

Coordinated phalarope surveys at western North American staging sites, 2019–2023



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Cover photo: Wilson's Phalaropes at Mono Lake, by David Carle

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Summary: Wilson’s and red-necked phalaropes (*Phalaropus tricolor* and *P. lobatus*, respectively) breed in mid- to northerly latitudes of North America and make a migratory staging stop at saline lakes in western North America. At saline lake staging sites, Wilson’s phalaropes double their fat reserves and molt before migrating to South America. At the same sites, red-necked phalaropes stop for an unknown amount of time to feed and continue their southward migration. Saline lake habitat is threatened worldwide by water diversion and climate change, and there is a need to better understand the population trends, habitat use of phalaropes, and responses of phalaropes to rapid habitat changes. We conducted coordinated monitoring of western North American staging areas of importance to phalaropes: Great Salt Lake, Mono Lake, Lake Abert, Owens Lake, south San Francisco Bay, and Chaplin Lake. We conducted surveys at each site during week-long “survey windows,” from mid-July to mid-September, 2019–2023, with the goal of at least one survey per site per window. Methods were standardized within sites but varied across sites, and included surveys from plane, boat, and land. We report results from Great Salt Lake, Mono Lake, and Lake Abert in 2019 and for all six surveyed sites in 2020–2023. When reporting peak annual totals, we report totals of unidentified phalaropes combined with the species-specific totals counted for the same window to help interpret and account for large variations in unidentified phalaropes on some surveys. The exceptionally wet winter of 2022–2023 resulted in increased water levels at Great Salt Lake, Lake Abert, Mono Lake, and Owens Lake. There were increases of >20,000 phalaropes in overall phalarope numbers at Lake Abert and Owens Lake in 2023 compared to recent years. At Mono Lake, the Wilson’s/unidentified phalarope 2023 high count (6,252) was half as large as in 2022, but the red-necked/unidentified phalarope high count (33,157) was much higher than 2019–2022 totals. Great Salt Lake had an all-phalarope high count of 385,050 on August, 14, 2023, the highest of any survey 2019–2023. Seventy-six percent of that count was unidentified phalaropes, complicating interpretation of species-specific interpretation of regional trends. For analyses, we assigned those unidentified birds as Wilson’s phalaropes, because the peak of identified Wilson’s phalaropes occurred in the same survey window. Based on that interpretation, the peak number of Wilson’s/unidentified phalaropes at Great Salt Lake in 2023 (367,540) was the highest it has been during our study period (2019–2023). The peak count for Wilson’s/unidentified phalaropes across all six sites in 2023 was 392,472 during the mid-August survey window. The average annual Wilson’s/unidentified phalarope peak count across sites from 2019–2023 (297,201 [SD 82,607], range 197,112–392,472) was 232,944 birds lower than a 1986 count (with different methods and coverage at some sites) of 530,145 birds at the same sites. The red-necked/unidentified phalarope peak count across the six sites in 2023 was 156,927 in the late August-early September survey window. Red-necked phalarope peak annual totals across sites were much greater in 2019 (291,524) than in 2020–2023 (range 123,694–156,927). In 2023, red-necked phalarope site-specific totals increased greatly (by >20,000 birds) at Mono Lake and Owens Lake. There is a need for continued monitoring of phalarope populations and habitat use as phalaropes respond to rapid habitat loss in western North America, particularly at Lake Abert and Great Salt Lake.

Introduction

Wilson's and red-necked phalaropes (*Phalaropus tricolor* and *P. lobatus*, respectively) are iconic species of saline lakes in the interior west of North America, where hundreds of thousands of individual phalaropes stop each year to fatten up and molt. The population trends of both species are poorly understood (Rubega et al. 2020, Castellino et al. 2024), but evidence suggests that Wilson's phalarope populations have declined in North and South America since the 1980s (Smith et al. 2023a, Castellino et al. 2024). Surveying phalaropes is difficult because these unusual shorebirds spend much of their time swimming far from shore on large lakes. Many saline lakes are threatened by water diversion and climate change (Larson et al. 2016, Wurtsbaugh et al. 2017, Hall et al. 2023), so there is an urgent need to better understand the population trends of the phalaropes that critically rely on them.

Phalaropes breed in mid- to northerly latitudes of North America, and during southward migration, hundreds of thousands of Wilson's and red-necked phalaropes stop at large hypersaline lakes in western North America (Jehl 1986, 1988). Smaller numbers of phalaropes also visit smaller wetlands across a broad geographic front, mostly in the Intermountain West flyway region of North America (Oring & Reed 1997). The majority of the world population of Wilson's phalaropes uses North American saline lakes as migratory staging sites (Jehl 1988, 1999). The North American red-necked phalarope population uses a greater diversity of habitat, including the Atlantic and Pacific coasts, and it is unknown what proportion of their overall population stages at saline lakes (Rubega et al. 2020). Wilson's phalaropes spend the boreal winter at interior saline wetlands in South America (Castellino et al. 2024), and red-necked phalaropes winter at sea, off the western coast of South America (Rubega et al. 2020).

In the 1980s and 1990s, among the most important North American phalarope staging sites were Great Salt Lake (Utah, hereafter GSL), Mono Lake (California), Lake Abert (Oregon), San Francisco Bay (California; hereafter SF Bay), and Chaplin Lake (Saskatchewan; Jehl 1986, 1988, 1999). Owens Lake, California, which was dry during surveys in the 1980s and 1990s, now contains suitable wetland habitat for phalaropes (Herbst & Prather 2014) and is now a significant phalarope staging site (Castellino et al. 2024). With major phalarope population concentrations occurring during a relatively short period at these sites (i.e., around 90% of all adults in some years), coordination of surveys across sites offers an opportunity to survey a large proportion of the population simultaneously (Jehl 1986, 1999). To achieve this, these major staging sites must be surveyed in a narrow time range, so that movement of the phalaropes between sites does not confound results.

In 2019, we founded the International Phalarope Working Group with partners from around the Western Hemisphere and identified coordination of surveys in western North America as a top priority for phalarope conservation research (Carle and Rubega 2019). Objectives of the coordinated surveys are (1) to create an annual index of phalarope numbers at major staging sites to evaluate population trends and habitat use, and (2) to understand phalarope response to habitat change at saline lakes. From 2019–2023, we annually conducted coordinated phalarope-specific surveys throughout the summer at Great Salt Lake, Mono Lake, south San Francisco Bay, Lake Abert, Owens Lake, and Chaplin Lake.

Methods

Study sites

In 2019–2023, we coordinated surveys across six phalarope staging sites in the western U.S. and Canada: Great Salt Lake, Mono Lake, Lake Abert, Owens Lake, south San Francisco Bay, and Chaplin Lake (Fig. 1). These sites were chosen because they historically hosted consistent large aggregations of Wilson’s and red-necked phalaropes (Jehl 1986, Jehl 1988, Rubega et al. 2020). Dust mitigation ponds on the Owens Lake bed currently host >1,000 phalaropes annually (see results of this report), but the lakebed was dry during historic surveys in the 1980s and 1990s, supporting few phalaropes at that time.

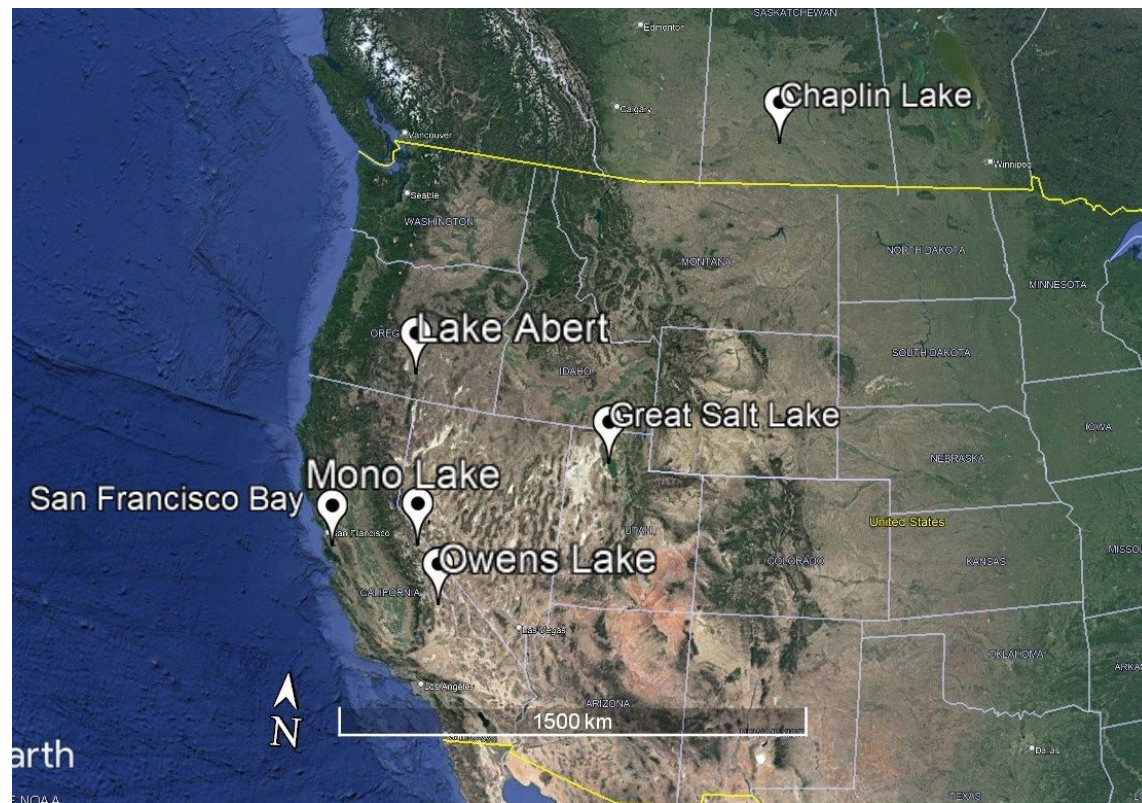


Figure 1. Western North American phalarope staging site surveys locations, 2019–2023.

We conducted surveys at all sites during week-long survey windows, with each window separated by eight days. By surveying all sites during each survey window, we reduced the chance of double-counting phalaropes moving between sites. Our goal was to conduct at least one survey per site per window (see Carle et al. 2022, 2023 for previous survey year dates and effort). At Mono Lake, two surveys were conducted per survey window (see Mono Lake methods). Survey windows were in late June–early July (2021–2023 only), mid-July, late July–early August, mid-August, late August–early September, and mid-September (2019–2023; see dates in Table 1). Despite efforts to do all surveys within the exact dates of the windows, for various reasons this was sometimes not possible, and some surveys occurred outside windows.

We included surveys in analysis that fell within two days on either side of the survey window, effectively lengthening the each survey window to 11 days. In a limited number of cases in which a site had both a survey that fell in the exact survey window, and one that fell one to two days outside it (e.g., Lake Abert for two survey windows during 2023), we preferentially used the survey that fell within exact survey window dates.

Table 1. Dates of 2023 phalarope surveys at western North American staging sites.

“No count” indicates no survey was conducted during that window. Asterisks indicate dates that were one to two days outside the week-long survey windows. We included surveys in results if they fell either within survey window dates or were ≤ 2 days outside the window. Results from surveys two or more days outside of survey windows are listed in Appendix, Table A5.

Site	Jun 29- Jul 5	Jul 14-20	Jul 29- Aug 4	Aug 13-19	Aug 28- Sep 3	Sep 12-18
Great Salt Lake	6/29	7/17	8/1	8/14	8/29	9/13
Mono Lake	7/3, 7/4	7/14, 7/17	7/29, 7/31	8/18	8/28, 8/29	9/12, 9/13
Lake Abert	6/28*, 7/6*	7/14, 7/21*	7/27*, 7/31	8/16	9/2	9/16
Owens Lake	7/1	7/19	7/29	8/18	8/28	9/13
Chaplin Lake	No count	7/17	7/28*	8/18	9/1	No count
SF Bay	7/3, 7/4, 7/5	7/17, 7/18, 7/19	7/31, 8/1, 8/2, 8/3	8/14, 8/15	8/28, 8/29, 9/1	9/11, 9/12

Based on partners’ goals and efforts, for some sites there were additional counts that fell three or more days outside of standardized survey windows. We did not include those counts in our analyses, figures, or official results tables, but in some cases we reference them in discussion if they added additional important context to interpret results, such as notable high counts. All counts from three or more days outside survey windows are listed in the Appendix, Table A5.

Survey methods were tailored to the specific terrain, resources, and staffing available at each site (see site-specific methods below). Methods and survey coverage were standardized within sites so that each survey window’s data could be directly compared. At GSL, Mono Lake, Lake Abert,

and Chaplin Lake, the entire site was surveyed in a single day. At SF Bay and Owens Lake, the site was sometimes covered over multiple days within the survey window, with non-overlapping areas surveyed on different days. In those cases, all survey days were summed to obtain a single survey window result for the site. We present results from 2019 for Great Salt Lake, Mono Lake, and Lake Abert, because those sites had consistent surveys with coordinated timing that year. We report results from all six monitored sites for 2020–2023.

Great Salt Lake

At GSL, Utah (41.115 N°, -112.477 W°) aerial surveys were conducted by Utah Division of Wildlife Resources personnel from a small plane (Cessna 205) between 25–60 m above the surface of the water travelling at 130–160 km per hour. Phalarope counts by species, number, and general location were recorded by two separate observers, one looking out each side of the aircraft, using hand-held audio tape recorders during the flight and transcribed afterward. Flocks of >75,000 phalaropes were counted several times by both surveyors, usually by groups of 5,000, and totals decided by consensus.

Each survey started around 7 a.m. and lasted approximately three hours traveling over the water ~800 m from the shoreline of GSL in a counter-clockwise direction (see Appendix, Fig. A1 for route map). Counting started on the shoreline along the north side of Ogden Bay north of Fremont Island and west to Promontory Point then north to Little Valley Harbor in Gunnison Bay. From there, the survey continued across the lake west-northwest to Gunnison Island and south along the western and southern shores to the southern tip of Antelope Island where it turned east over adjacent wetlands and then entered Farmington Bay. The northern shoreline of Antelope Island to White Rock Bay was then surveyed followed by the rest of Ogden Bay, the western shore of Bear River Bay, Bear River Migratory Bird Refuge and adjacent private wetlands, and Willard Spur. The survey finished along the eastern shore of Bear River Bay if extensive water was present. If phalarope flocks were observed in the open water away from the shoreline, transects parallel to the shore and spaced approximately 1.9 km apart were flown over the extent of those concentrations.

Mono Lake

At Mono Lake, California (38.028° N, -119.011° W) surveys were conducted by Oikonos Ecosystem Knowledge, with staff, advising, and equipment support from University of Connecticut, California State Parks and the Mono Lake Committee. Two surveys were conducted during each survey window, either on consecutive days or with one day between surveys. Surveys consisted of a combination of boat- and shore-based counts. The survey protocol was based on that of surveys conducted by Rubega & Keimel (2017) in 1990 and 1991, with modifications (see Carle & Rubega 2020 for detailed methods). Boat counts consisted of two surveyors visiting permanent boat survey points (56 in 2019, 59 in 2020–2023; Appendix, Fig. A2) and simultaneously counting phalaropes in a 400 m radius from the boat, using binoculars. Trained volunteers conducted shore surveys using spotting scopes and binoculars from locations in standardized and defined areas (Appendix, Fig. A2, Table A6) with limited

overlap with the boat survey (there were 4 shore count locations in 2019, 5 in 2020–2023; Appendix, Fig. A2). To produce a single-day full survey estimate for each species, we averaged the total counts of the two boat surveyors and summed this with the average totals of the two shore surveyors (Carle et al. 2023). In areas where boat and shore survey points overlapped, the proportion of overlap was multiplied by the number of phalaropes counted in the boat count, and the result was subtracted from that boat point's count (these instances made up a small proportion of overall points and phalaropes; Carle & Rubega 2020). The Mono Lake survey is an index count that samples approximately 20% of the surface of Mono Lake (the exact percentage sampled varies slightly annually depending on the lake level). Count stations were spread across the full extent of the lake, with stratification for greater sampling effort in areas expected to have more phalaropes (e.g., tufa groves and the shallow northeastern part of the lake; Appendix, Fig. A2). For windows with multiple Mono Lake surveys, we report here the highest single-day survey counts in each window.

Lake Abert

At Lake Abert, Oregon, (42.703° N, -120.221° W) shore-based surveys were conducted by volunteers from East Cascades Bird Alliance from 2019–2022 and a biologist from the Oregon Natural Desert Association in 2023. Observers arrived early in the morning to avoid heatwaves reducing visibility and drove along Highway 395 on the east side of the lake, stopping at 15 pullouts to make counts, with ~0.25 miles between pullouts. Observers used binoculars to identify and count nearby phalaropes and used scopes for distant phalaropes. Because Lake Abert is three to five miles across on average, the survey area included approximately half the lake, where phalaropes were adequately visible. Phalaropes usually appeared to be in relatively visible areas either at the narrow south end of the lake or near the east side springs at the north end of the lake. Occasional large flocks of shorebirds that could be seen on the far shore, but not counted or identified accurately, were excluded. Phalaropes were identified to species if they were close enough to make accurate identifications, otherwise they were recorded as unidentified phalarope spp. Where birds were in flocks, the numbers of birds in each field of view were estimated in multiples of 25, 50, 100, etc. and then the size of the entire flock was estimated by multiplying the numbers of birds in each field times the numbers of scope fields the flock occupied.

Owens Lake

At Owens Lake, California (36.445 N°, -117.945 W°) surveys of the Owens Lake Dust Control Program Area were conducted by both Eastern Sierra Audubon (ESA) and the Los Angeles Department of Water and Power (LADWP). The Owens Lake Dust Control Program Area totals 48 square miles, of which 30 square miles are currently water-based. LADWP applies water to portions of Owens Lake from October–June to control dust. Some water is also released outside this period to maintain wildlife habitat. The Dust Control Program Area is divided into numerous discrete dust control management units called Dust Control Areas (DCAs; Appendix, Fig. A3), which differ in size, depth, salinity, and water persistence.

LADWP biologists conducted four surveys a year of the entire Owens Lake Dust Control Program Area in April, August, September, and October. These “lakewide surveys” required six to seven people one to three days to complete. ESA conducted surveys covering a smaller area during other survey windows to fill in these gaps. LADWP worked with ESA to determine the best subsample of DCAs to consistently survey during the other phalarope survey windows. Based on an analysis of previous data on phalarope abundance on lakewide surveys for the time period 2015–2020, 16 DCAs were subsampled, which accounted for 91% of all phalarope records (D. House, LADWP, unpublished data; Appendix, Fig. A3).

Surveys of the DCAs were conducted from roads using binoculars and a spotting scope. There is a network of gravel roads and berms along which observers can drive and stop at strategic viewing locations to survey. The road network allows a complete survey of each DCA. Phalaropes were identified to species when possible. When large flocks were encountered, the numbers of phalaropes in each scope or binocular field of view was estimated in multiples of 25, 50, 100, etc. and then total flock size estimated by multiplying the numbers of phalaropes in each field times the numbers of scope fields the flock occupied, adjusting the scope view estimate based on phalarope density. Although all DCAs were surveyed once in August during the phalarope survey period, the number of phalaropes reported here is the total of only the 16 DCAs that were surveyed consistently during each survey window, in order to provide comparable data.

South San Francisco Bay

At SF Bay, California (37.444° N, -122.069° W) the San Francisco Bay Bird Observatory (SFBBO), with financial and logistical support from multiple agencies and landowners (see acknowledgments), surveyed former salt evaporation ponds, managed ponds, and several other sites in southern SF Bay. Thirty-one sites were selected, composed of a subset of former salt production ponds in Eden Landing Ecological Reserve and the Alviso and Ravenswood complexes of the Don Edwards San Francisco Bay National Wildlife Refuge, remaining active salt production ponds in the Mowry and Newark complexes, and other wetlands and ponds including Alviso Marina County Park, Spreckles Marsh, New Chicago Marsh, Crittenden Marsh, Coyote Hills Regional Park, and the Sunnyvale Water Pollution Control Plant (Appendix, Fig. A4). Together these sites encompass areas where >99% of historical SFBBO phalarope observations occurred, comprising 6,687 out of 20,357 acres of current and former commercial salt pond habitat and 378 acres of other diked wetlands and treatment ponds in SF Bay (Tarjan 2019). Habitats were only surveyed south of the San Mateo Bridge; managed ponds, diked or muted tidal marshes, and storage or treatment ponds exist in north SF Bay but were not surveyed.

SFBBO staff and trained volunteers conducted the surveys from shore or levees that crisscrossed the wetlands using binoculars and 40x spotting scopes. Count boundaries were delineated by maps and instructions. Surveys generally were conducted between dawn and 12 p.m., though some surveys extended into the afternoon when necessary. While the entire SF Bay site was surveyed within the survey window, a few areas within the site were surveyed on alternative dates surrounding the primary survey dates, due to staff availability and access limitations. Because the SF Bay site was surveyed over various days during each survey window, the counts reported are the sums of all birds observed within the survey window, rather than single-day high counts.

In 2023, SFBBO also began collecting opportunistic observations at the remaining unsurveyed 13,678 acres of former and current salt pond habitat, in order to identify whether the area that historically supported 99% of observations still continued to do so. Opportunistic observations were solicited from SFBBO staff, National Wildlife Refuge staff, and volunteers. Of all observations, systematically surveyed sites represented 83% of the total phalarope observations during 2023 (18,017). The majority of the remaining 17% of opportunistic observations that were not within the set of 31 sites systematically surveyed were in one site (Eden Landing Pond E5C), where SFBBO staff observed 2,785 red-necked phalaropes across two survey windows. Excluding the observations at E5C, the remaining sites did still cover 99% of all observations. For consistency of survey sites across years, data from E5C were excluded from this report, so that peak and total counts in this year could be compared to previous years' counts.

Chaplin Lake

At Chaplin Lake, Saskatchewan (50.411° N, -106.603° W), an established protocol developed by the Canadian Wildlife Service and University of Saskatchewan involved weekly fall shorebird surveys at 21 point count stations throughout the roads and dikes that surround and bisect the lake (Appendix, Fig. A5). Point count stations had a radius of 200m or 500m depending on topography and proximity of neighboring stations, and therefore these surveys did not cover the entire available habitat on the lake (Appendix, Fig. A5). However, from 2020–2023, all phalaropes seen while traveling in a vehicle between survey points were counted, essentially covering the entire road/dike system that is accessible by vehicle, and the associated distance that is visible into the lake from the shore.

Observers counted all shorebirds seen within the point count station radius during an unlimited time period, using binoculars and spotting scopes. Shorebirds were identified to species whenever possible, and surveys were conducted at any time of day provided weather conditions were appropriate (i.e., no heavy precipitation or strong winds). In 2023, surveys were conducted during four of the six survey windows (see Table 1).

In previous years, observers noted large numbers of shorebirds foraging outside of our survey locations, so three new survey locations were added in 2023 to capture their presence. The new survey points are: CL103G, CL103H, and CL110 (Appendix, Fig. A5). In this report we include data only from the points that were also surveyed in 2020-2022 and exclude the new 2023 points to maintain comparability.

Caveats for comparisons between sites

The methods and coverage of surveys varied at each site. Reasons for differing survey methodologies were related to factors including the site topography and conditions, the level and training of staffing available, and the choices of those designing the surveys at each site. In comparing the results, it is important to keep in mind that the following factors varied across sites: 1) observer training; 2) survey area; 3) estimation methods; 4) vantage/proximity to phalaropes; 5) methods to control double-counting and error; 6) time of day/time distribution of effort; and 7) completeness of site coverage. Care was taken to keep methods consistent *within* sites, meaning that surveys carried out on different dates or years at a single site are comparable.

Data summary & analysis

For each site, we summed the grand total of Wilson's, red-necked, and unidentified phalaropes observed in each survey window. For each survey window, we summed the totals across all sites to produce a region-wide total for each species. We defined the peak annual region-wide totals for each species as the highest count of that species occurring within a single survey window, combined with the unidentified phalarope count from the same window.

Whether phalaropes can be identified to species depends on a variety of factors, including survey method, site characteristics, weather conditions, flock size, and observer. Unidentified phalaropes present a challenge for data summary and interpretation. Wilson's phalaropes generally occur in large numbers at staging sites earlier than red-necked phalaropes (Jehl 1986, 1988, 1999). At our survey sites, Wilson's phalaropes are typically the predominant species present from June to mid-July, both species can be present in large numbers in late July-mid August, and from late August on most birds are red-necked phalaropes. No quantitative analysis has been completed to determine a correction factor ratio to categorize unidentified phalaropes to species. Jehl (1999) estimated that 75% of unidentified phalaropes at staging sites in late July were Wilson's. Given differences in timing, phalarope use, and latitudes of the sites we surveyed, we were not confident that a single correction ratio would be appropriate, so we did not use Jehl's ratio.

We report raw counts of Wilson's, red-necked, and unidentified phalaropes in Appendix, Tables A1, A2, and A3 and combined species/unidentified counts in Appendix, Table A4. For interpretation, discussion, and visualization of 2023 high counts at individual sites, we report totals of Wilson's and red-necked phalaropes identified to species separate from unidentified phalarope totals.

To identify inter-annual peak counts for each site, and to identify region-wide annual peak counts, we identified the highest single-survey window count of each identified species, and combined that total with the unidentified birds from that survey window. In the case of Mono Lake, with multiple surveys per window, we used the unidentified phalarope count from the survey day that corresponded to the identified species' high count at Mono Lake during the survey window. In identifying annual peak counts, all unidentified birds were considered to be the species for which it was a high count, and to *not* be the other species. Using this method, the counts of identified species drove assignment of annual peak counts, rather than assignment being driven by high counts of unidentified birds, which could sometimes be greater than those of identified birds. In the vast majority of year/site peaks, counts of identified Wilson's and red-necked phalaropes occurred on different days, so double-counting of unidentified birds did not occur. However, in two cases (GSL in 2021 and Chaplin Lake in 2021), peaks of identified birds of both species were on the same survey day, with accompanying counts of unidentified birds. Because of the limited number of these situations, we allowed for unidentified birds to be counted in both Wilson's/unidentified and red-necked/unidentified phalarope totals in those cases. This issue affected only site-specific peak counts, and not region-wide peak counts, which never had overlapping dates for both species. There were no region-wide annual peak-count

survey windows that were the same for both Wilson's and red-necked phalaropes during our time-series.

These methods are imperfect and involve assumptions about the species-identity of unidentified phalaropes. A caveat of these methods for assigning unidentified phalaropes is that, especially in late July-mid August, unidentified birds were likely a mixture of both species, but we treat them as all one or the other. For counts falling in late July-mid August, it should be kept in mind that though we grouped unidentified birds with whichever species had a high count for a given window or survey, that species proportions are uncertain.

Another caveat is that the method of lumping all unidentified birds with one or the other species, based on the region-wide count peak count of identified birds, results in the loss of site-specific detail. For example, a given site may have had a higher proportion of red-necked than Wilson's phalaropes on the day of the peak region-wide count of Wilson's phalaropes. In that case, all unidentified birds from that site were characterized as Wilson's phalaropes, despite there being locally more red-necked phalaropes at that time. Functionally, Great Salt Lake's results drove region-wide high counts of identified species, and thus also drove our characterization of unidentified phalaropes. However, we chose this method as a relatively simple way to interpret and discuss unidentified numbers. We examined what impact this method had on region-wide peak totals by also characterizing unidentified birds based on site-specific totals (i.e., whichever species had the higher count at each site on each date, we lumped unidentified birds from that site with that species). There was little difference in region-wide annual peak totals between these two methods (the average difference in the number of unidentified birds for Wilson's and red-necked phalaropes were 2% and 0%, respectively, using the two different methods). Thus, we chose to use the method of characterizing unidentified birds based on region-wide identified species' peaks. We discuss instances where characterization of unidentified birds substantially complicates interpretation of results.

Results

Peak counts: Wilson's phalaropes

The maximum 2023 count during a single survey window across all sites combined of Wilson's phalaropes was 73,845 individuals during the mid-August survey window (Fig. 2). That total, combined with unidentified phalaropes from the same window (318,627), resulted in a 2023 Wilson's/unidentified phalarope high count of 392,472 individuals during the mid-August window (Fig. 2; Appendix, Table A4). Only 19% of this count was identified as Wilson's phalaropes however, given the mid-August timing, many unidentified birds could have been red-necked phalaropes. The second highest region-wide Wilson's/unidentified phalarope count in 2023 was 119,418 individuals during the late July-early August window. Of that count, 43,614 phalaropes (37%) were identified as Wilson's phalaropes (Fig. 3) and the remainder were unidentified phalaropes. Previous Wilson's/unidentified single-window high counts across all sites were 197,112 in 2022 (late July-early August), 295,624 in 2021 (late July-early August), 236,452 in 2020 (mid-July), and 364,345 in 2019 (mid-July; GSL and Abert only; Fig. 2). The average annual single-window region-wide Wilson's/unidentified phalarope peak from 2019–2023 was 297,201 (SD 82,607).

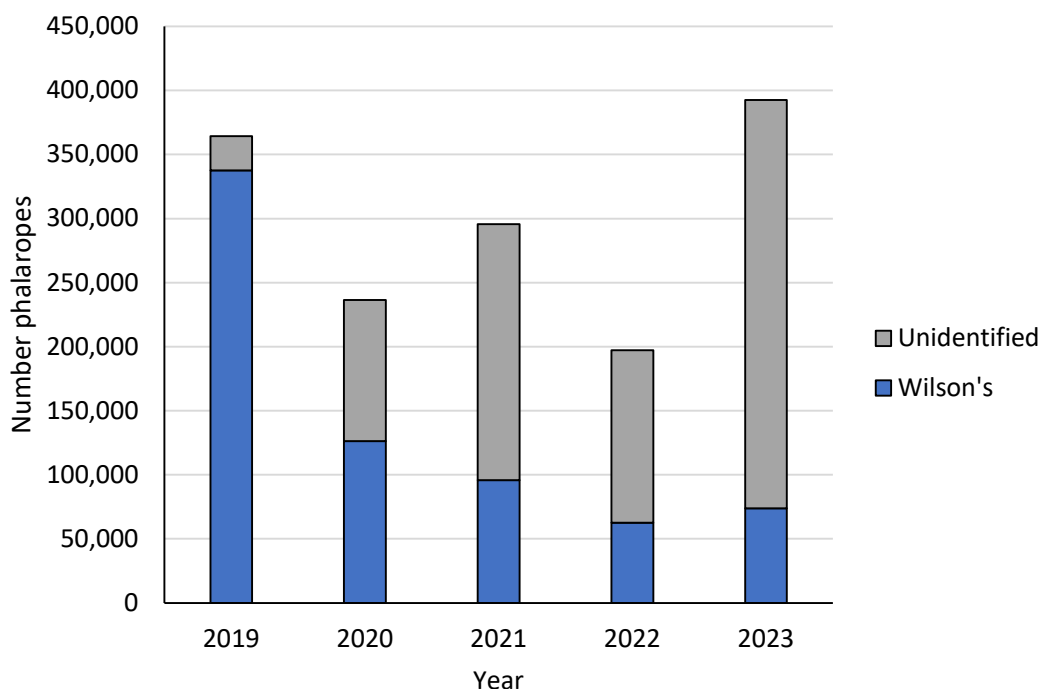


Figure 2. Peak counts of Wilson's/unidentified phalaropes across six sites, 2019-2023. Peak counts were identified based on the single survey window with the highest count of identified Wilson's phalaropes across all six sites; the unidentified counts from the same window were added to the Wilson's phalarope count. At Mono Lake, where there were two surveys per window, the unidentified count corresponding with the day of the peak count of identified Wilson's phalaropes was used. Peak counts occurred during the mid-July window in 2019 and 2020. Peak counts occurred during the late July-early August window in 2021 and 2022, and the mid-August window in 2023. During late July and August windows, many red-necked phalaropes can be present, though we assume here that all unidentified birds were Wilson's. In 2019, the only data available during the peak count window were from Great Salt Lake and Lake Abert.

Comparisons across sites: Wilson's phalaropes

As in previous years, GSL had the largest aggregations of Wilson's phalaropes in 2023, with a peak Wilson's phalarope count of 73,065 on August 14 (Fig. 3), and a peak Wilson's/unidentified phalarope count of 367,540 on the same date (Fig. 4). This was above average for the 2019–2023 period for annual Wilson's/unidentified peak counts from GSL (average 276,780 [SD 81,703]; Fig. 4). Mono Lake's 2023 peak Wilson's/unidentified count was 6,252 on July 4 (99% identified as Wilson's) down from 12,863 in 2022 and below average for Mono Lake (average 16,746 [SD 16,654], years 2019-2023; Figs. 3-5). At Owens Lake, the Wilson's/unidentified peak count in 2023 was 29,976 on July 29 (91% identified as Wilson's; Figs. 3-5). This was exceptionally high for Owens Lake compared to 2020–2022 peak counts (range 1,169–1,987), and above average for 2020–2023 (8,588 [SD 14,264]; Figs. 3-5). At SF Bay, the Wilson's phalarope/unidentified peak 2023 count was 1,082 on July 17–19, which was

higher than 2020–2022 peak counts (range 735–907) and above average for 2020–2023 (average 870 [SD 161]; Figs. 3-5).

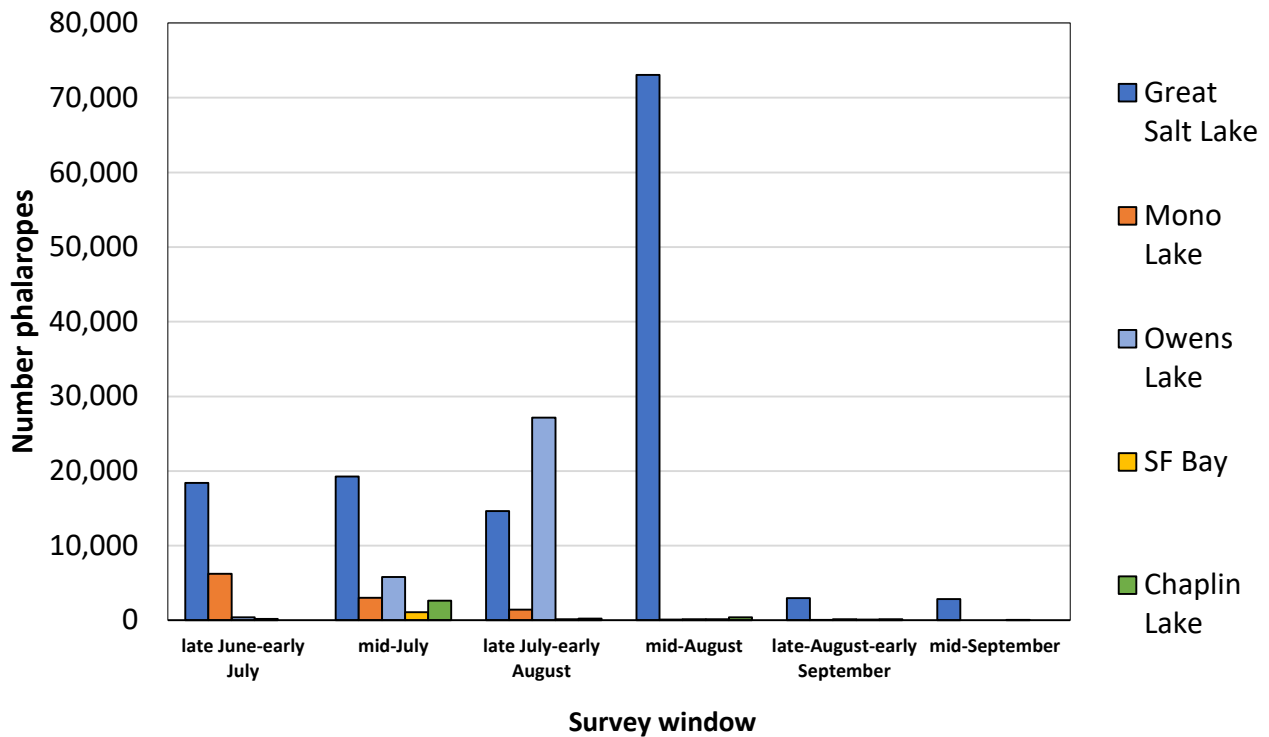


Figure 3. Peak counts of Wilson’s phalarope during each survey window at western North American staging sites, 2023. Only phalaropes identified as Wilson’s phalaropes are shown. Lake Abert is not shown because phalaropes were not identified to species there in 2023; however, Lake Abert had a peak of 28,200 unidentified phalaropes during the late July/early August window. See Appendix, Table A1 for exact numbers from each site for 2023. All sites except Chaplin Lake were surveyed in each survey window (see Table 1). SF Bay is the south San Francisco Bay salt ponds.

At Chaplin Lake, the Wilson’s/unidentified peak in 2023 was 2,651 on July 17, which was much greater than peaks in 2020 (120) and 2021 (1,280), but much less than the peak in 2022 (15,735) and closer to the 2020–2023 average (4,947 [SD 7,266]; Figs. 3-5). At Lake Abert, phalaropes were not identified to species in 2023, but the highest counts of unidentified birds in 2023 were 31,190 on July 27 (two days outside the survey window) and 28,200 on July 31 (within the survey window). Both the July 27 and 31 counts could have been composed of either or both species based on the date, which is in the early season for red-necked phalaropes and the middle of the season for Wilson’s. A count of 10,800 unidentified phalaropes on July 6 at Lake Abert were likely Wilson’s based on the early date. Peak numbers of all-phalaropes at Lake Abert were much greater than those of 2022 (6,500 on July 7, all identified as Wilson’s) and 2021 (9,855 on August 17). In 2023, peak all-phalarope numbers at Lake Abert were more comparable to those of 2020 (21,830 on July 1, outside official window that year, 2,088 on July 15), and 2019 (peak within-window count of 24,261 on July 15, peak outside window count of 89,000 on August 10).

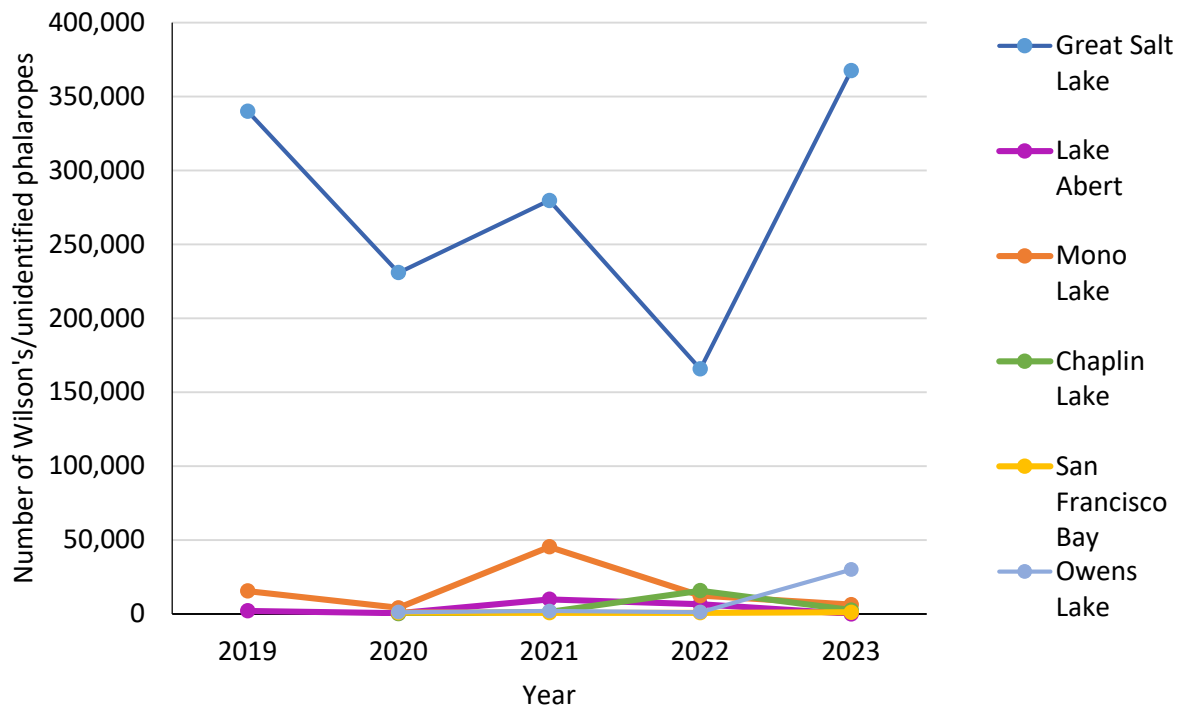


Figure 4. Peak counts of Wilson's/identified phalaropes from each site, 2019-2023. Peak counts at each site were identified based on the survey window with the highest count of identified Wilson's phalaropes; the unidentified counts from the same window were added to the Wilson's phalarope count. At Mono Lake, where there were two surveys per window, the unidentified count corresponding with the day of the peak count of identified Wilson's phalaropes was used. Phalaropes were not identified to species at Lake Abert in 2023, so Lake Abert 2023 results are not shown here. There were insufficient data to show Chaplin Lake, San Francisco Bay and Owens Lake in 2019.

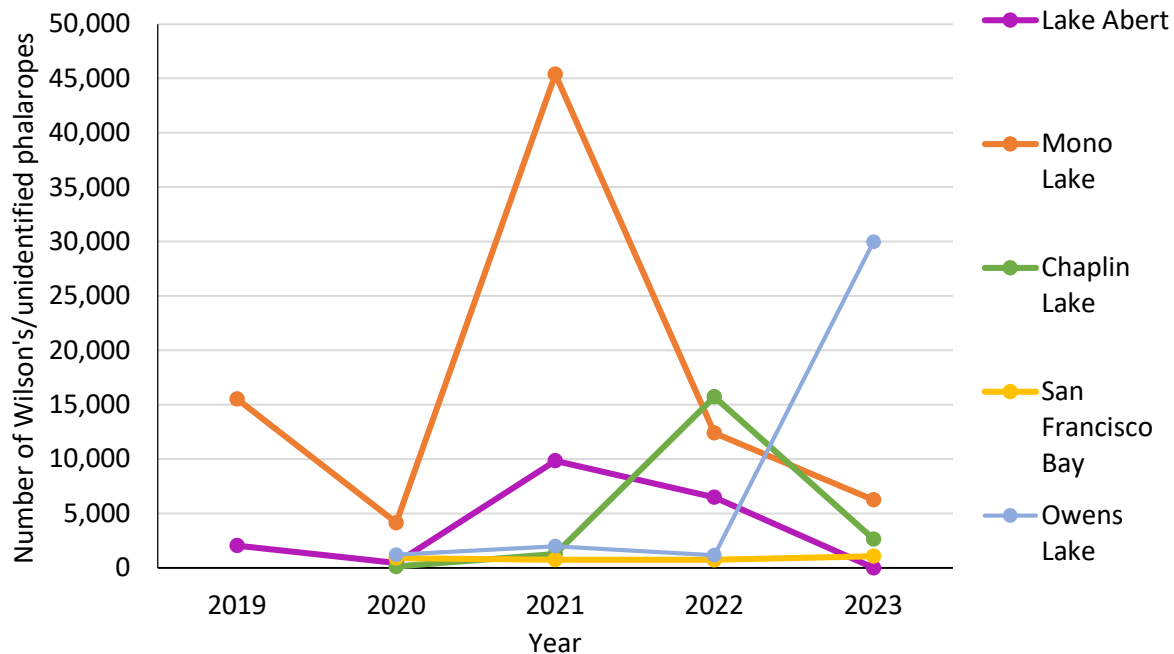


Figure 5. Peak counts of Wilson's/identified phalaropes from each site, excluding GSL, 2019-2023. GSL is excluded to better show patterns from Figure 4 at sites with smaller numbers of phalaropes. Peak counts at each site were identified based on the survey window with the highest count of identified Wilson's phalaropes; the unidentified counts from the same window were added to the Wilson's phalarope count. At Mono Lake, where there were two surveys per window, the unidentified count corresponding with the day of the peak count of identified Wilson's phalaropes was used. Number of Wilson's phalaropes at Lake Abert is likely under-represented here, because large (>20,000 birds) flocks of unidentified phalaropes occurred in 2019 and 2023 at Lake Abert on days with no identified birds; those counts are not shown here. There were insufficient data to show Chaplin Lake, San Francisco Bay and Owens Lake in 2019.

Peak counts: red-necked phalaropes

The maximum 2023 count during a single survey window of red-necked phalaropes was 104,968 individuals during the late August-early September window (Fig. 6). That total, combined with unidentified birds from the same window, resulted in a red-necked/unidentified phalarope high count of 156,927 individuals during the late August-early September window (Fig. 6). Sixty-two percent of birds in this count were from GSL. Notably, the mid-August count at GSL included 294,475 unidentified birds, some of which may have been red-necked phalaropes; we categorized unidentified birds from this count as Wilson's, because that survey window had the overall highest total for Wilson's phalaropes. Previous red-necked/unidentified phalarope peak counts from single windows were 124,184 in 2022 (mid-August), 147,952 in 2021 (mid-August), 123,694 in 2020 (late August-early September), and 291,524 in 2019 (mid-August; GSL, Mono Lake and Lake Abert only; Fig. 2). The average of annual single-window region-wide red-necked/unidentified phalarope peak from 2019-2023 was 168,856 (SD 70,110).

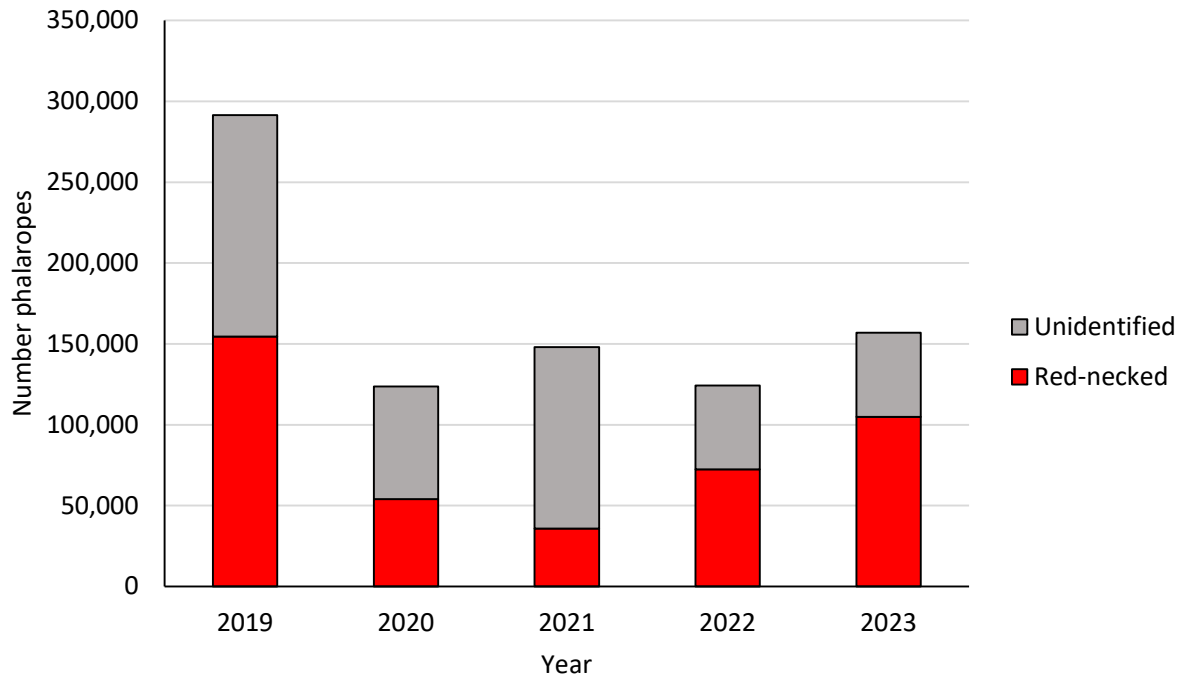


Figure 6. Peak counts of red-necked/unidentified phalaropes across six sites, 2019–2023. Peak counts were identified based on the single survey window with the highest count of identified red-necked phalaropes across all six sites; the unidentified counts from the same window were added to the red-necked phalarope count. At Mono Lake, where there were two surveys per window, the unidentified count corresponding with the day of the peak count of identified red-necked phalaropes was used. Peak red-necked/unidentified phalarope counts occurred during the mid-August window in 2019, 2021, and 2022 and during the late August-early September window in 2020 and 2023. During the mid-August window, many Wilson’s phalaropes can be present, though we assume here that all unidentified birds were red-necked. In 2019, the only data available during the peak count window were from Great Salt Lake, Lake Abert, and Mono Lake.

Comparisons across sites: red-necked phalaropes

In 2023, GSL had the highest counts of red-necked phalaropes across sites, with 96,943 red-necked/unidentified phalaropes on August 29 (54,193 identified as red-necked [56% of count]; Figs. 7, 8). The 2023 peak count of red-necked/unidentified phalaropes from GSL was lower than those of 2019–2022 (range 109,680–264,430) and well below the 2019–2023 average (160,015 [SD 75,317]; Fig. 8). Mono Lake’s peak red-necked/unidentified phalarope count was 33,157 on August 28 (32,657 identified as red-necked [98% of count]; Figs. 7-9). That count broke the previously published red-necked phalarope single-day count from Mono Lake of 21,613 on August 30, 1976 (Winkler et al. 1977). The average annual peak count of red-necked/unidentified phalaropes at Mono Lake 2019–2023 was 14,579 (SD 10,715; unidentified birds made up <1% of any annual red-necked/unidentified phalarope high count at Mono Lake in that period; Figs. 8, 9).

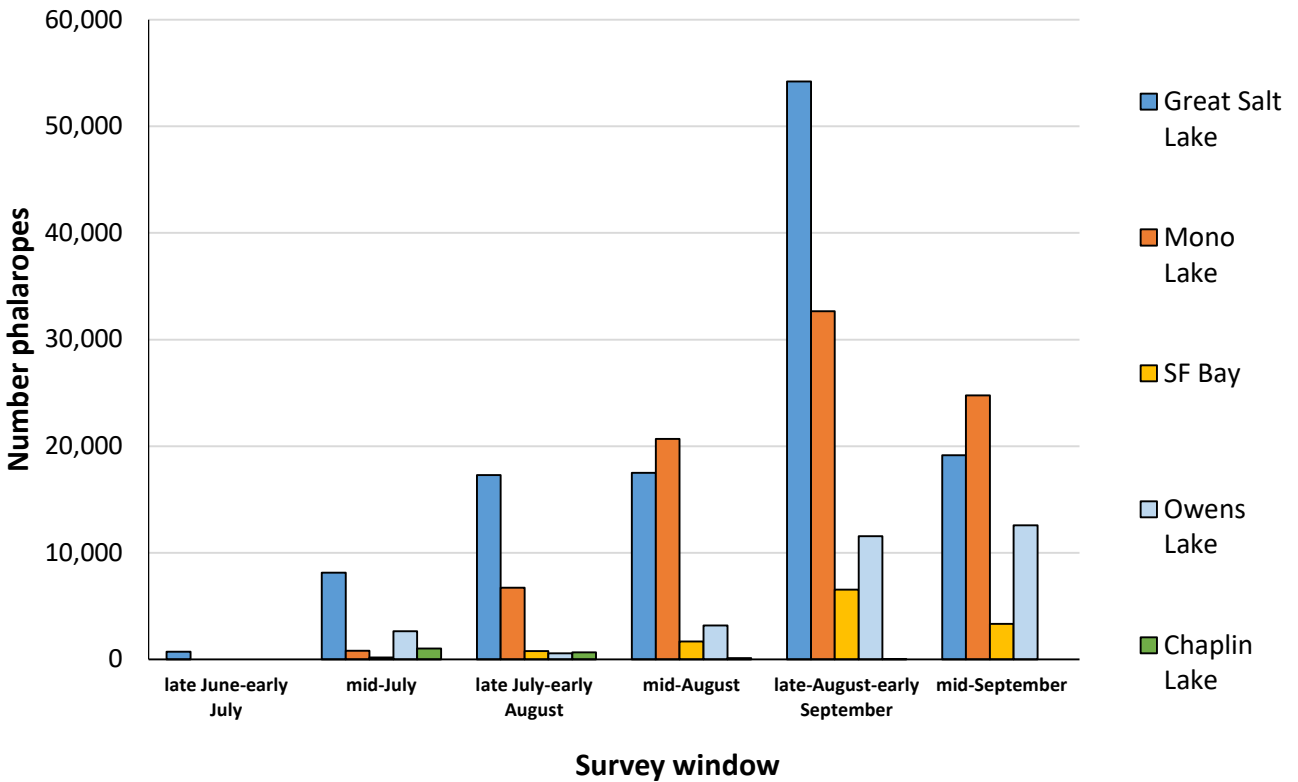


Figure 7: Peak counts of red-necked phalaropes during each survey window at western North American staging sites, 2023. Only phalaropes identified as red-necked phalaropes are shown here. Lake Abert data are not shown because phalaropes were not identified to species in 2023; however, Lake Abert had a peak of 28,200 during the late July/early August window. See Appendix, Table A2 for exact numbers from each site. All sites except Chaplin Lake were surveyed in each survey window (see Table 1). SF Bay is the south San Francisco Bay salt ponds.

The 2023 high count of red-necked/unidentified phalaropes at Owens Lake was 32,897 on September 13 (12,576 identified as red-necked [38% of count]; Figs. 7, 8, 9). That count was remarkably high compared to 2020–2022 Owens Lake peak counts, which ranged from 1,404–3,241 (average 2020–2023 9,773 [SD 15,439]; Figs. 8, 9). The SF Bay high count of red-necked/unidentified phalaropes was 6,888 on August 29–September 1 (6,554 identified as red-necked [95% of count]; Figs. 7, 8, 9). That was similar to the 2021 peak at SF Bay (6,767) and greater than 2020 and 2022 peak counts (1,700 and 4,357, respectively; 2020–2023 average at SF Bay was 4,928 [SD 2,447]; Figs. 8, 9). The 2023 high count at of red-necked/unidentified phalaropes at Chaplin Lake was 1,022 (all identified as red-necked; 2020–2022 range 50–907, 2020–2023 average 592 [SD 454]; Figs. 8, 9). All phalaropes were reported as unidentified during Lake Abert surveys in 2023. Counts of 8,200 and 2,500 unidentified phalaropes at Lake Abert on September 1 and 16, respectively, were likely composed mainly of red-necked phalaropes, based on the dates.

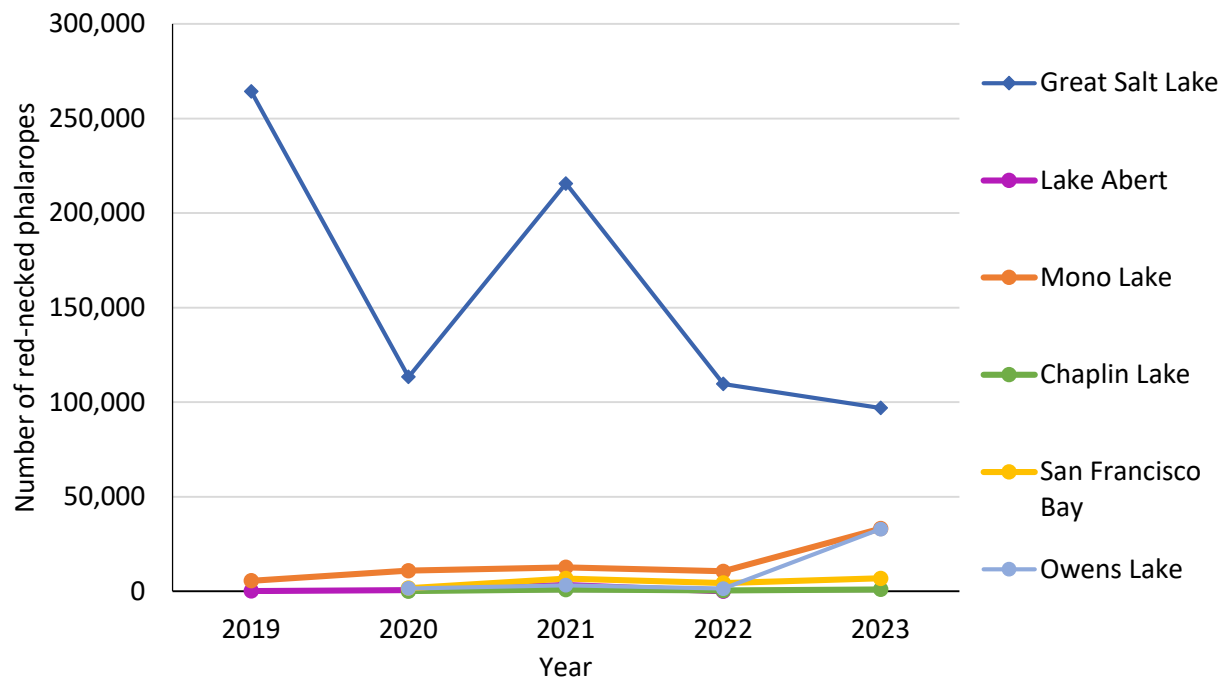


Figure 8. Peak counts of red-necked/unidentified phalaropes from each site, 2019-2023. Peak counts at each site were identified based on the survey window with the highest count of identified red-necked phalaropes; the unidentified counts from the same window were added to the red-necked phalarope count. At Mono Lake, where there were two surveys per window, the unidentified count corresponding with the day of the peak count of identified red-necked phalaropes was used. Phalaropes were not identified to species at Lake Abert in 2023 and not shown here. There were insufficient data to show Chaplin Lake, San Francisco Bay and Owens Lake in 2019.

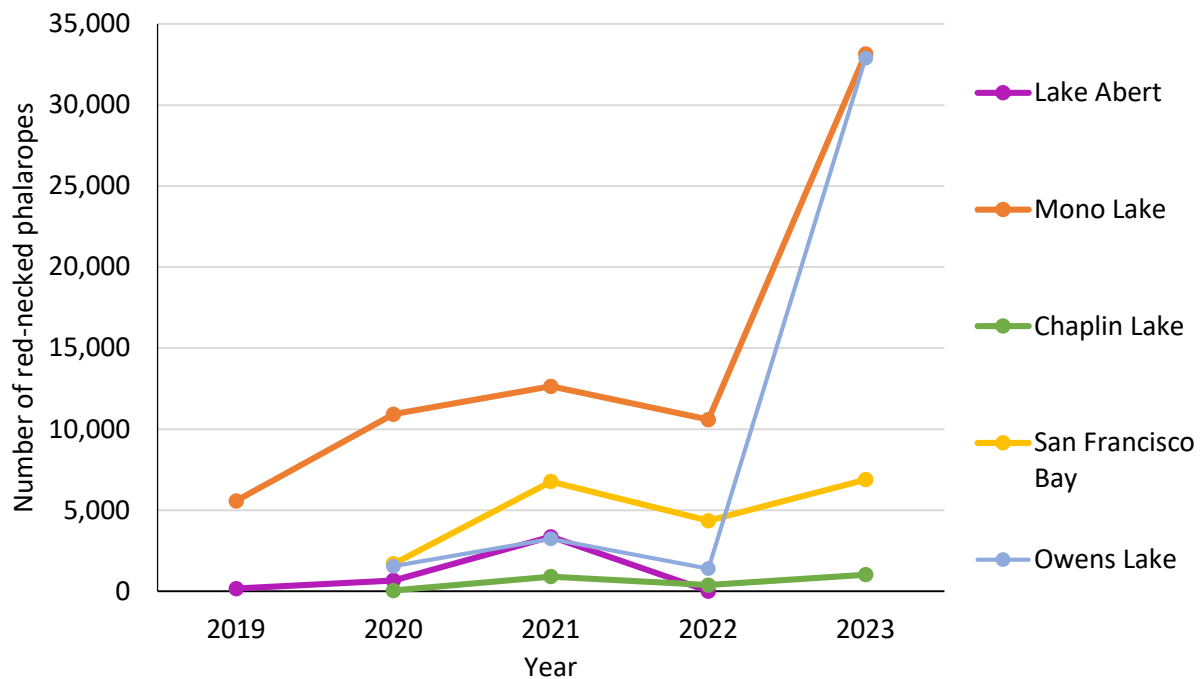


Figure 9. Peak counts of red-necked/unidentified phalaropes from each site, excluding GSL, 2019-2023. GSL is excluded to better show patterns from Figure 8 at sites with smaller numbers of phalaropes. Peak counts at each site were identified based on the survey window with the highest count of identified red-necked phalaropes; the unidentified counts from the same window were added to the red-necked phalarope count. At Mono Lake, where there were two surveys per window, the unidentified count corresponding with the day of the peak count of identified red-necked phalaropes was used. Phalaropes were not identified to species at Lake Abert in 2023 and not shown here. There were insufficient data to show Chaplin Lake, San Francisco Bay and Owens Lake in 2019.

Unidentified phalaropes

During 2023, GSL, Lake Abert, and Owens Lake had large counts of unidentified phalaropes (i.e., $\geq 20,000$ at each site; Fig. 10). Because of the large size of GSL, the magnitude of the flocks there, and the aerial survey methods, it is sometimes impossible to identify phalaropes to species. Likewise, at Lake Abert, land-based observers often may not be able to identify distant phalaropes to species.

Largely driven by a count of 294,475 unidentified phalaropes at GSL, the peak count of unidentified phalaropes across all sites occurred during the mid-August survey window (Fig. 10). The highest counts of unidentified phalaropes at Lake Abert in 2023 were 31,190 on July 27 (2 days outside of the survey window) and 28,200 on July 31 (inside the survey window [note than in Table A1 the July 31 count is listed because we preferentially used counts exactly within survey window days; the July 27 count is listed in Table A5). Owens Lake had a count of 14,770 unidentified phalaropes on August 18 and 20,321 on September 13 (Fig. 10). Possible species composition of these counts, with the exception of the September 13 count at Owens Lake, is difficult to interpret, because both Wilson's and red-necked phalaropes can be present in substantial numbers at staging sites from late-July to mid-August. The September 13 Owens

Lake count was likely composed primarily of red-necked phalaropes based on the late-season timing, and because 12,361 red-necked and zero Wilson’s were identified at Owens Lake that day. There were few (≤ 500) or no unidentified phalaropes reported from Mono Lake, Chaplin Lake, or San Francisco Bay in 2023 (Appendix, Table A3) .

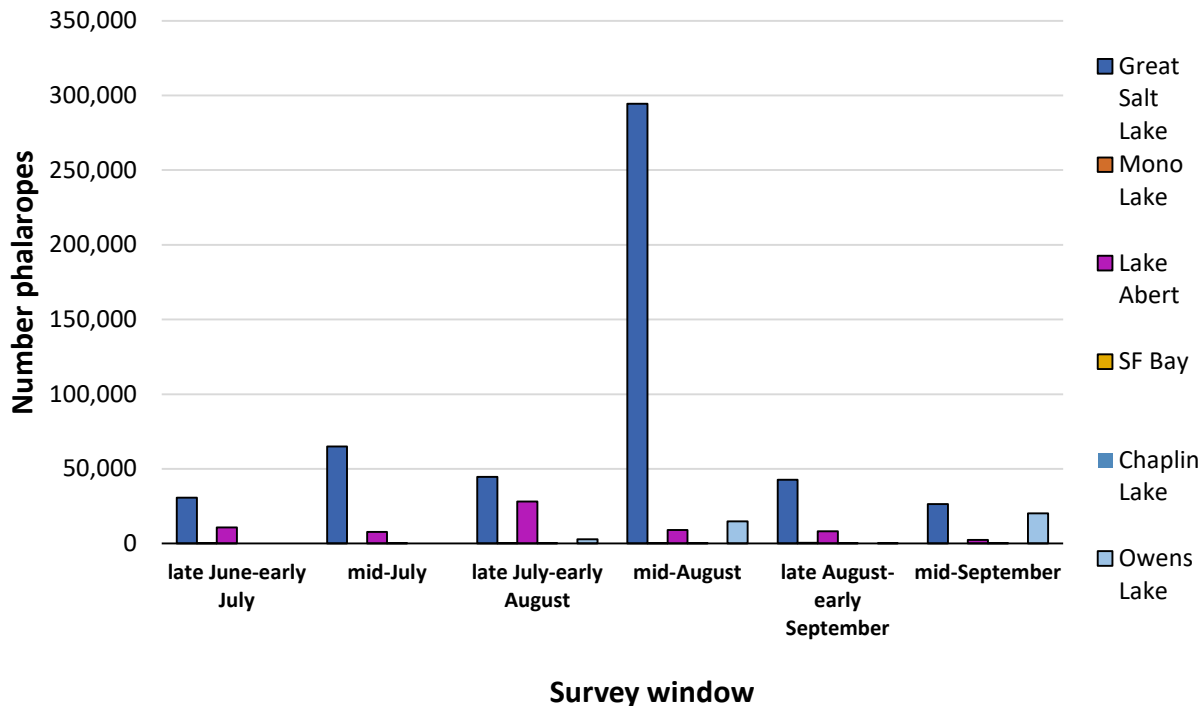


Figure 10: Peak counts of unidentified phalaropes during each survey window at western North American staging sites, 2023. See Appendix, Table A3 for exact numbers of unidentified phalaropes from each site. All phalaropes were recorded as unidentified at Lake Abert in 2023. SF Bay is the south San Francisco Bay salt ponds.

Discussion

After five years of annual coordinated surveys across six staging sites, trends and patterns in regional phalarope numbers are emerging (Fig. 11). GSL hosted the vast majority of numbers of both species, and overall inter-annual trends have been driven by GSL counts (Figs. 4, 8). The use of the other staging sites was dynamic year to year, especially for Wilson’s phalaropes (Figs. 7-9). Annual Wilson’s phalarope high counts at each site did not always mirror each other, nor did annual trends at individual sites always mirror regional trends (Figs. 5, 6, 12). On average, Lake Abert and Mono Lake had the largest congregations of Wilson’s phalaropes after GSL, but annual peak count numbers at each site varied (Figs. 4, 5). For example, Chaplin Lake had a larger Wilson’s phalarope count than Lake Abert or Mono Lake in 2022, but not in any other year in our study (Fig. 5). Owens Lake had a peak count of 29,976 Wilson’s/unidentified phalaropes in 2023, far more than the peak of 1,000–2,000 individuals from 2019–2022, (Fig. 5). Also unusual was that in 2023 Owens Lake’s high count of Wilson’s/unidentified phalaropes was more than four times greater than that of its neighboring Mono Lake (6,261, Fig. 5).

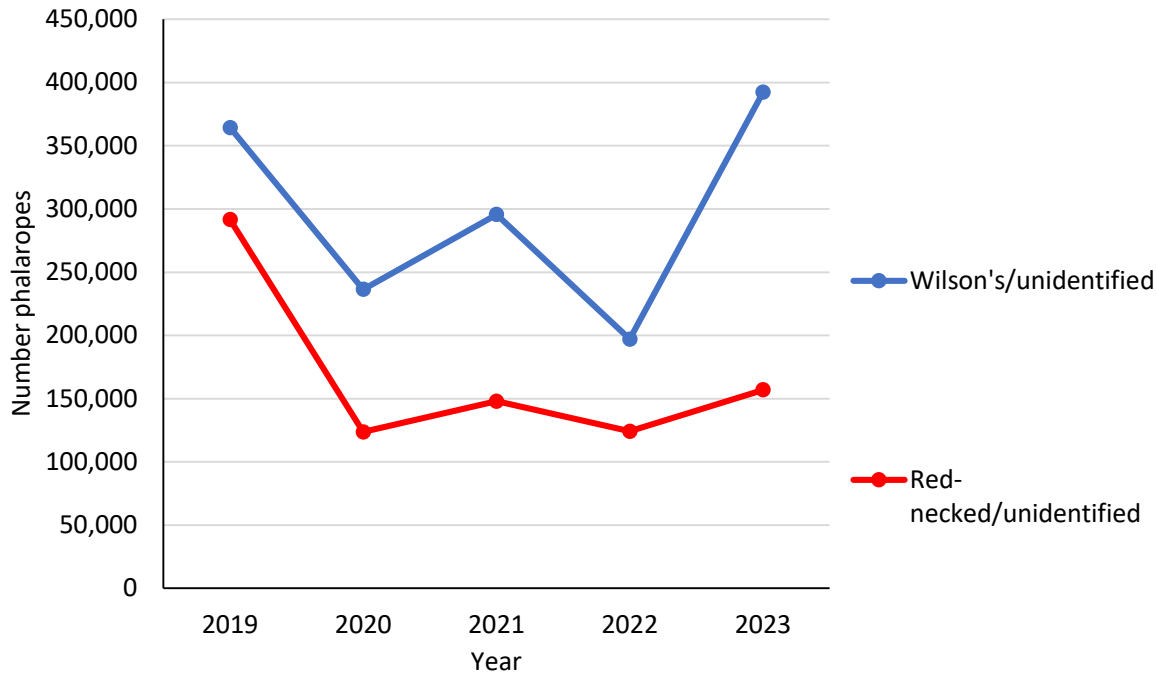


Figure 11. Peak counts of Wilson's/unidentified and red-necked/unidentified phalaropes across six sites, 2019-2023. Peak counts were identified based on the survey window with the highest count across sites of identified individuals of each phalarope species; the unidentified counts from the same window were added to each species' total. At Mono Lake, where there were two surveys per window, the unidentified count corresponding with the day of the peak count of identified of each species phalaropes was used.

Annual variation in red-necked phalarope numbers was more consistent across sites than that of Wilson's phalaropes. For example, all sites had relatively lower numbers of red-necked phalaropes in 2020 than in 2021 (Fig. 8). Similarly, all sites except GSL had increases in red-necked phalarope peak numbers in 2023 compared with 2022 (Figs. 8, 9). A caveat to this is that had we considered the large flock of unidentified birds at GSL on August 14 (367,540) to be red-necked rather than Wilson's phalaropes, then there would also have also been an increase in red-necked phalaropes in 2023 at GSL. Red-necked phalarope numbers increased dramatically at Mono Lake and Owens Lake in 2023, exceeding 2019–2022 high counts by >20,000 at Mono Lake and by >29,000 birds at Owens Lake (Fig. 9). The high inter-annual variability in phalarope numbers, and in habitat conditions, demonstrates the value of both multi-year and multi-site monitoring.

Unidentified phalaropes and interpretation of species-specific trends

The August 14, 2023 count at GSL of 294,475 unidentified phalaropes complicates interpretation of both Wilson's and red-necked high counts for 2023, because it occurred in mid-August when both species could be present. Also, the count was so large that considering the unidentified birds as one species or the other would affect interpretation of species' inter-annual trends. We treated them as all Wilson's phalaropes, because that survey window corresponded to the peak count of

identified Wilson’s phalaropes across the region. We acknowledge the assumptions inherent in our assignation of unidentified birds limits the interpretation of our results. On the August 14 survey at GSL there were 73,065 Wilson’s and 17,510 red-necked phalaropes identified, but these ratios do not necessarily correspond with the ratio of the unidentified phalaropes. Objectively, there were 385,050 phalaropes at GSL on August 14, 2023, 76% of which were unidentified. That all-phalarope count was the highest single-day count of any at GSL during 2019–2023, and was more than double the 2022 all-phalarope high count at GSL (183,690 on August 1). To further assess patterns at GSL, we examined the average sum of all phalaropes at GSL across surveys each year, excluding the late June/early July survey window, which was not surveyed every year (Fig. 12). Average counts at GSL in 2023 were relatively similar to those in 2020–2022 (Fig. 12). Also, 2022 had less variability in all-phalarope counts (SD = 49,800; range 64,295–183,690) than 2023 (SD = 138,121; range 48,525–385,050; Fig 11). The highest average all-phalarope total for a single year was in 2019, with over 250,000 phalaropes on three of the four surveys conducted (Fig. 12).

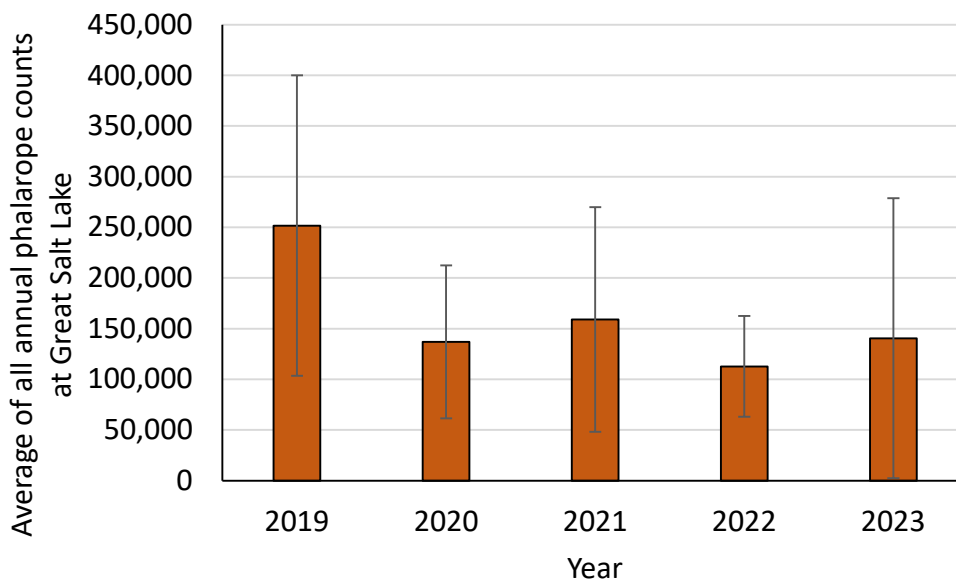


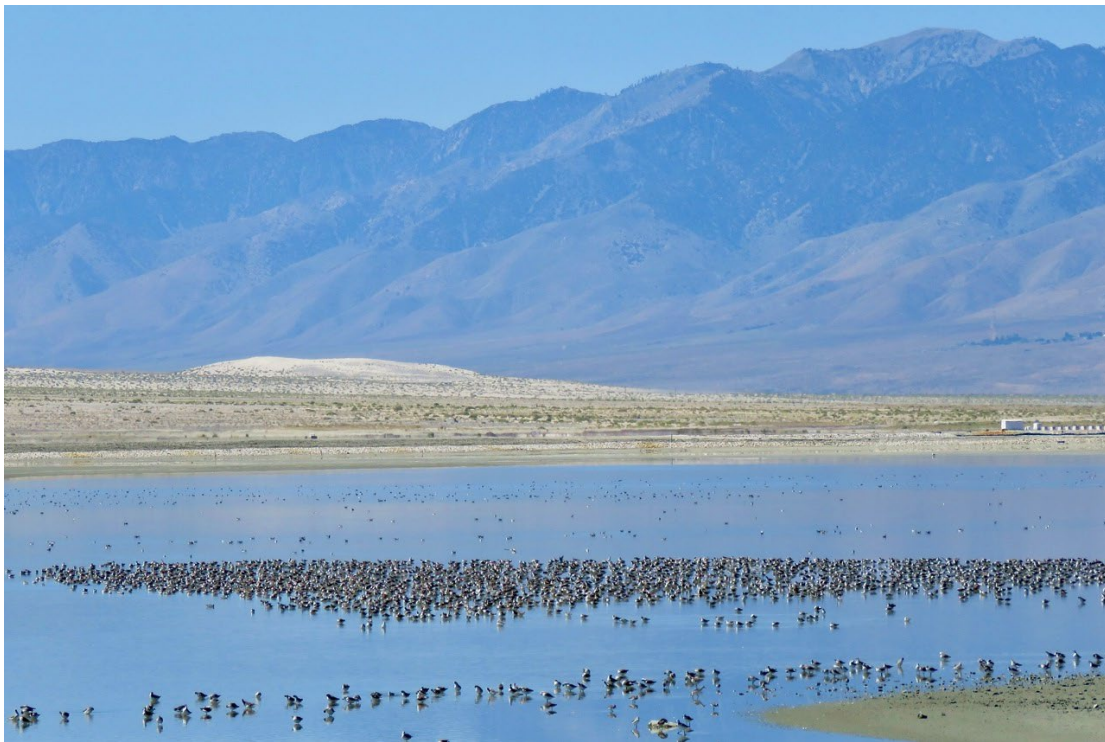
Figure 12. Average annual all-phalarope counts across all surveys at Great Salt Lake 2019–2023, excluding late June/early July surveys. Error bars show ± 1 standard deviation of the average. All-phalaropes counts include all Wilson’s, red-necked, and unidentified phalaropes. Surveys were conducted in all survey windows from mid-July to mid-September each year ($n = 5$ surveys per year), except 2019, which did not have a late-August/early September survey ($n = 4$ surveys).

Patterns of site use in association with habitat conditions

The inter-annual differences in relative phalarope use of different staging sites were likely driven, at least in part, by habitat conditions. For example, Lake Abert high counts of phalaropes (all categories) exceeded 20,000 in years when the lake had water (2019, 2020, and 2023; note that the 2020 count we refer to was outside a standardized survey window on July 1 that year [Appendix, Tables A1, A5]; Fig. 10). However, in 2021 and 2022, Lake Abert was nearly dry

and neither phalarope/unidentified species had counts exceeding 10,000 those years (Fig. 5; Appendix, Tables A1, A5). An approximately 40,000 bird increase in Wilson's phalaropes at Mono Lake in 2021 compared to 2020 could have been related to phalaropes moving to Mono Lake in response to the desiccation of Lake Abert.

At Owens Lake in 2023, the numbers of both Wilson's and red-necked phalaropes increased by an order of magnitude, possibly due to increased habitat availability and/or quality. Although the Owens Lake Dust Control Program Area is a heavily-managed system, conditions were also influenced by the exceptionally wet winter of 2022–2023. Storm damage to the Los Angeles Aqueduct system and excessive runoff in 2023 overwhelmed the capacity of the aqueduct and resulted in a diversion of more water to the Program Area than is typical. As a result, ponds in the Program Area remained filled throughout the summer and fall, as opposed to experiencing mid-summer contraction or desiccation. In addition to creating additional flooded acreage, the high water levels and filled ponds may have also moderated water quality and salinity values, keeping the ponds productive.



Flocks of phalaropes at Owens Lake in 2023, which hosted an order of magnitude more phalaropes in 2023 than in most years. Photo by Mike Prather.

Phalarope numbers increased at Lake Abert and Owens Lake in 2023 but Wilson's phalarope numbers decreased at Mono Lake (a high of 6,252 in 2023 vs. 12,409 in 2022; Fig. 6). It is unclear why fewer Wilson's phalaropes used Mono Lake in 2023, but rapidly changing conditions that influenced the food supply might have been a factor. Mono Lake rose nearly five feet from December 2022 (6,378.4') to September 2023 (6,383.2'; [Mono Basin Clearinghouse 2024](#)). Rising water levels when the lake surface is in this elevation range results in a greater

amount of submerged tufa rocks, providing hard substrates needed for alkali fly (*Ephydra hians*) reproduction (Herbst & Bradley 1993). However, the biomass of alkali fly larvae and pupae at Mono Lake are maximized at depths of 0.5-1.0 meters below the water surface, and substantially reduced at depths greater than three meters (Herbst & Bradley 1993). The greatest alkali fly biomass potential at Mono Lake was modeled to be at a lake elevation of 6,380' based on the mapping of available rocky substrates and fly densities at different depths (Herbst & Bradley 1993). Though salinity's impact on fly populations was not modeled by Herbst & Bradley (1993), the authors noted that lower salinities associated with a higher lake elevation would predict greater fly production at elevations >6,375' relative to the those of the substrate-only model; the net effect would predict a maximized fly population at higher lake elevations (Herbst & Bradley 1993). However, during periods of exceptionally rapid lake rise such as occurred during the spring and summer of 2023, there could be lag time in alkali fly production at Mono Lake as some tufa is submerged out of the optimal range of alkali flies while newly submerged tufa has yet to be colonized by flies.

In November 2022, the south part of GSL reached its all-time lowest recorded lake level (4,188.5'), and lake salinities (measured at Gilbert Bay) were above the optimal range for brine shrimp (*Artemia franciscana*; >120-160 g/L) from June 2022–February 2023 ([USGS 2024](#)). Brine fly (*Ephydra gracilis*) adults, larvae, and pupae comprise a significant proportion of the diet of phalaropes at GSL (Frank & Conover 2021). Qualitative observations by brine fly researchers suggested there were fewer flies at GSL in 2022 due to the high salinities and the exposure and desiccation of microbialites, the preferred substrate in GSL for larvae and pupae ([Larsen 2022](#)). Phalarope numbers at GSL were also relatively low in 2022 (Fig. 12). After the exceptionally wet winter in 2022–2023, the lake's level rebounded to 4,194.0', peaking in June 2023, and the salinity decreased from a high of 185 g/L in November 2022 to 132 g/L in June 2023 ([USGS 2024](#)). It is unclear how each phalarope species responded to these changing habitat conditions at GSL, but all-phalarope numbers were markedly lower in 2022 and increased in 2023 (Fig. 12). The all-phalarope high count at GSL in 2023 (385,050 on August 14) was the highest of any survey 2019–2023. However, that was the only all-phalarope count at GSL in 2023 that exceeded 100,000 during 2023, unlike other years such as 2019, in which three survey windows had counts of >250,000 total phalaropes (Appendix, Tables A1, A2, A3). Given the rapid habitat changes at GSL and the importance of the habitat there, more in-depth site-specific analyses examining timing, spatial use, and species ratios of our GSL results would be useful.

Overall trends: Wilson's phalaropes

Wilson's phalarope regional annual trends, based on the maximum sum across all sites during a single window, are challenging to interpret for 2023 because of the large count of unidentified phalaropes at GSL in mid-August. With our assumption that those unidentified birds were Wilson's phalaropes, regional Wilson's phalarope trends appear stable (Fig. 11). If those same unidentified birds were instead categorized as red-necked phalaropes, then it would appear that Wilson's phalaropes are on a declining trend. The reality is likely somewhere between these extremes, with the unidentified phalaropes being a mixture of both species, with unknown ratios. More work is needed to quantitatively address the issue of unidentified phalaropes.

Despite these uncertainties, maximum totals across all sites were substantially lower than those recorded in a 1986 survey of the same sites (Jehl 1988). Differences in methodology and coverage of each survey are important to keep in mind, but nevertheless average high counts of Wilson's/unidentified phalaropes from 2019–2023 (297,201 [SD 82,607]) were far lower than a 1986 count of 530,145 phalaropes at the same sites (excluding Owens Lake, which was dry in the 1980s; Jehl 1988). Note that survey dates for the 1986 counts fell in the date range of July 5–July 11 for all sites except GSL, which was surveyed on July 25 (GSL had 387,000 birds on that date), and that all birds were reported as Wilson's phalaropes (Jehl 1988). It is also noteworthy that our 2019–2023 surveys at Mono Lake only cover ~20% of the lake surface, compared to historical surveys that attempted to make whole-lake counts (the record single-day count of Wilson's phalaropes at Mono Lake was 93,000 in 1976; Winkler 1977). However, the change in survey methods at Mono Lake cannot fully account for the decrease of 232,944 Wilson's phalaropes across these sites compared with 1986 (difference of 1986 count and 2019–2023 averages).

The apparent decline in Wilson's phalaropes at staging sites since the 1980s aligns with a new analysis of International Shorebird Survey data indicating a >70% decline in Wilson's phalarope numbers in North America from 1980–2019 (Smith et al. 2023a). Breeding Bird Survey trends for North America, and site-specific trends in South America, also indicate declines in the Wilson's phalarope population since the 1980s (Castellino et al. 2024). Finally, new analyses of San Francisco Bay data (including data included in this report) indicated a 98% decline in phalaropes at San Francisco Bay salt ponds compared to counts in the 1980s (LaBarbera et al. 2023, Burns et al. 2023).

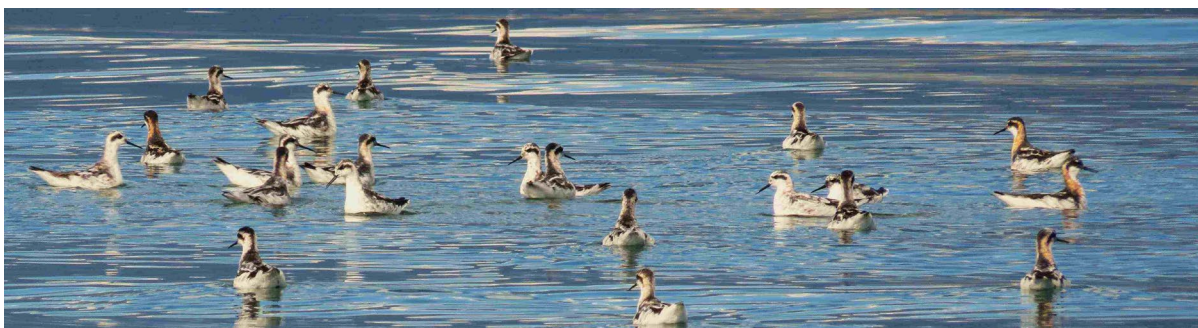
Overall trends: red-necked phalaropes

Region-wide red-necked phalarope numbers were higher in 2019 compared to 2020–2023 (Fig. 11). Interpretation of 2023 numbers was challenging because of the large unidentified phalarope count at GSL in August; assuming those phalaropes were Wilson's phalaropes, red-necked numbers appear fairly stable 2020–2023 (Fig. 11). If those unidentified phalaropes were instead assumed to be red-necked phalaropes, then 2023 saw a major increase over previous years that even exceeded the 2019 total. It is probable that the GSL count was composed of both species and the true number of red-necked phalaropes was somewhere in the middle of these two extremes. Based on the major increase in red-necked phalarope numbers at Mono Lake and Owens Lake in 2023, and relatively high numbers of late-season unidentified phalaropes at Lake Abert, it is plausible that there was a region-wide increase in red-necked phalarope numbers in 2023. A shore-based survey that registered a record 69,073 phalaropes at the Salton Sea on August 16, 2023 as part of the Intermountain West Shorebird Survey further supports the notion of high numbers of red-necked phalaropes regionally in 2023 (count composed of 16% red-necked phalaropes, 1% Wilson's, and the remainder unidentified; Point Blue Conservation Science unpublished data).

There are few historical data for red-necked phalarope populations at staging sites. Jehl (1988) only surveyed for Wilson's phalaropes, so there is not a historical population baseline from staging sites with which to compare red-necked phalaropes' current estimated abundances. On

the breeding grounds, Breeding Bird Survey data from Canada indicated a declining trend in red-necked phalarope abundance both Canada-wide and in all sub-regions, from 1971–2021 (-4.5%/year upper and lower confidence limits -8.12 and -0.79, “low” reliability; Smith et al. 2023b). In Breeding Bird Survey analysis, trends are defined as a yearly geometric mean of proportional changes in population size, expressed as a percentage, where a trend of zero indicates no annual change in proportional population size (Smith et al. 2021a).

Some historical data for red-necked phalaropes exist from Mono Lake, which was surveyed regularly during June–September 1981–1984, with single-day red-necked phalarope annual high counts ranging from 8,000–14,000 (average 11,500 [SD 2,517] $n = 4$ years; Jehl 1986). Our single-day Mono Lake red-necked phalarope high counts from 2019–2023 averaged 14,479 [SD 10,519]. It is notable that our contemporary counts had higher totals than the 1980s counts, considering our surveys cover approximately 20% of Mono Lake’s surface and Jehl attempted to survey the entire lake (Jehl 1986). A survey using a point-count based methodology similar to ours (but possibly with a smaller-count radius) registered single-day high counts at Mono Lake of 17,536 and 18,000 red-necked phalaropes in 1990 and 1991, respectively (Rubega & Keimel 2017). Based on the available data, it appears that contemporary numbers are relatively similar to historic numbers of red-necked phalaropes at Mono Lake, at least based on single-day counts. However, red-necked phalarope turnover rates are not well understood, and it is unclear how much importance should be put on single-day high counts, as was done for this report, versus cumulative season counts for this species. What might drive patterns in red-necked phalarope populations at staging sites—whether it is related to habitat conditions, success on the breeding grounds, survival during migration or on the wintering grounds, a combination of all three, or other factors—likewise remains unclear. It is likewise unknown whether individual red-necked phalaropes are flexible in their choice of using interior saline lakes for staging versus marine habitats (Rubega et al. 2020). If that choice is flexible, then it could influence the numbers of red-necked phalaropes occurring annually at saline lakes.



Red-necked phalaropes at Mono Lake in August 2023. Photo by Ryan Carle.

The future of phalarope habitat

Over this five-year period of monitoring, we have observed major habitat changes and emerging threats at crucial phalarope staging sites. GSL and Lake Abert are particularly threatened by the ongoing diversion of freshwater inputs. The extraordinarily wet winter of 2022–2023 raised the

water levels of GSL, Lake Abert, Mono Lake, and Owens Lake substantially. This precipitation gave a much-needed buffer of water to these ecosystems that phalaropes rely on. Unfortunately, the increased lake levels at GSL and Lake Abert may be short-lived if the diversion of freshwater inputs continues at current levels ([Larsen 2022](#), Larson 2023), particularly given the long-term climate trend toward aridification (Seager et al. 2007, Snyder et al. 2019, Hall et al. 2023). Coordinated monitoring of phalaropes has proven valuable for providing a modern baseline with which to assess phalarope responses to the unfolding habitat issues at saline lakes. As saline lakes continue to be threatened by water diversion and climate change across western North America, it is important to continue monitoring phalarope populations to understand their response to rapidly changing habitat. Phalaropes are a bell-weather indicator for the hemispheric network of saline lakes, and the near-future is a crucial time in the effort to protect saline lakes.

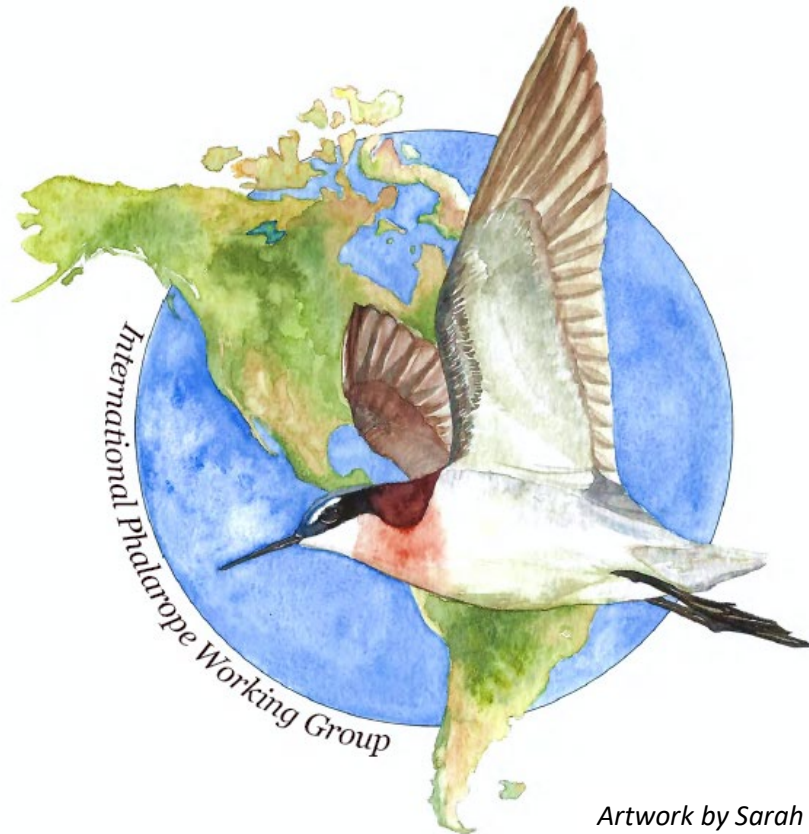
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Artwork by Sarah Hecoeks

Literature cited

- Burns, G., & Van Schmidt, N. D. (2023). *Bridging the gap between disparate phalarope survey methodologies to evaluate population status*. San Francisco Bay Bird Observatory. Report prepared for the South Bay Salt Pond Restoration Project.
https://www.southbayrestoration.org/sites/default/files/documents/bridging_phalarope_survey_data_report_final.pdf
- Carle R. and Rubega, M. 2019. International Phalaropes Meeting Summary. Unpublished report of International Phalarope Working Group.
https://www.researchgate.net/publication/348579766_Mono_Lake_Phalarope_Surveys_2020_Report
- Carle, R. and Rubega, M. 2020. Mono Lake phalarope surveys 2020 report. Unpublished report to California State Parks.
https://www.researchgate.net/publication/348579766_Mono_Lake_Phalarope_Surveys_2020_Report
- Carle, R.D., Burns, G., Clapp, M., Caruso, K., House, D., Larson, R., Lewis, A., McKellar, A.E., Neill, J., Prather, M., Reuland, J., and M. Rubega. 2022. Coordinated phalarope surveys at western North American staging sites 2019-2021. Unpublished report of the International Phalarope Working Group.

- <https://www.oikonos.org/es/publicaciones/coordinated-phalarope-surveys-at-western-north-american-staging-sites-2019-2021>
- Carle R.D., Burns, G. Caruso, K., House, D., Larson, R. Lewis, A., McKellar A.E., Neill, J., Prather, M., Reuland, J., Rubega, M, and K. Tarr. 2023. Coordinated phalarope surveys at western North American staging sites 2019–2022. Unpublished report of the International Phalarope Working Group. <https://www.oikonos.org/es/publicaciones/coordinated-phalarope-surveys-at-western-north-american-staging-sites-2019-2022>
- Castellino, M., Carle, R., Lesterhuis, A. & R. Clay. (2024). Conservation Plan for Wilson’s Phalarope (*Phalaropus tricolor*). Version 2.0. Manomet Center for Conservation Sciences, Manomet, Massachusetts. https://whsrn.org/plan_wiph_2024_final_en/
- Frank, M. G., & Conover, M. R. 2021. Diets of Staging Phalaropes at Great Salt Lake, Utah. *Wildlife Society Bulletin*, 45(1), 27–35. <https://doi.org/10.1002/wsb.1157>
- Hall, D. K., Kimball, J. S., Larson, R., DiGirolamo, N. E., Casey, K. A., & Hulley, G. 2023. Intensified warming and aridity accelerate terminal lake desiccation in the Great Basin of the western United States. *Earth and Space Science*, 10, e2022EA002630. <https://doi.org/10.1029/2022EA002630>
- Herbst, D.B., & Bradley, T.J. 1993. A population model for the alkali fly at Mono Lake: Depth distribution and changing habitat availability. *Hydrobiologia*, 267, 191–201.
- Herbst, D.B., & Prather, M. 2014. Owens Lake – From dustbowl to mosaic of salt water habitats. *Lakeline Fall* 2014: 34-39.
- Jehl, J.R. 1986. Biology of Red-necked Phalaropes (*Phalaropus lobatus*) at the western edge of the Great Basin in fall migration. *Great Basin Naturalist* 46: 185-197.
- Jehl, J. R. 1988. Biology of the Eared Grebe and Wilson's Phalarope in the nonbreeding season: a study of adaptations to saline lakes. *Studies in Avian Biology* 12.
- Jehl, J. R. 1999. Population studies of Wilson's Phalaropes at fall staging areas, 1980-1997: A challenge for monitoring. *Waterbirds* 22: 37-46.
- LaBarbera, K., Burns, G., & Van Schmidt, N. D. 2023. *Review and analysis of historical phalarope population trends*. San Francisco Bay Bird Observatory. Report prepared for the South Bay Salt Pond Restoration Project
- Larsen, L. 2022. December 8. Water districts vowed to send billions of gallons to the Great Salt Lake this year. Here’s how it’s going. *The Salt Lake Tribune*, December 8, 2022. <https://www.sltrib.com/news/environment/2022/12/08/water-districts-vowed-send/>
- Larson, R., Eilers, J., Kreuz, K., Pecher, W.T., DasSarma, S. and Dougill, S. 2016. Recent desiccation-related ecosystem changes at Lake Abert, Oregon: a terminal alkaline salt lake. *Western North American Naturalist* 76: 389-404.
- Larson, R. 2023. *A Natural History of Oregon’s Lake Abert in the Northwest Great Basin Landscape*. University of Nevada Press, Reno Nevada.
- Rubega, M. and B. Keimel. 2017. Final report on a 2017 census of phalaropes at Mono Lake, California. Unpublished report to California State Parks.
- Rubega, M. A., D. Schamel, and D. M. Tracy. 2020. Red-necked Phalarope (*Phalaropus lobatus*), version 1.0. In *Birds of the World* (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bow.renpha.01>
- Seager, R., Ting, M., Held, I., Kushnir, Y., Lu, J., Vecchi, G., Huang, H.-P., Harnik, N., Leetmaa, A., Lau, N.-C., Li, C., Velez, J., & Naik, N. (2007). Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America. *Science*,

- 316(5828), 1181–1184. <https://doi.org/10.1126/science.1139601>
- Sahagún, L. 2024. Cost of Owens Valley storm damage continues to mount for Los Angeles Department of Water and Power. Los Angeles Times, February 18, 2024. <https://www.latimes.com/environment/story/2024-02-18/cost-of-owens-valley-storm-damage-continues-to-mount-for-los-angeles-department-of-water-and-power>
- Smith, P. A., A. C. Smith, B. Andres, C. M. Francis, B. Harrington, C. Friis, R. I. G. Morrison, J. Paquet, B. Winn, & S. Brown. 2023a. Accelerating declines of North America's shorebirds signal the need for urgent conservation action. *Ornithological Applications* 125:duad000.
- Smith, A.C., Hudson, M-A.R. Aponte, V.I., English, W.B., and Francis, C.M. 2023b. North American Breeding Bird Survey - Canadian Trends Website, Data-version 2021. Environment and Climate Change Canada, Gatineau, Quebec, K1A 0H3
- Snyder, K. A., Evers, L., Chambers, J. C., Dunham, J., Bradford, J. B., & Loik, M. E. (2019). Effects of Changing Climate on the Hydrological Cycle in Cold Desert Ecosystems of the Great Basin and Columbia Plateau. *Rangeland Ecology & Management*, 72(1), 1–12. <https://doi.org/10.1016/j.rama.2018.07.007>
- Tarjan, L.M. 2019. Migration timing and spatial distribution of phalaropes in San Francisco Bay. Report prepared for the South Bay Salt Pond Restoration Project Management Team. Revised April 2020.
- U.S Geological Survey (2023). Great Salt Lake Hydro Mapper. <https://webapps.usgs.gov/gsl/>
- Winkler, D.W. 1977. *AN ECOLOGICAL STUDY OF MONO LAKE, CALIFORNIA*. Institute of Ecology Publication.
- Wurtsbaugh, W.A., Miller, C., Null, S.E., DeRose, R.J., Wilcock, P., Hahnenberger, M., Howe, F. and Moore, J. 2017. Decline of the world's saline lakes. *Nature Geoscience* 11: 816–821.

Appendix

Table A1. Maximum Wilson's phalarope counts in survey windows at all sites surveyed. Wilson's phalarope counts were included in this table, and in summary and analysis for this report, if they fell within the specific survey window dates or were ≤ 2 days outside of it. Only Mono Lake consistently had >1 count per survey window. At south San Francisco Bay salt ponds (SF Bay), Owens Lake, and Chaplin Lake, the entire site was sometimes surveyed over multiple days (maximum 3 days). Counts that were outside exact survey dates (≤ 2 days) are italicized. The late June-early July survey window was surveyed only in 2021-2023.

Year	Survey window	Window dates	Great Salt Lake	Mono Lake	Lake Abert	Owens Lake	SF Bay	Chaplin Lake	Total
2023	late June-early July	June 29- July 5	18,400	6,240	0*	404	177	No survey	25,221
2023	mid-July	July 14-July 20	19,275	3,016	0*	5,800	1080	2,651	31,822
2023	late July-early August	July 29-August 4	14,630	1,427	0*	27,156	146	255	43,614
2023	mid-August	August 13-August 19	73,065	86	0*	170	136	388	73,845
2023	late August-early September	August 28-September 3	2,990	13	0*	162	100	137	3,402
2023	mid-September	September 12-September 18	2,850	0	0*	0	43	No survey	2,893
2022	late June-early July	June 29-July 5	No survey	6,078	<i>6,500</i>	74	85	No survey	12,737
2022	mid-July	July 14-July 20	325	12,409	No survey	43	735	3,129	16,641
2022	late July-early August	July 29-August 3rd	36,970	10,805	0	299	10	14,535	62,619
2022	mid-August	August 13-August 19	19,170	5,887	0	1,169	19	19	26,264

2022	late August-early September	August 29-September 3	6,080	129	0	50	220	No survey	6,479
2022	mid-September	September 12-September 18	150	60	0	10	15	No survey	235
2021	late June-early July	June 29-July 5	35,750	22,440	9855	19	738	No survey	68,802
2021	mid-July	July 14-July 20	23,825	45,143	No survey	1,987	12	780	71,747
2021	late July-early August	July 29-August 3	93,310	1,579	0	11	240	580	95,720
2021	mid-August	August 13-August 19	14,490	158	0	425	24	0	15,097
2021	late August-early September	August 28-September 3	975	No survey	No survey	0	33	No survey	1,008
2021	mid-September	September 12-September 18	1,185	0	No survey	0	0	No survey	1,185
2020	mid-July	July 15-July 21	122,850	2,475	80	90	767	26	126,288
2020	late July-early August	July 29-August 4	74,045	2,765	450	670	446	120	78,496
2020	mid-August	August 13-August 19	10,530	637	No survey	1,144	162	5	12,478
2020	late August-early September	August 31-September 6	145	15	6	81	110	No survey	357
2020	mid-September	September 15-September 21	100	No survey	25	0	0	No survey	125
2019	mid-July	July 11-July 17	337,698	No survey	0	No survey	No survey	No survey	337,698

2019	late July-early August	July 30-August 5	231,920	2,712	2,050	No survey	No survey	No survey	236,682
2019	mid-August	August 16-August 22	4,895	312	0	No survey	No survey	No survey	5,207
2019	late August-early September	August 31-September 6	No data	4	0	No survey	No survey	No survey	4
2019	mid-September	September 11-September 17	2	0	0	No survey	No survey	No survey	2

*Birds were not identified to species at Lake Abert in 2024; see Table A3 totals of unidentified birds for Lake Abert.

Table A2. Maximum red-necked phalarope counts in survey windows at all sites surveyed. Red-necked phalarope counts were included in this table, and in summary and analysis for this report, if they fell within the specific survey window dates or were ≤ 2 days outside of it. Only Mono Lake consistently had >1 count per survey window. At south San Francisco Bay salt ponds (SF Bay), Owens Lake, and Chaplin Lake, the entire site was sometimes surveyed over multiple days (maximum 3 days). Counts that were outside exact survey dates (≤ 2 days) are italicized. The late June-early July survey window was surveyed only in 2021-2023.

Year	Survey window	Window dates	GSL	Mono	Abert	Owens	SF Bay	Chaplin	Total
2023	late June-early July	June 29- July 5	715	0	0*	0	0	No survey	715
2023	mid-July	July 14-July 20	8,130	802	0*	2,650	172	1,022	12,776
2023	late July-early August	July 29-August 4	17,290	6,733	0*	559	774	<i>650</i>	26,006
2023	mid-August	August 13-August 19	17,510	20,689	0*	3,170	1,669	123	43,161
2023	late August-early September	August 28-September 3	54,193	32,657	0*	11,560	6,554	4	104,968
2023	mid-September	September 12-September 18	19,150	24,768	0*	12,576	3,344	No survey	59,838

2022	late June-early July	June 29-July 5	No survey	0	0	0	0	No survey	0
2022	mid-July	July 14-July 20	200	9	No survey	0	186	88	483
2022	late July-early August	July 29-August 3rd	17,985	8,345	0	117	87	72	26,606
2022	mid-August	August 13-August 19	59,075	10,587	0	1,277	1,557	0	72,496
2022	late August-early September	August 29-September 3	48,000	10,064	0	1,404	4,357	No survey	63,825
2022	mid-September	September 12-September 18	16,470	1,831	10	533	2,882	No survey	21,726
2021	late June-early July	June 29-July 5	6,710	5	0	0	35	No survey	6,750
2021	mid-July	July 14-July 20	3,570	218	No survey	0	313	407	4,508
2021	late July-early August	July 29-August 3	29,255	1,694	300	3	370	0	31,622
2021	mid-August	August 13-August 19	28,170	6,378	0	110	1,196	0	35,854
2021	late August-early September	August 28-September 3	10,115	No survey	No survey	2,719	2,992	No survey	15,826
2021	mid-September	September 12-September 18	9,065	12,647	No survey	2,489	6,767	No survey	30,968
2020	mid-July	July 15-July 21	0	129	8	5	182	50	374
2020	late July-early August	July 29-August 4	2,505	8,220	300	0	758	0	11,783

2020	mid-August	August 13- August 19	28,235	10,891	No survey	280	904	0	40,310
2020	late August- early September	August 31- September 6	43,725	8,252	267	86	1,700	No survey	54,030
2020	mid- September	September 15- September 21	<i>6,570</i>	No survey	<i>675</i>	<i>1,550</i>	935	No survey	9,730
2019	mid-July	July 11-July 17	33,030	No survey	0	No survey	No survey	No survey	33,030
2019	late July- early August	July 30- August 5	81,330	2,612	5	No survey	No survey	No survey	83,947
2019	mid-August	August 16- August 22	149,660	4,921	0	No survey	No survey	No survey	154,581
2019	late August- early September	August 31- September 6	No survey	5,573	0	No survey	No survey	No survey	5,573
2019	mid- September	September 11- September 17	35,100	4,707	<i>70</i>	No data	No data	No data	39,807

Table A3. Maximum unidentified phalarope counts in survey windows at all sites surveyed. Unidentified phalarope (UNID) counts were included in this table, and in summary and analysis for this report, if they fell within the specific survey window dates or were ≤ 2 days outside of it. Only Mono Lake consistently had >1 count per survey window. "Mono WIPH high-date" and "Mono RNPH high-date" columns show unidentified counts corresponding to the high-count date within the window for Wilson's (WIPH) and red-necked (RNPH) phalaropes at Mono Lake, due to multiple counts per window there. At south San Francisco Bay salt ponds (SF Bay), Owens Lake, and Chaplin Lake, the entire site was sometimes surveyed over multiple days (maximum 3 days). Counts that were outside exact survey dates (≤ 2 days) are italicized. The late June-early July survey window was surveyed only in 2021-2023.

Year	Survey window	Window dates	GSL	Mono WIPH high-date	Mono RNPB high-date	Lake Abert	Owens Lake	SF Bay	Chaplin Lake	UNID total on WIPH high count dates	UNID total on RNPB high count dates
2023	late June-early July	June 29- July 5	30,815	12	12	10,800	0	0	No survey	41,627	41,627
2023	mid-July	July 14- July 20	65,040	0	0	7,870	0	2	0	72,912	72,912
2023	late July-early August	July 29- August 4	44,625	100	0	28,200	2,820	59	0	75,804	75,704
2023	mid-August	August 13- August 19	294,475	172	172	9,010	14,770	200	0	318,627	318,627
2023	late August-early September	August 28-Sep 3	42,750	500	500	8,200	175	334	0	51,959	51,959
2023	mid-September	Sep 12- Sep 18	26,525	0	0	2,500	20,321	301	No survey	49,647	49,647
2022	late June-early July	June 29-July 5	No survey	11	11	0	0	2	No survey	13	13
2022	mid-July	July 14- July 20	63,770	0	70	No survey	0	0	300	64,070	64,140
2022	late July-early August	July 29- August 3rd	128,735	2,058	658	2,500	0	0	1,200	134,493	133,093
2022	mid-August	August 13- August 19	50,605	3	3	1,050	0	30	0	51,688	51,688
2022	late August-early Sep	August 29-Sep 3	67,225	510	510	2,870	0	0	No survey	70,605	70,605
2022	mid-September	Sep 12- Sep 18	49,145	211	211	0	125	875	No survey	50,356	50,356
2021	late June-early July	June 29-July 5	81,977	0	60	0	0	16	No survey	81,993	82,053
2021	mid-July	July 14- July 20	202,125	245	245	No survey	0	414	500	203,284	203,284
2021	late July-early August	July 29- August 3	186,420	10,253	10,253	3,070	76	84	1	199,904	199,904

2021	mid-August	August 13-August 19	102,675	5,105	5,105	4,315	0	3	0	112,098	112,098
2021	late August-early Sep	August 28-Sep 3	36,700	No data	No data	No survey	522	792	No survey	38,014	38,014
2021	mid-September	Sep 12-Sep 18	53,545	0	0	No data	515	0	No survey	54,060	54,060
2020	mid-July	July 15-July 21	107,990	1	1	2,000	33	140	0	110,164	110,164
2020	late July-early August	July 29-August 4	119,335	1385	743	0	0	5	0	120,725	120,083
2020	mid-August	August 13-August 19	62,270	241	37	No survey	76	0	30	62,617	62,413
2020	late August-early Sep	August 31-Sep 6	69,620	0	0	0	44	0	No survey	69,664	69,664
2020	mid-September	Sep 15-Sep 21	36,975	No survey	No survey	0	0	32	No survey	37,007	37,007
2019	mid-July	July 11-July 17	2,386	No survey	No survey	24,261	No survey	No survey	No survey	26,647	26,647
2019	late July-early August	July 30-August 5	12,735	12,817	12,817	0	No survey	No survey	No survey	25,552	25,552
2019	mid-August	August 16-August 22	114,770	107	173	22,000	No survey	No survey	No survey	136,877	136,943
2019	late August-early September	August 31-Sep 6	No survey	0	0	1,050	No survey	No survey	No survey	1,050	1,050
2019	mid-September	Sep 11-Sep 17	3640	0	0	200	No survey	No survey	No survey	3,640	3,640

Table A4. Sums of peak counts across six sites during each survey window for each phalarope species and species/unidentified phalaropes combined. The highest annual counts per year for each phalarope species and species/unidentified phalarope are in bold. Only Great Salt Lake, Mono Lake, and Lake Abert are included in 2019 totals because of limited data from other sites. Data from all six sites are included in 2020-2023 totals. The late June-early July survey window was surveyed only in 2021-2023. WIPH is Wilson's phalarope and RNPH is red-necked phalarope.

Year	Survey window	Window dates	WIPH sum	WIPH/unidentified sum	RNPH sum	RNPH/unidentified sum
2023	late June-early July	June 29-July 5	25,221	66,848	715	42,342
2023	mid-July	July 14-July 20	31,822	104,734	12,776	85,688
2023	late July-early August	July 29-August 4	43,614	119,418	26,006	101,710
2023	mid-August	August 13-August 19	73,845	392,472	43,161	361,788
2023	late August-early September	August 28-September 3	3,402	55,361	104,968	156,927
2023	mid-September	September 12-September 18	2,893	52,540	59,838	109,485
2022	late June-early July	June 29-July 5	12,737	12,750	0	13
2022	mid-July	July 14-July 20	16,641	80,711	483	64,623
2022	late July-early August	July 29-August 3rd	62,619	197,112	26,606	159,699
2022	mid-August	August 13-August 19	26,264	77,952	72,496	124,184
2022	late August-early September	August 29-September 3	6,479	77,084	63,825	134,430
2022	mid-September	September 12-September 18	235	50,591	21,726	72,082
2021	late June-early July	June 29-July 5	68,802	150,795	6,750	88,803
2021	mid-July	July 14-July 20	71,747	275,031	4,508	207,792

2021	late July- early August	July 29- August 3	95,720	295,624	31,622	231,526
2021	mid-August	August 13- August 19	15,097	127,195	35,854	147,952
2021	late August- early September	August 28- September 3	1,008	39,022	15,826	53,840
2021	mid- September	September 12- September 18	1,185	55,245	30,968	85,028
2020	mid-July	July 15-July 21	126,288	236,452	374	110,538
2020	late July- early August	July 29- August 4	78,496	199,221	11,783	131,866
2020	mid-August	August 13- August 19	12,478	75,095	40,310	102,723
2020	late August- early September	August 31- September 6	357	70,021	54,030	123,694
2020	mid- September	September 15- September 21	125	37,132	9,730	46,737
2019	mid-July	July 11-July 17	337,698	364,345	33,030	59,677
2019	late July- early August	July 30- August 5	236,682	262,234	83,947	109,499
2019	mid-August	August 16- August 22	5,207	142,084	154,581	291,524
2019	late August- early September	August 31- September 6	4	1,054	5,573	6,623
2019	mid- September	September 11- September 17	2	3,642	39,807	43,447

Table A5. Phalarope counts occurring outside of standardized survey windows that were not used in analyses, 2019-2023. These phalarope counts were not included in

summary results but followed the same protocols as other counts. Counts 3 or more days outside of survey windows were never used in analyses. Counts 1-2 days outside of survey windows were used in analyses and are listed in tables A1-A3 (italicized cells) if no count other survey occurred within exact survey window dates. When there was both a survey 1-2 days outside a window and one within the exact window dates at the same site, we preferentially used results from the survey in the exact window dates, even if the survey outside the window had more birds. In those cases, we list the counts from 1-2 days outside the survey window, which were not used in analyses, in this table. When there were surveys that were 1-2 days outside a survey window at a given site and no survey in the exact window dates, we used the count with the higher total number of phalaropes in analyses (Tables A1-A3) and the count with lower numbers is listed here. Noteworthy survey totals from outside the survey windows are sometimes referenced in the text. The late June-early July window was first introduced and standardized in 2021. The 7/1/2020 count at Lake Abert would have fallen in that window had it been surveyed that year. SF Bay is south San Francisco Bay salt ponds.

Year	Site	Days outside window	Survey Date	Wilson's	Red-necked	Unidentified
2023	Chaplin Lake	3	7/11/2023	2,222	977	0
2023	Chaplin Lake	3	8/25/2023	178	32	0
2023	Lake Abert	1	6/28/2023	0	0	0
2023	Lake Abert	1	7/21/2023	0	0	5,900
2023	Lake Abert	2	7/27/2023	0	0	31,190
2023	Lake Abert	3	8/10/2023	0	0	25,578
2023	Lake Abert	3	8/25/2023	0	0	13,000
2023	Lake Abert	3	9/9/2023	0	0	5,000
2023	SF Bay	9, 10	6/19/2023, 6/20/2023	0	0	0
2023	SF Bay	7, 8	9/25/2023, 9/26/2023	1	1,565	53
2022	Lake Abert	3	7/23/2022	0	0	5,400
2022	Owens Lake	3	7/26/2022	539	38	0
2022	SF Bay	8	6/21/2022	18	0	0
2022	SF Bay	9	9/27/2022	0	1,963	0
2021	Lake Abert	2	7/27/2021	0	0	3,930
2021	SF Bay	10	9/28/2021	0	811	0
2020	Chaplin Lake	3	7/24/2020	178	0	0
2020	Chaplin Lake	3	8/7/2020	370	0	0
2020	Lake Abert	14	7/1/2020	21,800	30	0
2020	SF Bay	8	7/7/2020	548	1	0
2020	SF Bay	8	9/29/2020	1	40	0
2019	Lake Abert	24	6/17/2019	0	0	736
2019	Lake Abert	1	7/27/2019	1084	5	0
2019	Lake Abert	6	8/10/2019	0	0	89,000
2019	Lake Abert	2	8/24/2019	160	170	0

Table A6. Total estimated lake surface areas (km²) of phalarope survey points at Mono Lake (using November 2019 satellite imagery of lake level). See Carle and Rubega 2020 for full methodological details of Mono Lake surveys.

Phalarope Survey Point	Total Count Area (km ²)
Boat point – 400 m radius	0.50
County Park shore survey	0.20
Lee Vining Tufa shore survey point 1	0.13
Lee Vining Tufa shore survey point 2	0.16
Old Marina shore survey	0.47
South Tufa shore survey point 1	0.22
South Tufa shore survey point 2	0.25
Black Point shore survey	0.66

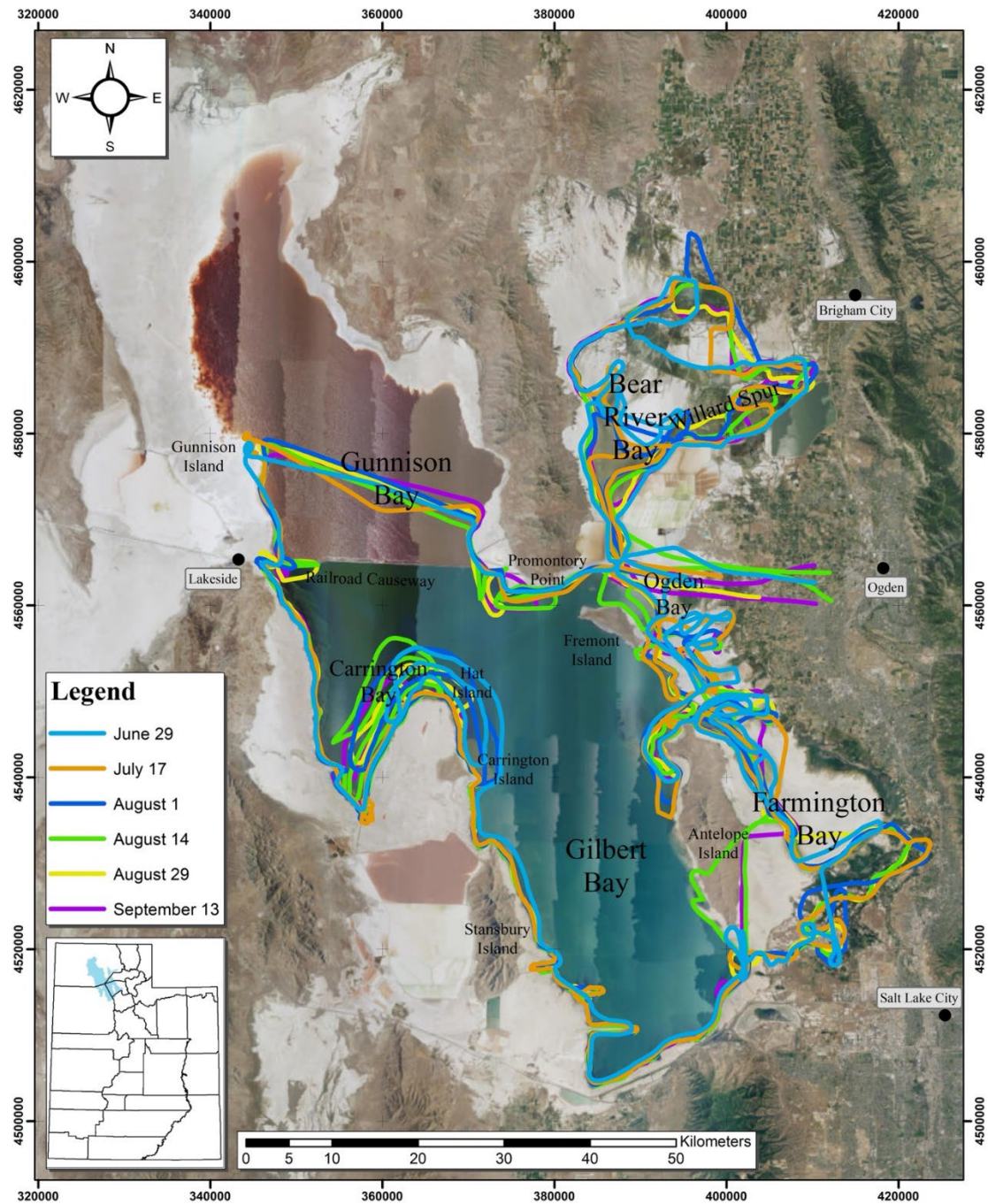


Figure A1. Phalarope survey flight paths in 2023 at Great Salt Lake, Utah. All flights originated and ended at the Ogden Airport and generally traveled in a counterclockwise direction.

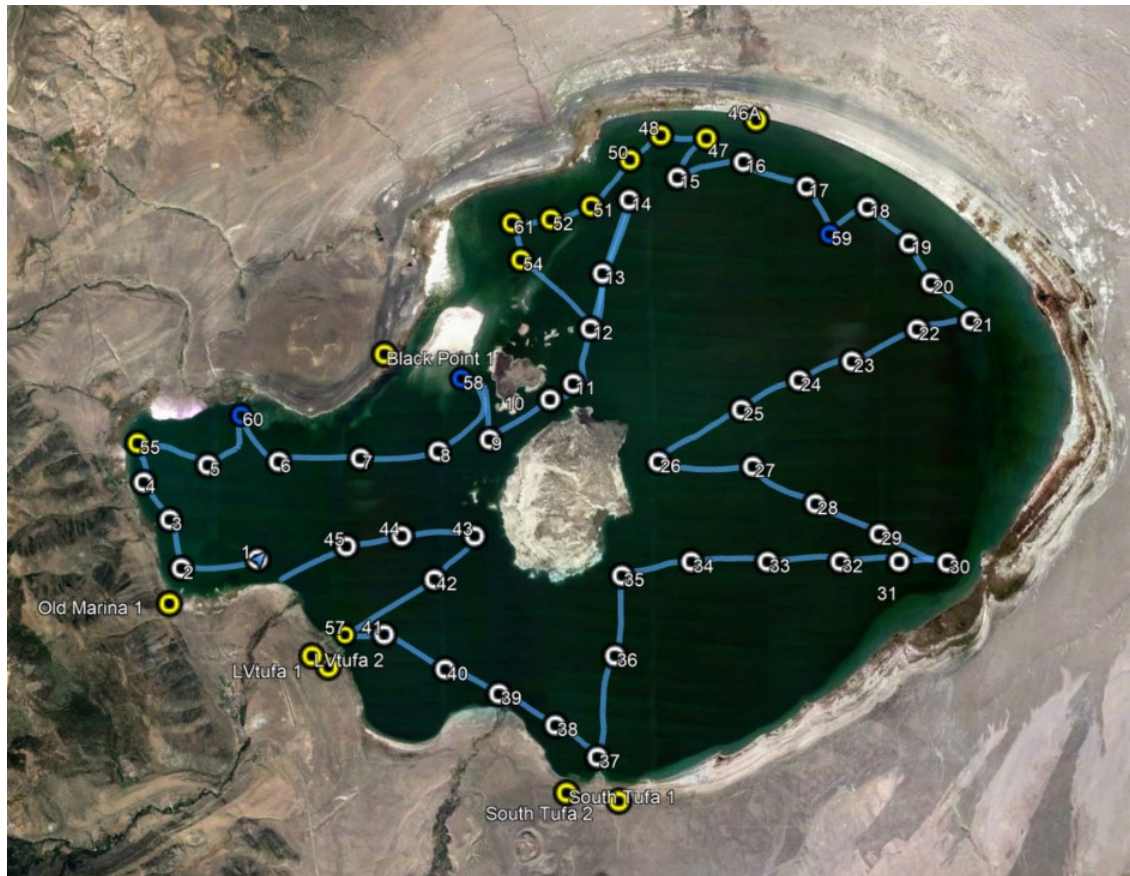
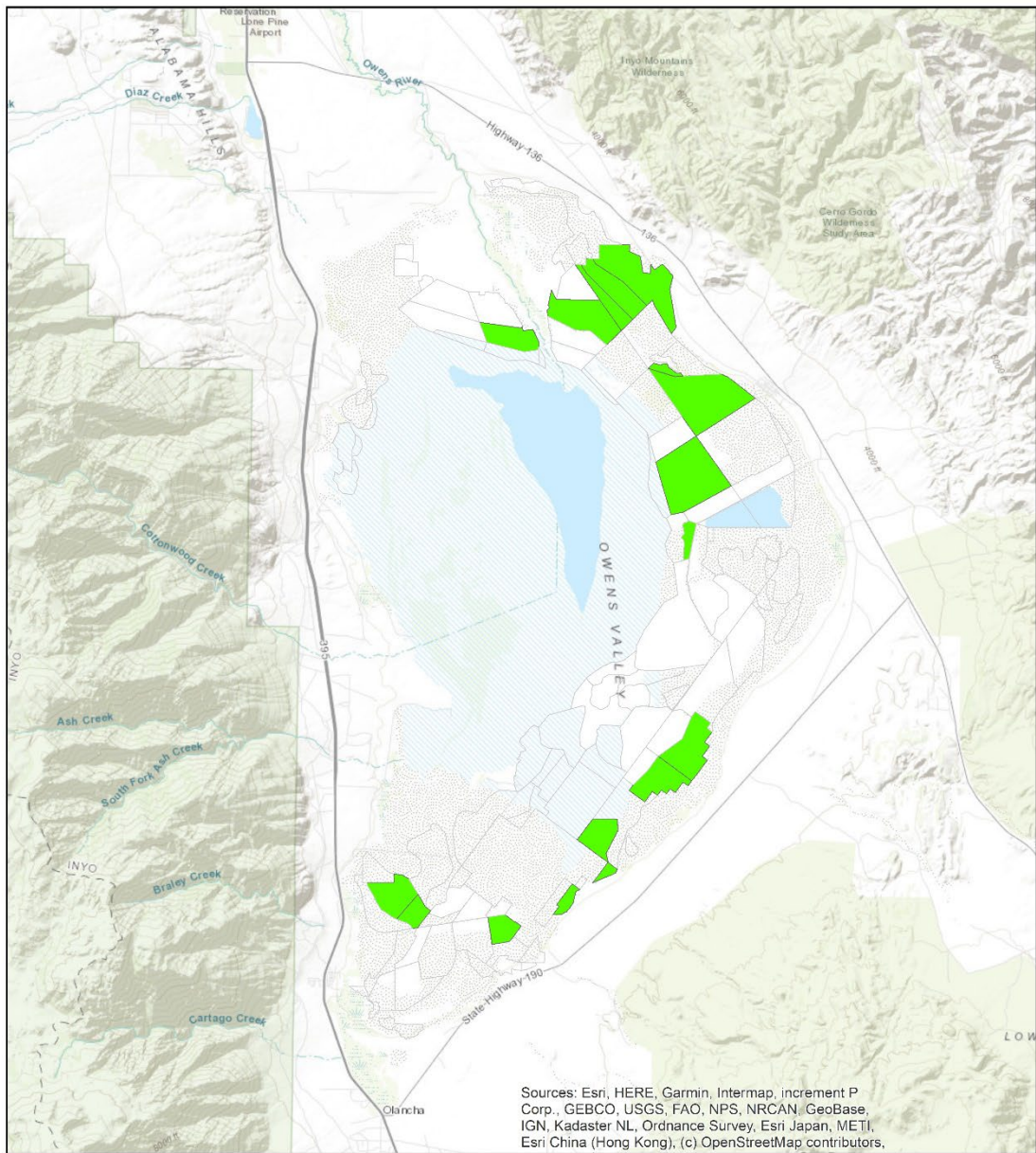


Figure A2. Mono Lake phalarope survey points. White dots are original 1990-1991 phalarope boat survey points, yellow dots are points added since surveys were re-initiated in 2017. Blue lines connecting dots show the typical route of the boat survey between points—counts are only made at points. Numbered dots are boat survey points, named dots are shore survey points. New points were added in areas likely to be used by phalaropes that were dry when the survey was originally designed in the 1990s.



**Owens Lake Dust Control Program DCAs
Surveyed for Phalaropes**

☐ No
☒ Yes



0 2.5 5
Miles

Map Prepared by Los Angeles Department of Water and Power

Figure A3. Owens Lake dust control area "cells." Sixteen Dust Control Areas (DCAs) were surveyed by Los Angeles Department of Water and Power and Eastern Sierra Audubon in 2023.

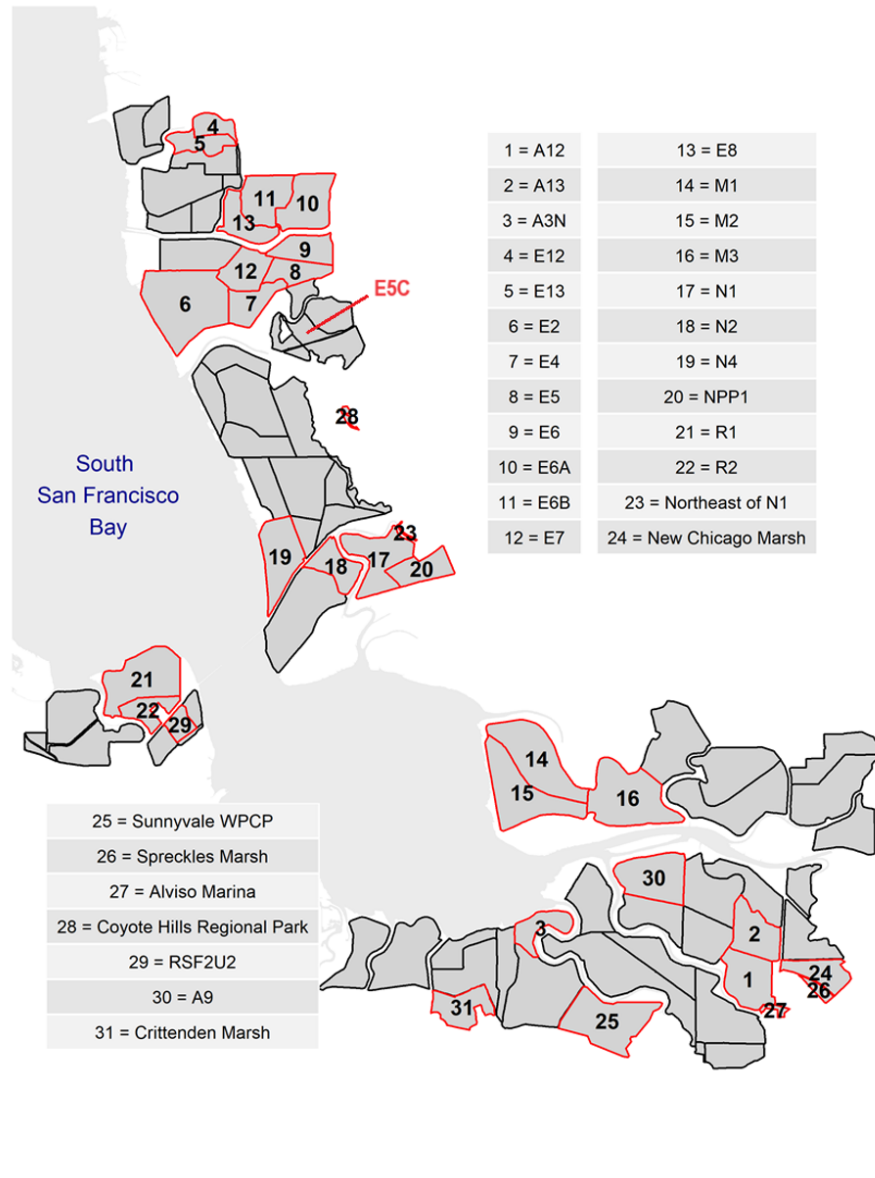


Figure A4. Map of 2023 phalarope survey sites in south San Francisco Bay. San Francisco Bay Bird Observatory used an area search approach to survey for phalaropes at sites outlined in red. Sites 1-22 and 29-30 are former salt production ponds. Other former and current salt production ponds are outlined in black. Sites 23-27 and 31 include water treatment ponds and diked wetlands. Pond E5C, which was not formally part of the survey area because it was historically not used by phalaropes, had an unusual observation of 2,400 red-necked phalaropes on August 22, 2023, outside of the formal survey window.

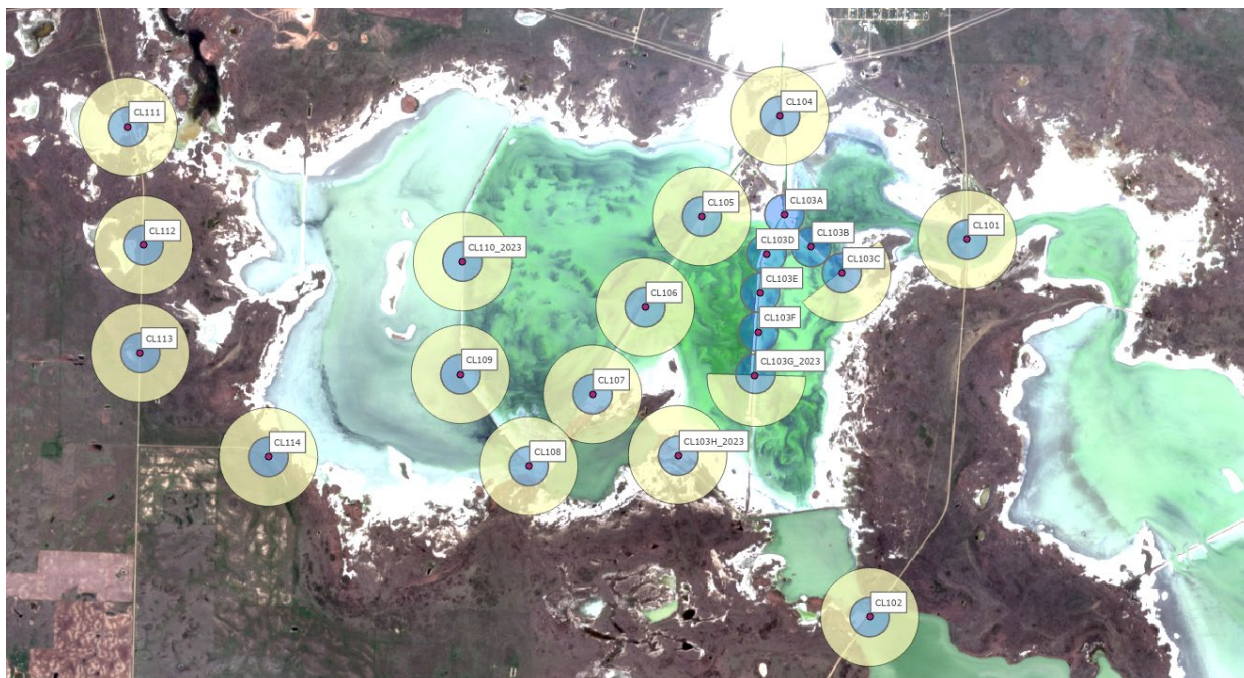


Figure A5. Point count stations at Chaplin Lake, Saskatchewan. Blue circles indicate the 0-200 m buffers and the yellow circles indicate the 200-500 m buffers.