left (declining populations), top to bottom:

- American White Pelican, Mick Thompson
- American Avocet, Mick Thompson
- Double-crested Cormorant, Ben Knoot/Audubon Photography Awards
- Ruddy Duck, Joseph Mahoney/Audubon Photography Awards

Pictured right (increasing populations), top to bottom:

- Northern Shoveler, Gerald Lisi/Audubon Photography Awards
- Western Sandpiper, Ronan Donovan/Audubon Photography Awards
- Black-necked Stilt, William Dix/Audubon Photography Awards

CONTACT

Dan Orr

Director, Geospatial Science
Audubon California
daniel.orr@audubon.org

Keilani Bonis-Ericksen

Manager, Geospatial Science
Audubon California
keilani.bonisericksen@audubon.org

Camila Bautista

Manager, Salton Sea and Deserts Program
Audubon California
camila.bautista@audubon.org

Andrea Jones

Senior Director, Conservation
Audubon California
andrea.jones@audubon.org

OFFICE

Audubon California Oakland Headquarters
1901 Harrison St #1450
Oakland, CA 94612
ca.audubon.org
(415) 644-4600



Drone captures Bombay Beach wetlands during the Intermountain West Shorebird Survey. Photo: Sydney Walsh/Audubon