RANGEWIDE DATA GATHERING FOR *SPIRANTHES DILUVIALIS*

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October 6, 2017

Suggested citation for this report: Beauvais, G.P., Andersen, M.D., Handley, J., and Hubbard, K. 2017. Rangewide data gathering for *Spiranthes diluvialis*. Report prepared by the Wyoming Natural Diversity Database, Laramie, Wyoming, for the United States Fish and Wildlife Service.

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INTRODUCTION

Spiranthes diluvialis (Ute Ladies' Tresses) is a rare species of orchid that was listed as Threatened under the U.S. Endangered Species Act (ESA) in 1992 due to its apparent global rarity and documented habitat loss (U.S. Fish and Wildlife Service 1992). The first known specimen was collected in 1856 by Henry Engelmann (*s.n.*) along the South Fork Platte River in present day Colorado, during Lieutenant Francis T. Bryan's surveying expedition from Fort Riley to Bridger Pass. However, it was not recognized as a new species until the early 1980s (Jennings 1989, Fertig et al. 2005). Charles J. Sheviak examined many specimens of *Spiranthes* from throughout the Western United States, and discovered several specimens misdetermined as *S. romanzoffiana*, *S. cernua*, and *S. porrifolia* were a totally different species. Sheviak (1984) described *S. diluvialis*, based on collections and live plants, by means of chromosomal numbers, morphological traits, and habitats. *Spiranthes diluvialis* ($2n = 74$) is an allopolyploid resulting from the past (perhaps Pleistocene) hybridization of *S. romanzoffiana* ($2n = 44$) and *S. magnicamporum* ($2n = 30$). Morphologically, *S. diluvialis* differs from others in its genus by having glandular-pubescent stems, leaves that persist at the time of flowering, a sparsely pubescent inflorescence, and sepals that are separate or fused only at the base and often spreading at their tips. The lip petals of *S. diluvialis* are oval to lance shaped, narrowed at the middle, with crispy-wavy margins (Sheviak 1984, Sheviak and Brown 2002, U.S. Fish and Wildlife Service 1992, Fertig et al. 2005).

Spiranthes diluvialis is known only from west-central North America, extending from extreme western Nebraska, central Colorado, and southern Utah northwest to southern British Columbia. Suitable habitat is found in the floodplains of rivers with active deposition and seasonal flooding, and on moist valley bottoms fed by groundwater, at elevations 220 -2130m (720-7000ft) (Fertig et al. 2005, Heidel 1998, Moseley 1998, Arft and Ranker 1998, U.S. Fish and Wildlife Service 2007).

Efforts to de-list *S. diluvialis* from the ESA are on-going. To inform these efforts the Utah Ecological Services Office of the U.S. Fish and Wildlife Service (USFWS) contracted the Wyoming Natural Diversity Database (WYNDD; University of Wyoming) to gather existing, but previously unconsolidated, data on the distribution of the species throughout its known range. This report details that effort.

Project Summary

WYNDD contacted relevant personnel and organizations located throughout the species' range to identify sources of distribution data. Such data included both positive data (i.e., current and historic locations where the species has been documented), and negative records (i.e., locations where surveys were conducted for the species, but it was not found). WYNDD consolidated and synthesized all data from these contributors, using a consistent attribute schema, to enable mapping and analysis of the species at a rangewide scale. The resulting geographic information systems (GIS) database can be used to better understand the distribution of the species, and will also be used by WYNDD to generate a rangewide predictive distribution model in an upcoming project.

METHODS and RESULTS

Outreach

We initiated work on this project by creating an MS Access database to store contact information, and to track communications, data requests, and resulting datasets with each contact we identified. This database was a critical tool, given the number of contacts and datasets expected to result from this effort. Next, we contacted relevant personnel and organizations in each of the eight states where *S. diluvialis* is known to occur, and also in the surrounding states, using a series of five mass emails plus opportunistic follow-up emails and phone calls when necessary. The mass email messages are described in more detail below; specific message text is provided in the set of final products (see Appendix 1).

On 15-16 March 2017, we sent a "*Contact Request*" message to 230 State Natural Heritage Program biologists and federal/ state/ provincial agency leads, with the dual goal of introducing the project and requesting contact information for additional people and organizations (e.g., consultants, herbariums, individual researchers, NGO's) that may have relevant data for *S. diluvialis*. This initial list of 230 contacts was derived from a survey of WYNDD biologists and our colleagues throughout the western U.S., plus a standardized list of relevant agency positions in each state and province (e.g., State Natural Heritage Program Botanist; BLM State Botanist; USDA Forest Service biologists). The response rate to this initial email was 43%, which included people who contributed new contact information to us and people who forwarded and/or redirected our original email to other people within their office, organization, or network. We followed this initial message with a "*Contacts Request – Reminder*" message on 3 April 2017 to 130 recipients who had not yet responded to the original message. The response rate to this reminder message was 50%, bringing the total response rate to 71%.

On 26 April 2017, we sent a "*Data Request*" email to 415 federal, state, provincial, and non-governmental contacts across the U.S. and Canada. This list of 415 contacts was a combination of our original contact list and new contacts derived from responses to the 15-16 March and 2 April emails. The response rate to this first direct call for data was 50%, which included people who submitted data to us and people who forwarded and/ or redirected the message to other people within their office, organization, or network. Again hoping to boost response levels, we sent a "*Data Request – Reminder*" message on 17 May 2017 to the 195 contacts who had not yet responded to the 26 April message. The response rate to this reminder message was 40%, which brought the overall response rate to our request for data to 69%.

Finally, on 26 July 2017, we sent a "*Project Update*" message to 545 contacts. This list was a combination of all people contacted in the project to-date, plus other parties that had interest in the work but had already indicated that they had no data to contribute. The email message included a preliminary, coarse-resolution map showing all positive records of *S. diluvialis* in the U.S. and Canada collected by our efforts as of 20 July 2017. No negative records were depicted in this map. The purpose of the email was to provide a brief project update to contacts who had already participated in the project, especially those who had provided data, while also encouraging additional responses from contacts who had not yet responded to previous communications. Numerous people thanked us for the update, and about ten people reached out with comments or questions about the map.

In total, we logged nearly 1,700 individual communications with almost 600 contacts.

Data Compilation

The communications outlined above resulted in data submissions from 84 individuals across 64 organizations. The format of data submissions varied widely, from shapefiles of positive and/or negative records ready for inclusion in a GIS database, to hard-copy reports containing survey or distribution information in tables or map graphics. A substantial amount of effort was sometimes required to generate spatially-explicit, digital records from some sources.

Because the available attributes and ancillary information in the data submitted by various contributors varied widely, we identified a common set of critical fields for both positive and negative data records. These fields were represented in most of the contributed datasets, and were necessary for appropriate interpretation and usage of positive and negative features. In some cases, cross-walking and interpretation was needed to populate our standardized fields from existing fields in the original datasets. For example, some contributors provided a range of dates over which a particular survey was conducted. In such cases we chose the mid-range date to populate our *Obs_Date* field, and made note of this choice in the *Date_Notes* field. Similarly, some contributed records contained only the year of observation or survey. Again, in such cases, we made our best estimate for the actual date based on available information, and made note of the assumed date, in the *Date_Notes* field.

Some records from the contributed datasets represented the results of multiple years of survey, with each survey results nested in various fields for the record. We split each of these records into a series of records representing each date of survey or observation, so that each record in our final database would represent, as nearly as possible, a single positive or negative location for the species at a single point in space and time. Expressing all data as discrete "observations" in this manner allows for more consistent interpretation of records across datasets.

The geographic locations of contributed data records were represented variously as points, lines, and polygons, depending on the type of survey and precision of mapping. Rather than "downgrading" line and polygon data to centroids, we chose to retain the original representation of the location wherever possible. As we integrated each of these features into a final dataset, we evaluated each to determine whether it represented a duplicate record, and, if duplicates were found, retained the record obtained from the original survey source wherever possible.

Although we processed all input datasets to a common database schema for ease of use and interpretation, we retained all original, unmodified datasets, in the event that more information is needed for a given record. All original datasets, except those deemed "sensitive" by the data contributor, were packaged together and provided to the USFWS as a project deliverable. Sensitive records were expressed in the delivered geodatabase as the Township, or collection of adjacent Townships, that encompass the original feature. This allowed the data to be used for evaluation at a coarse scale, but protects the data privacy concerns of the data contributors.

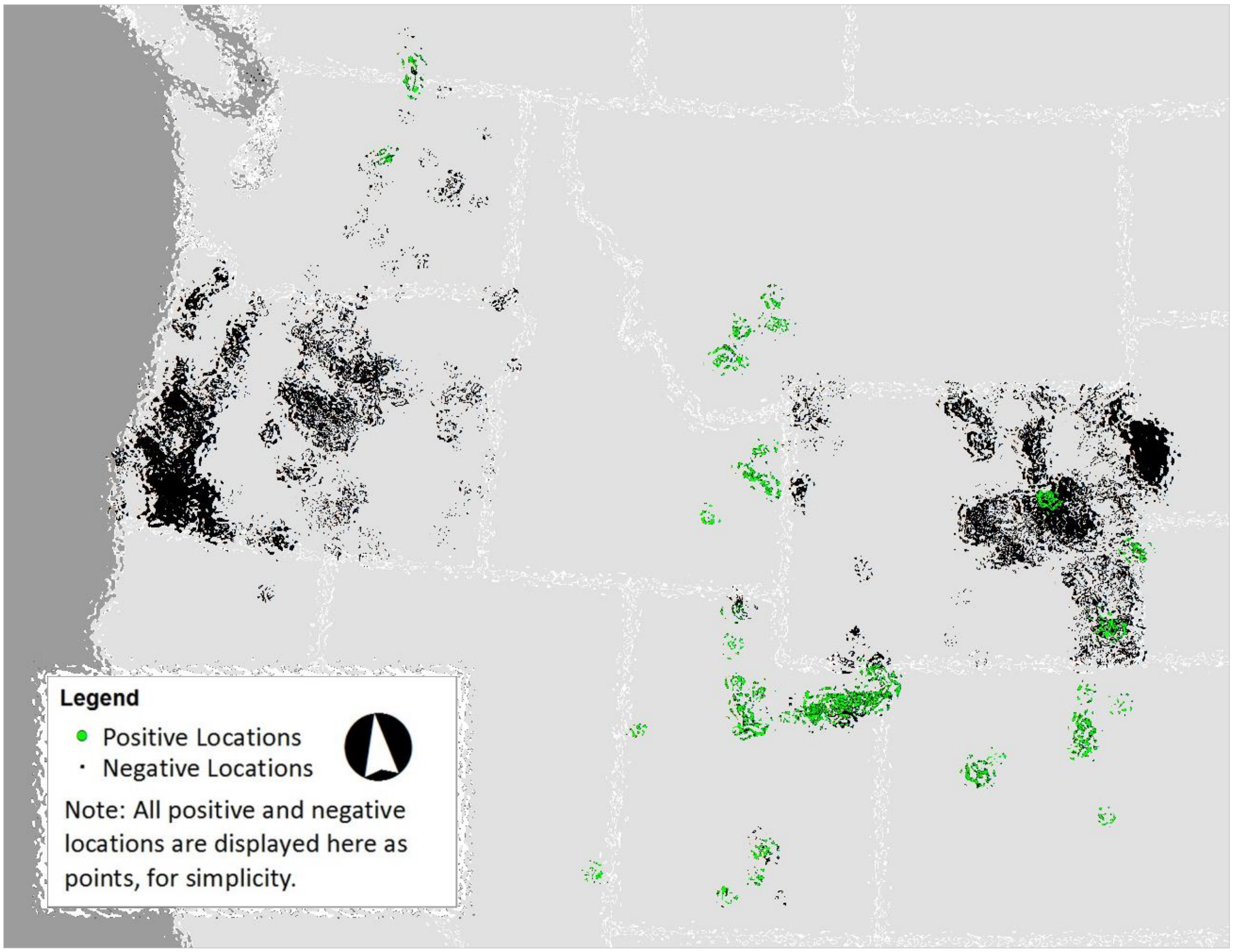
After processing all locations for the species to create the common set of attributes, we combined them into a single file geodatabase. This file geodatabase contains one feature class each for point, line, and polygons representing both positive and negative survey locations, for a total of 6 feature classes. Additionally, we imported the three tables from the contact database ('contacts,' 'datasets,' and 'log') into the file geodatabase, and created relationship classes that link the individual features in the positive and negative feature classes to their source datasets, allowing users to trace the record back to its original source and get additional information, as needed.

Altogether, we compiled 11,946 records representing positive surveys, or observations, for *S. diluvialis* throughout its range (Table 1; Figure 1). The majority of these records comprised point locations, though in some states mapped polygons of occupied habitat were more common than in other states. Data was obtained for several recently-discovered populations of the species, though these new populations generally occur near previously known populations. Nearly 40,000 negative survey locations were obtained for the species, with most of these occurring in Oregon, Utah, South Dakota, and Wyoming.

Table 1. Total number of point, line, and polygon features representing positive or negative surveys for S. diluvialis, compiled for this effort.

	Points	***Lines***	***Polygons***	**Total**
Positive	10,017	34	1,895	11,946
Negative	242	1,335	37,577	39,154

Figure 1. Positive and negative locations for S. diluvialis, throughout its known range.



DISCUSSION

Figure 1 indicates an obvious dearth of negative records in major portions of *S. diluvialis* range, particularly Colorado, Utah, Idaho, and Montana. This does not necessarily indicate a lack of sampling effort for the species in those areas. The availability of negative records is as much a function of careful record keeping by field surveyors as it is of actual field survey – it is common for field surveyors to neither record, organize, nor archive “failed” surveys for target species, despite the value of such negative data. We are confident that our efforts uncovered nearly all known positive records for the species, but we are equally confident that an intensive search for negative records would uncover substantially more than we were able to gather here. Such records would likely require a large amount of processing to be incorporated into the rangewide dataset.

Our efforts made it clear that survey methods, field data codes, and data storage formats vary widely by surveyor and surveying organization. Standardizing survey protocols would greatly assist in data compilation efforts like this, and would make the maintenance and update of the rangewide dataset started here much more efficient and cost-effective.

WYNDD will use the positive and negative data synthesized in this effort to produce a rangewide, predictive distribution model for *S. diluvialis*, as part of ongoing efforts to better understand the species' distribution and status. A rangewide model could help guide targeted surveys for currently-unknown populations of the species in areas of suitable environmental conditions that have not yet been surveyed. It could also serve as a valuable starting point for designing a rangewide monitoring program that simultaneously assesses status of known population segments and potential expansion of those segments into nearby suitable areas.

The resulting model will be made available to USFWS as well as other land and resource managers and researchers interested in the species' distribution and status.

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