

Appendix 2B: Documentation for the 2020 Analysis of the GSL Waterbird Survey, with Notes on Result Interpretation

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Background

The GSL Waterbird Survey has been conducted for more than 20 years. Data from 1997 through 2001 were initially analyzed and summarized in a report published during 2002 (<https://wildlife.utah.gov/gsl/waterbirdsurvey/>). That report contained a comprehensive narrative along with eight appendices that provided summary tables, plots, and maps. The objective of the recent 2020 analysis was to create a similar set of appendices using a much larger dataset collected between 1997 and 2017.

There were several issues to consider when creating a dataset spanning 1997 through 2017. The survey protocol had changed several times over this time period. Study areas were added, dropped, combined, and divided. Study periods were generally reduced. Several steps were required to create a harmonized dataset that could be used to summarize bird surveys between 1997 and 2017.

This appendix has three main sections. First, we describe efforts to create the harmonized long-term dataset (HLD). Second, we describe how the HLD was used to create new appendices that were fashioned after those in the 2002 report. Third, we discuss issues related to comparing old and new appendices, given the many changes in protocol over the years.

Data Harmonization

It is useful to think of the GSL Waterbird Survey as occurring over three distinct phases. The first phase, from 1997 through 2001, was an extensive 5-year effort to catalog migratory waterbirds occurring in a wide variety of habitats across the Great Salt Lake ecosystem. The surveys involved trained observers from federal, state, and private organizations along with volunteers from the general public. Surveys were conducted 17 times per year, every 10 days from April through September, at 50 different study areas.

The second phase of the survey occurred between 2004 and 2006. During the second phase, surveys were conducted nine times per year, concentrated during spring and fall migration seasons, at 22 different study areas.

The third phase of the survey has occurred from 2007 until the present. During the third phase, surveys were conducted five times per year, with two occurring during spring migration

season, and three occurring during fall migration season. Surveys were conducted annually at 11 study areas, and triennially at 11 study areas.

Harmonizing datasets collected with different spatial and temporal resolution generally requires aggregation. Creating the HLD required aggregation over both space and time. The first step in the harmonization process required creating spatial units and temporal units (HLD units) that could be applied over the three different phases of the survey. The HLD units generally reflected those from the third phase of the survey. In terms of study areas, we settled on 24 spatial units, listed in Table 1. Details about each HLD study area are given in Appendix 4B.

Table 1. HLD study areas.

Study area code	Study area name	Surveyed area (ha)
3	Stansbury Island South	1,726
7	Associated Duck Club	887
10	Crystal Lakeside	786
11	Farmington Bay Lakeside	522
12	Farmington Bay WMA	2,954
16	Antelope Island Causeway	850
18	West Layton	526
22	Ogden Bay North	389
25	Harold Crane WMA	585
29	Bear River Migratory Bird Refuge	3,135
32	Public Shooting Grounds WMA	650
33	Salt Creek WMA	302
35	Locomotive Springs WMA	304
40	Magcorp	752
41	New State Duck Club	600
14d	Antelope Island East & Audubon North	3,510
17b	West Kaysville - Shore	1,332
19d	Howard Slough WMA	484
20a	Ogden Bay WMA	1,497
22b	Ogden Bay Lakeside	851
28c	Willard Spur, Willard Bay & South Bear River	19,871
36b	Salt Wells Flat WHA	664
37a	Bear River Bay & East Promontory	17,955
8a	Kennecott - Lakeside	580

In producing the HLD, we utilized three study-area conversion-tables. Each table had a column for the appropriate phase one, two, or three study area code, and a column for the comparable HLD study area code. In many cases, there was a direct match between the study areas. When multiple study areas were merged over time to become one, counts for those study areas were summed for the HLD. When there were no recent analogues to old study areas, due to dropping or modifying survey areas, that data was removed from the HLD, as it was already well summarized in the 2002 report.

A second aggregation step included aggregating to common temporal units, or survey periods. For the HLD, survey periods were based on those from the third and least detailed phase of the survey. Study periods included: Period 1, from April 10 through April 24; Period 2, from April 25 through May 9; Period 3, from July 18 through August 1; Period 4, from August 2 through August 16; and Period 5, from August 17 through August 31. Periods 1 and 2 were classified as spring migration surveys, and periods 3, 4, and 5 were classified as fall migration surveys.

These HLD survey periods were used to assign old counts to new survey periods based on the count date. When multiple old counts occurred during a new survey period, they were averaged. In some cases, old counts could not be linked with an HLD survey period, in which case they were discarded as they were already well summarized in the 2002 report.

A third step in dataset preparation involved harmonizing species taxonomy over time. For this project, this step was simple and straightforward as none of the focal species had been lumped or split over the 21 years of the study.

The HLD resulting from this process, along with all raw count files, conversion tables, and computing code used to produce the HLD, have been archived by the Utah Division of Wildlife Resources.

Appendix Production

Once study areas, study periods, and species' taxonomies were harmonized, and zero counts were added as appropriate, we began production of Appendices 1B, 2B, 4B, 5B, 6B, and 8B. The new appendix numbers correspond to those from the 2002 report. The letter B indicates output from the 2020 analysis of 1997 through 2017 data.

Appendix 1B, the species list, was produced, simply, by querying the HLD for unique species names. This list was then filtered to exclude very rare species (< 10 individuals) and those that were highly unlikely and potentially the result of misidentification.

Appendix 4B, containing survey area accounts, was structured similarly to Appendix 4 in the 2002 report. Only survey areas found in the HLD were included. Study area codes, names, descriptions, number of years surveyed, and survey areas were updated to reflect the data harmonization process. The species listed in Appendix 4B were the same as those found in the 2002 version. Like the 2002 version, the mean counts were averages, across all years and then periods, during the season or seasons (Spring, Fall, or Spring and Fall) when the species was most abundant at Great Salt Lake. The designated season of highest abundance was retained from the 2002 analysis as that designation was based on many more sampling periods. Peak counts were the highest average counts during one survey period regardless of season. The density estimate, in birds per hectare, was simply calculated as the mean count divided by the area surveyed. This is not a true density, but should be considered as a density index, as detection probabilities were not quantified.

Appendix 5B, containing species accounts, was structured similarly to Appendix 5 in the 2002 report. The species included in the appendix were the same ones included in the 2002 version with the additions of cattle egret, Clark's grebe, and spotted sandpiper, while the scaup species account became the more specific lesser scaup. Global and continental population estimates in the tables were from the 2002 version, which were taken from the literature. Mean counts in the tables

were averages, across all years and then periods, during the season(s) of highest abundance. Peak counts were the highest average counts during one survey period regardless of season (see Appendix 4B for additional details). Seasons and periods of highest abundance are indicated in table headers. The high count in the tables, with the year given, is the highest recorded count during one period in the HLD. The status codes in the tables come from the Checklist of the Birds of Utah (Oct 2020) (utahbirds.org). The time series plots in Appendix 5B show the means, across all years, per study period. The maps are graphical representations of the species-specific mean counts for each study area from Appendix 4B. The count bins and color-coding used for the maps followed those from the 2002 version.

Appendix 6B, illustrating species distributions over time, was structured similarly to Appendix 6 in the 2002 report. The species included were the same as those included in the 2002 version. The maps show the mean count, across all years, per survey period and study area. The count bins and color coding used for the maps followed those from the 2002 version.

Appendix 8B, illustrating species distributions during years with relatively low or high lake levels, was structured similarly to Appendix 8 in the 2002 report. The species included were the same as those included in the 2002 version. The maps show the mean count per survey period and study area for 1999 (relatively high lake level) versus 2004 (relatively low lake level). The count bins and color coding used for the maps followed those from the 2002 version.

We recognize that the above descriptions of data harmonization and appendix construction are particularly concise. Note that every detail of these processes can be gleaned from a thorough analysis of code, archived by the Utah Division of Wildlife Resources.

Caution Regarding Comparisons

The new appendices described here should be considered as complementary to the ones created for the 2002 report. The new appendices are particularly valuable in that they were generated from a dataset that spanned 21 years of observations, compared to 5 years for the old appendices. The old appendices are particularly valuable in that they were generated from a dataset that included many more survey areas and survey periods per year, compared to the new appendices. When viewed as complementary, a reader can use the two sets of appendices to gain a clearer picture about the relative abundances and distributions of waterbird species across Great Salt Lake.

Given the superficial resemblance between the two sets of appendices, it may be tempting to compare metrics to infer something about changes in abundance or distribution across the 21 years represented by the HLD. Literal comparisons between the two sets of appendices are generally not recommended, however, due to changes in survey areas and survey periods over the years. In this section, we describe a case study that illustrates the pitfalls of such comparisons.

For the case study, consider the northern shoveler species account. A quick comparison of tables in the 2002 species account (Figure 1A) versus the 2020 species account (Figure 2A) suggests that average counts of northern shoveler have decreased dramatically, from 56,950 to 12,101 individuals. These numbers are not truly comparable, however. For example, Figures 1B and 2B highlight that two large areas surveyed in 2002 were not surveyed over the longer time series. The high counts from these large areas have a large impact on the mean total count. Further, Figures 1C and 2C highlight that the highest counts of this species were conducted during

September, a month that was not surveyed over the longer time series. The high counts from these survey periods also had a large impact on the mean total count. Given changes in protocol, direct comparisons between appendices from the two reports should be avoided.

A statistically rigorous analysis of trends based on the HLD has been completed and will be made publicly available pending scientific peer-review process.

Northern Shoveler

Code	Population estimates		Great Salt Lake			
	Global	North America	Mean Aug-Sep	Peak 10-Sep	High Count 1997	Abundance Status
NSHO	3,533,400	2,041,100	56,950	83,894	162,540	C

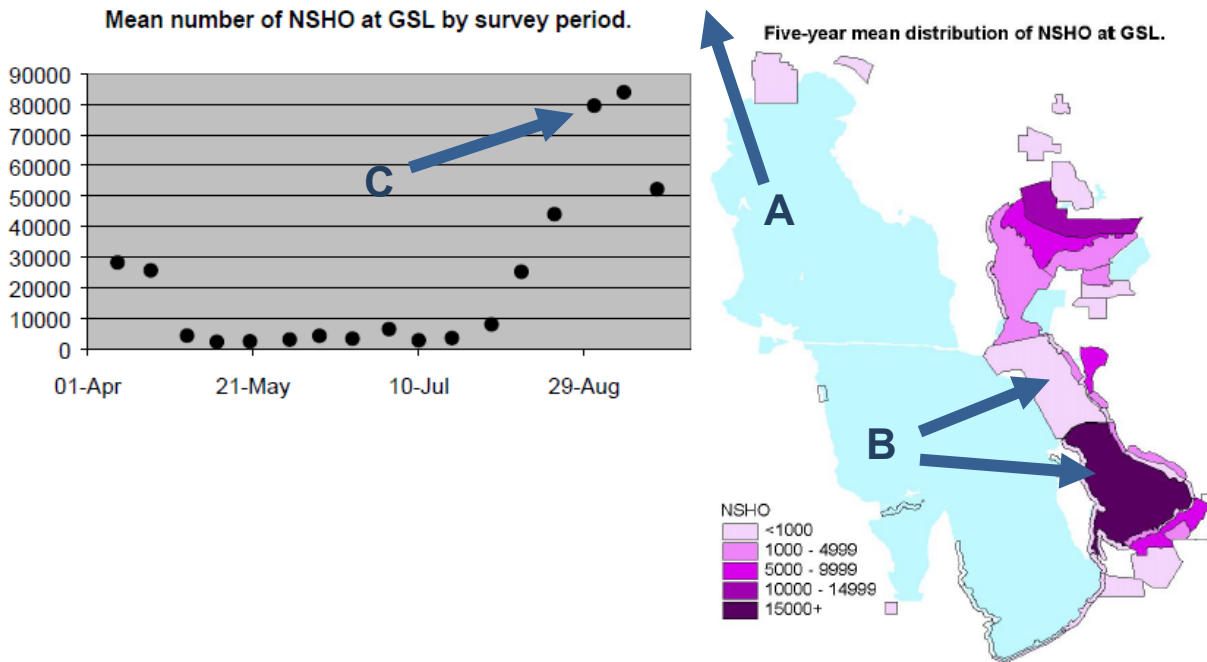


Figure 1. This figure shows the northern shoveler species account from Appendix 5 of the 2002 report. Letters are explained in the text.

Northern Shoveler

Code	Population Estimates		Great Salt Lake			
	Global	North America	Mean Fall	Peak Period 1	High Count 2014	Abundance Status
NSHO	3,533,400	2,041,100	12,101	30,391	43,888	C

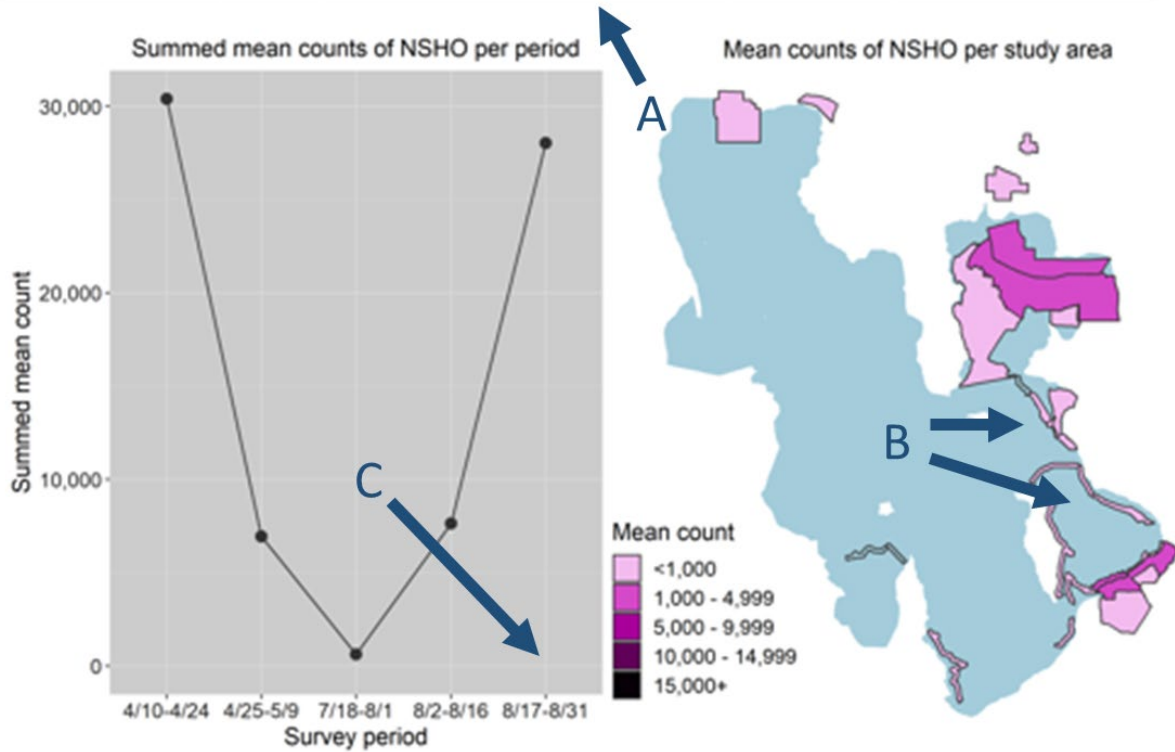


Figure 2. This figure shows the northern shoveler species account from Appendix 5B of the current report. Blue letters and arrows are explained in the text.