Wyoming negative database as record of plant species absences

Report prepared for

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Prepared by

Bonnie Heidel, Joy Handley and Mark Andersen

Wyoming Natural Diversity Database

University of Wyoming

Laramie, Wyoming

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Abstract

A searchable database was developed from over 30 years of survey records associated with statewide status reports on Threatened, Endangered and Sensitive plant species of Wyoming. Use of this database is discussed in the report as a springboard for prioritizing survey areas, prioritizing species, and building upon work that has already been conducted.

Acknowledgements

The work of Robert Dorn and each of the earlier Wyoming Natural Diversity Database botanists set the precedent for later surveys, and are acknowledged with great respect. We thank everyone who has inquired about a negative database over the years. This project was funded under BLM Agreement No. L1600389.

Literature Citation:

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OBJECTIVES

The purpose of this project is to lay the foundation for a searchable database to determine whether or not targeted surveys were conducted for a given plant species of concern[1] in a given area. By "targeted surveys", we refer to field surveys conducted at appropriate times of the growing season by informed botanists capable of identifying the species in question and its habitat. In most cases, the original survey work sought out a single species of concern as target.

The objectives for this project are based on the premise that plants are stationary and, as such, their presence values are likely to remain the same from one year to the next barring major landscape conversions. Conversely, their absence in any one year is likely to remain the same from one year to the next, and so a database of targeted surveys that addressed plant species absences has ongoing utility. A section of the discussion section is dedicated to exploring the breadth of considerations and extent to which the species in this study might have exceptions.

BACKGROUND

Wyoming botanists have worked diligently to gather the most complete information available on the status of plant species under consideration for listing as Threatened or Endangered (T/E) and other designations. Much of this work was prompted by passage of the Endangered Species Act in 1973. The gathered data included specimen documentation as deposited in herbaria, botanical literature, and the work of building on these information sources by conducted field studies. Almost all species studied required systematic surveys to determine species' distribution. The resulting body of information represented as much available information for regulatory and management agencies to evaluate the appropriate designation (status) of a species. Studies to determine plant distribution and compile the body of all other information on a species (taxonomically and biologically) were routinely called status reports (Henifin et al. 1981). An important part of such reports were the distribution data available shown in the report on maps and supporting information.

Wyoming plant species status report work started in the 1980s, including that by Robert Dorn, contracted by the U.S. Fish and Wildlife Service (USFWS). Work in the 1980s through present has been also conducted by Hollis Marriott and later botanists employed by the Wyoming Natural Diversity Database (WYNDD), in projects established between WYNDD and federal land management agencies including Bureau of Land Management (BLM).

Over time, 105 plant species of Wyoming were considered for T/E designation by USFWS (Heidel 2013). At present, four are designated T or E (USFWS 2021). Many were rejected from

[1] Species of concern (SOC) is a term that is assigned by Wyoming Natural Diversity Database in collaboration with the state botany community for priority rare plant species in the state. They include but are limited to all Threatened, Endangered and Sensitive species. Most plant SOC are ranked S1 and S2; and some that are ranked S3, as based on the best available information. The recognition of SOC and supporting documentation changes over time with new information. We use SOC in this report to refer to any plant species that has been recognized as such in the past or present, including plant species of potential concern (SOPC).

further consideration if documented to be more common than previously known (3C) or if new information came to light that they were not taxonomically valid (3B). Of the remainder, 41 species were regarded as under review on the Category 2 (C2) candidate list of species under consideration in 1996, when the maintenance and recognition of the C2 list was discontinued.

The C2 list did not afford formal protection, and some species on this list were informally regarded as still potentially at risk globally. In ensuing years, many of the species on it became subject of status report work if they had not previously been addressed. Of the 41 species placed in the C2 group on the 1996 list, 30 were known or suspected to be on BLM lands of Wyoming. Of these, many were later designated as sensitive by Wyoming BLM (2001) in the first iteration of the Sensitive species list in order to manage them so as to preclude the need for listing as T or E (Appendix A). Location information has been central to understanding status, and new location information has been important to maintaining an understanding of status changes.

Frequently, WYNDD would also be asked if we had records of "negative surveys" as record where a given species had been surveyed under suitable conditions but not found. The majority of status reports provided maps or tables of negative survey results. However, this information had never been compiled, much less in a digital format, for retrieval and searching. This project, referred to as a negative database project, is an offshoot of these discussions.

This background information on single-species studies in the state provides necessary context for understanding the negative data that also resulted from them. It also provides background for understanding BLM Sensitive plant species and SOC species in general. Single-species studies are only a fraction of all botany work conducted in Wyoming, by WYNDD and others, but they are the single best source of information for absence data, i.e., places that have been carefully searched for a given species where it was not found.

METHODS

Botany reports within the WYNDD library were checked for printed maps of survey routes or written tables with Public Land Survey System locations, recording where the target species were surveyed for but not found. The markings on these maps were converted into either point, line or polygon shapefiles, depending on the original survey source. Maps were either digitized by sight or scanned into TIF files, which were georeferenced onto digital USGS topographical maps (Figures 1-4). Some reports were accompanied by pre-made GIS files of survey locations, which were used as-is in subsequent steps. Public Land Survey System locations were entered into an Excel spreadsheet for later integration into the WYNDD database.

Many botany reports predate the first Wyoming BLM sensitive species list (2001). For this project, we addressed all reports about BLM sensitive species, and reports by WYNDD botanists and by Robert Dorn that addressed species on BLM lands.

Known locations for target species from the WYNDD database were compared to all survey locations. If the target species had been found within a mapped survey polygon, line or point,

that location was noted in the shapefile attribute table as a positive, rather than a negative, location.

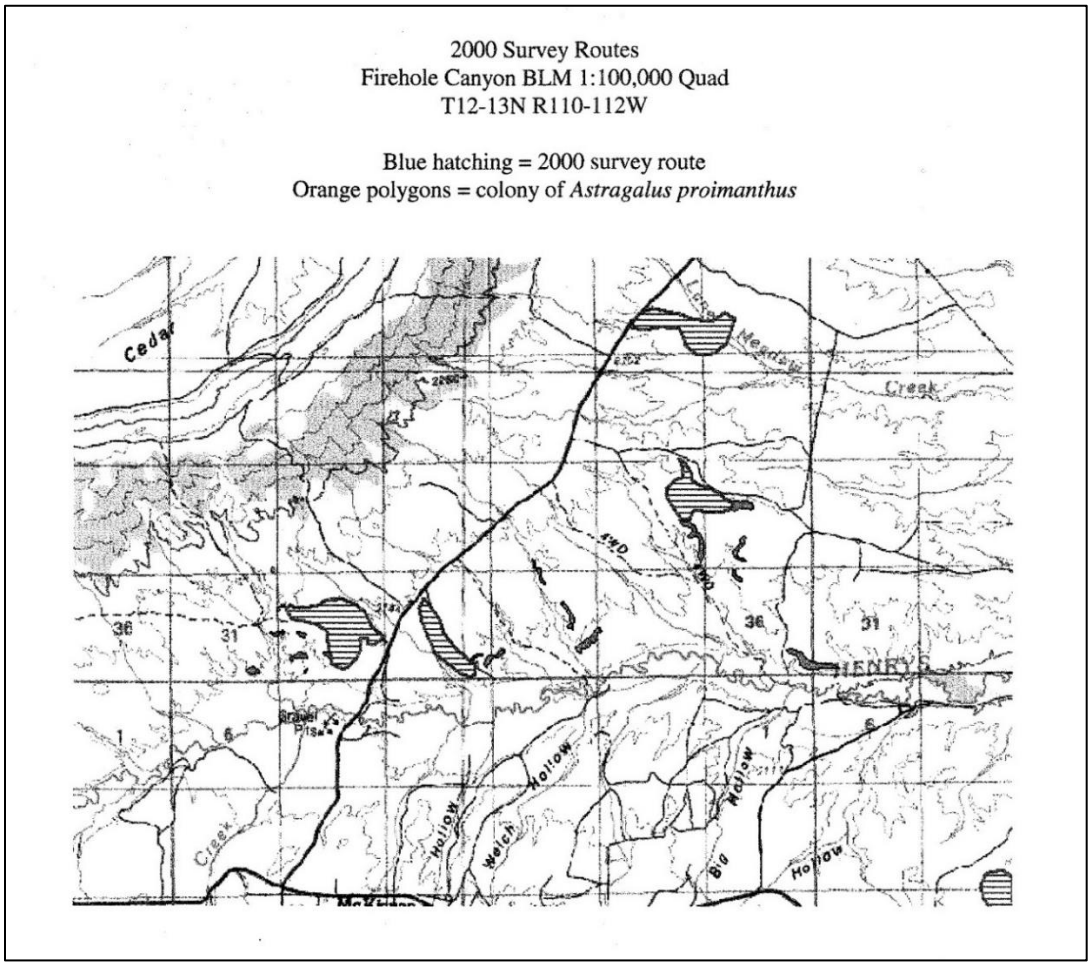

Figure 1. Example of a printed map in a WYNDD report (Fertig and Welp 2001), re. survey for *Astragalus proimanthus*

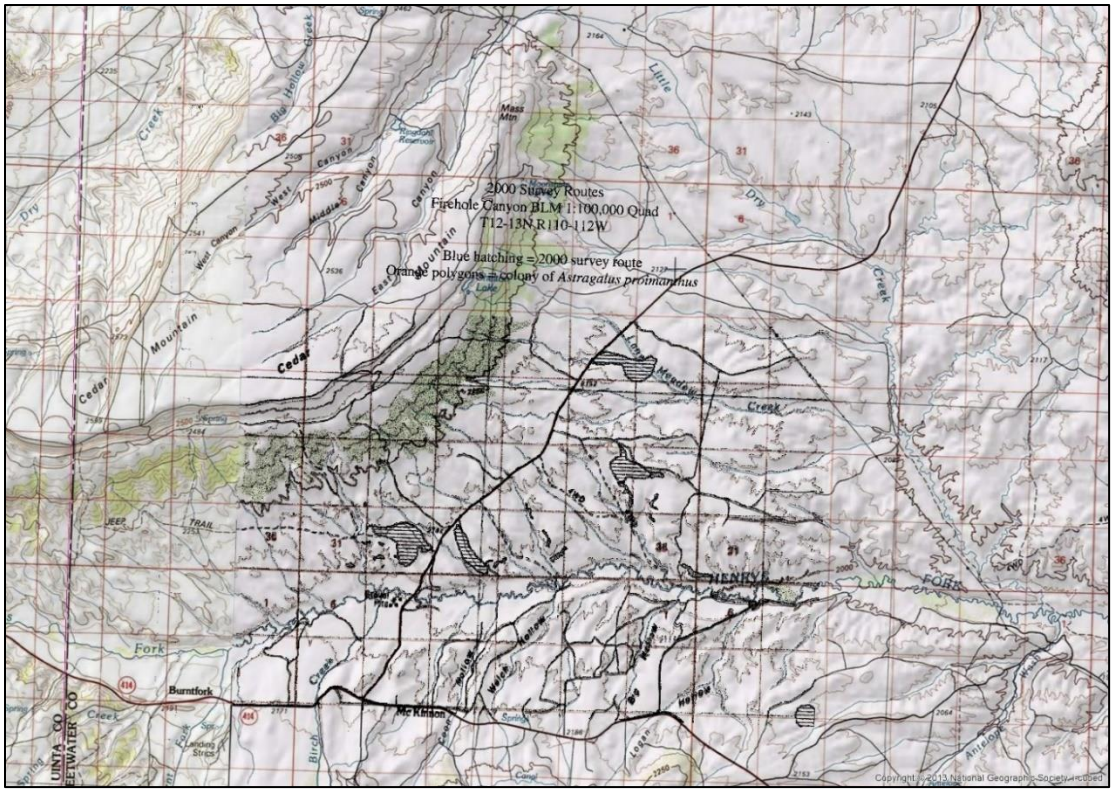

Figure 2. TIF file of a scanned map georeferenced onto topographical map GIS layer, for digitizing (blue hatching).

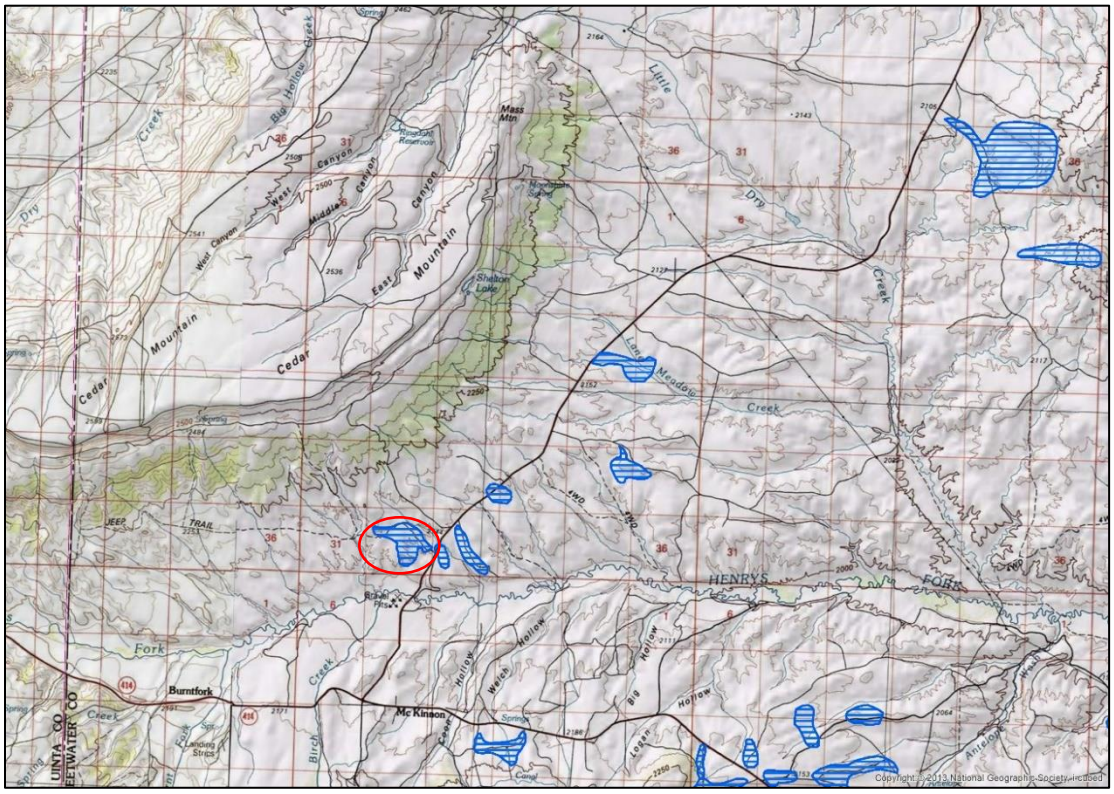

Figure 3. Survey polygons digitized from TIF file (blue hatching) (incorporating Figure 1 and additional surveys)

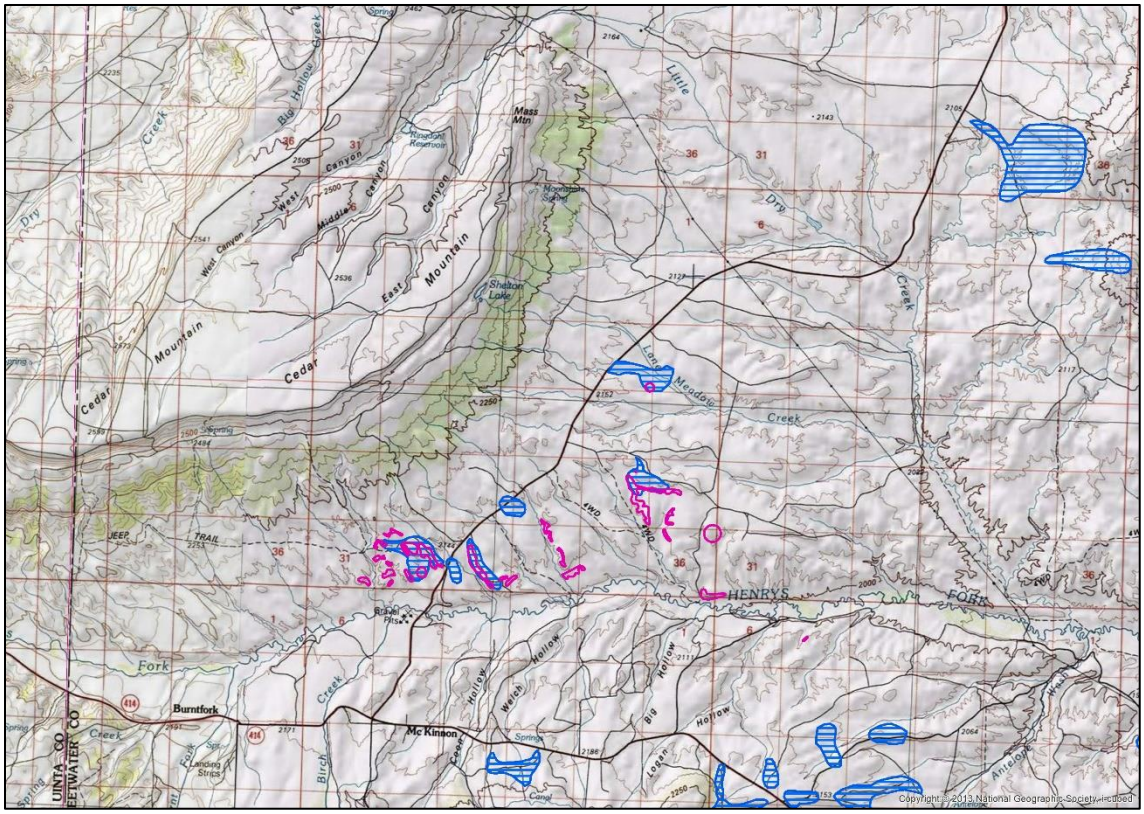

Figure 4. Comparison between survey polygons (blue hatching) with known populations (pink outline).

Attributes for each digitized survey location were recorded in the shapefiles (or spreadsheet, in the case of written Public Land Survey System locations) as outlined in Table 1. Shapefiles and spreadsheets were designed for thorough documentation and ease of data upload into the WYNDD database. All data were then combined into a total of 3 shapefiles (one each for point, line, and polygon survey features).

Table 1. Attribute table fields (example based on the polygon circled in red in Figure 3).

Field name	Field contents	Example	Required
FID	Unique identifier for the feature (numeric; shapefiles only)	134	TRUE
Shape	Feature type (shapefiles only)	Polygon	TRUE
id	To be used as a unique identifier when uploading into the WYNDD database (shapefiles only)	0	TRUE
survey_id	Unique ID for survey resulting in the negative data	polygon_survey_237	TRUE
sciname	Scientific name for plant species targeted by the survey, and not found	*Penstemon acaulis*	TRUE
comname	Common name for plant species targeted by the survey, and not found	Stemless beardtongue	TRUE
taxon_id	Taxon identifier used in WyBIS for plant species targeted by the survey, and not found	8547	TRUE
start_date	Start date of survey	6/13/2000	TRUE
end_datet	End date of survey	6/13/2000	TRUE
surveyor	Surveyor name	Laura Welp	TRUE

Field name	Field contents	Example	Required
surv_org	Organization of surveyor	WYNDD	TRUE
surv_type	Survey conducted by foot, vehicle, or unknown	foot	TRUE
surv_note	Any notes to clarify other field's information		FALSE
dataset	A description of the contents of the dataset	1999-2000 survey of *Astragalus proimanthus* in southwestern Wyoming	TRUE
target_spp	Target species of survey	*Astragalus proimanthus*	TRUE
location	Public Land Survey System data identifier or unique ID assigned to other feature types	0130N1110W0SN032	TRUE
loc_desc	Text description of location	Green River Basin	FALSE
ref	Report or other citation, if available	Fertig, W. and L. Welp. 2001. Status of precocious milkvetch (*Astragalus proimanthus*) in southwest Wyoming. Unpublished report prepared for the Bureau of Land Management Wyoming State Office by the Wyoming Natural Diversity Database, Laramie, WY.	FALSE
ref_url	URL that can be used to access the reference describing the survey effort associated with the feature, if available	https://www.uwyo.edu/wyndd/_files/docs/Reports/WYNDDReports/U01FER02WYUS.pdf	FALSE
sensitivit	Indicates whether the survey feature falls primarily on public or private lands. WYNDD cannot distribute private land information without landowner permission, so only features occurring mostly on public lands are included.	Public land	TRUE

A total of 78 WYNDD reports were examined for data (Appendix B). Shapefiles were made from 53 of the reports. In addition, nine reports prepared by Robert Dorn in the 1980s were examined for data as representing the only other plant species status reports conducted on a statewide basis. A few of the WYNDD reports and all of the Dorn reports presented negative survey information in Public Land Survey System data format (Township-Range-Section (Table 2).

In addition to reports as information sources, negative survey records for 12 species were represented on topographic maps that represented 1980s surveys conducted by Robert Dorn (not treated in reports), marked with his survey routes. He provided the map set to WYNDD for this purpose and these results were also recorded as represented on maps (Table 3).

A map of all digitized survey records in Wyoming is represented in Figure 5. It represents TES plant species survey work conducted in all counties of the state except for Goshen and Laramie counties.[2]

[2] Except in the case of *Spiranthes diluvialis*; addressed in a separate report.

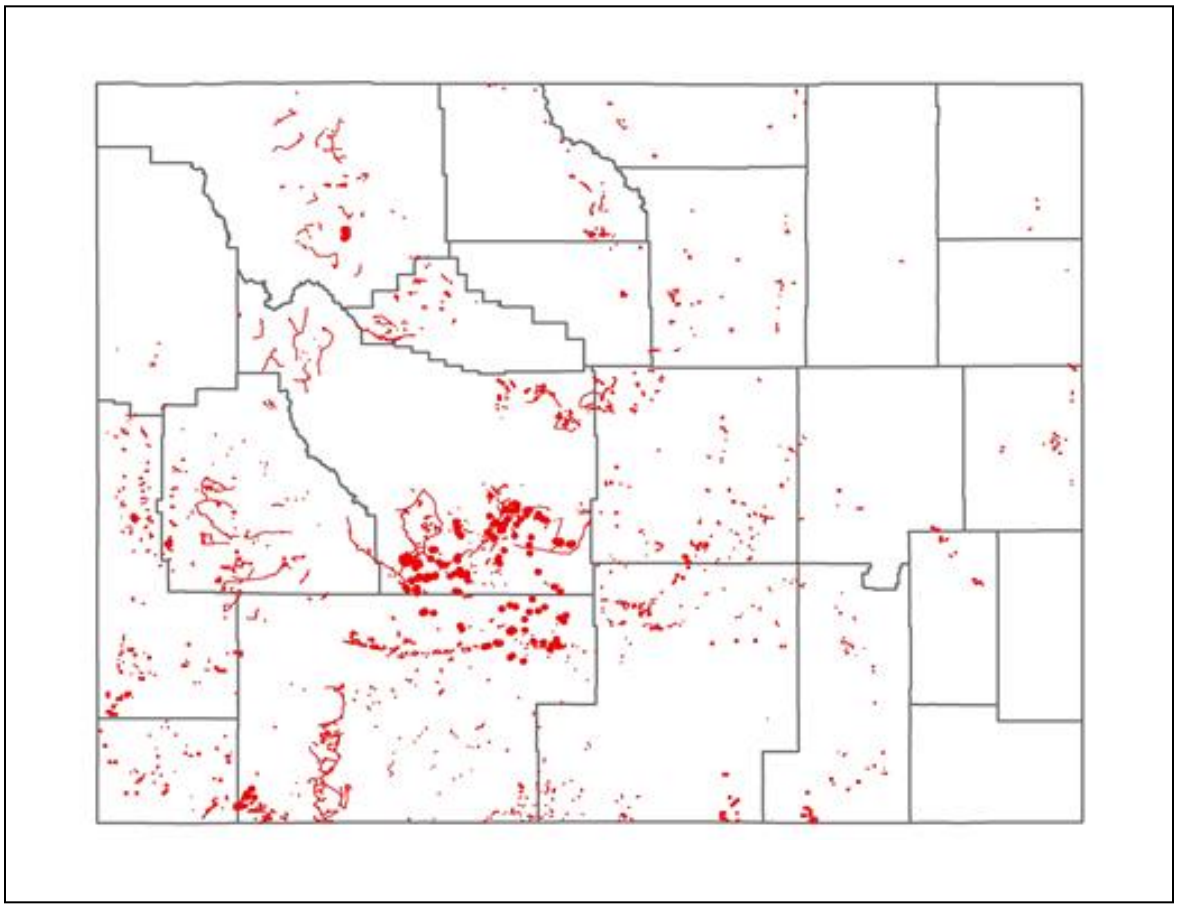

Figure 5. Composite map of all digitized TES plant species surveys in Wyoming. The concentration of surveys in southwestern Sweetwater County (circled) corresponds with Figures 1-4 on preceding pages.

Table 2. Species reports used for this project and data format that negative data were placed in[3].

Author. Year. Agency.	**Species[4]**	**Point**	**Line**	**Poly**	**TRS**
Marriott, H. J. 1993. BLM.	*Abronia mellifera* (not *Abronia ammophila*)		X		
Fertig, W. 1996. BLM.	*Antennaria arcuata*			X	
Marriott, H. J. 1986. USFWS.	*Antennaria arcuata*		X		
Heidel, B. 2013. BLM.	*Antennaria arcuata*		X		
Heidel, B. 2015. BLM.	*Antennaria arcuata*, *Astragalus diversifolius*, *Peritoma multicaulis* (*Cleome multicaulis*)	X			
Fertig, W. 1999. BLM.	*Artemisia biennis* var. *diffusa*		X		

[3] The full citations of all species reports reviewed, including those in which negative data was not address, are listed in Appendix B.

[4] Species that were surveyed are listed by current taxonomic treatment. If an earlier name for the species was used in the title, then the earlier name is in parentheses. In instances of multi-species surveys, the species are first listed in the order in which they appeared in the title. For purposes of this report, they are cross-listed by each species that was addressed, and the cross-listed entries are shaded.

Author. Year. Agency.	Species[4]	Point	Line	Poly	TRS
Fertig, W. 1993. BLM.	*Artemisia simplex* (*Sphaeromeria simplex*), *Cryptantha subcapitata*, *Physaria eburniflora*		X		
Handley, J. and B. Heidel. 2010. BLM.	*Artemisia simplex* (*Sphaeromeria simplex*)		X		
Marriott, H. J. 1992. BLM.	*Astragalus barrii*, *Physaria arenosa* var. *argillosa* (*Lesquerella arenosa* var. *argillosa*), *Symphyotrichum molle* (*Aster mollis*)		X		
Heidel, B. 2009. BLM.	*Astragalus diversifolius*		X		
Heidel, B. 2015. BLM.	*Astragalus diversifolius*, *Peritoma multicaulis* (*Cleome multicaulis*), *Antennaria arcuata*	X			
Fertig, W. 1998. BLM.	*Astragalus gilviflorus* var. *purpureu*		X		
Heidel, B. 2011. BLM.	*Astragalus gilviflorus* var. *purpureus*				X
Dorn, R.D. 1989. USFWS.	*Astragalus jejunus* var. *articulatus*				X
Fertig, W. and L. Welp. 2001. BLM.	*Astragalus jejunus* var. *articulatus*			X	
Heidel, B. 2017. BLM.	*Astragalus leptaleus*				X
Heidel, B. 2013. USFS.	*Astragalus paysonii*		X		
Fertig, W. and H. Marriott. 1993. USFS.	*Astragalus paysonii*, *Draba borealis*		X		
Fertig, W. and L. Welp. 2001. BLM.	*Astragalus proimanthus*			X	
Jouseau, M.R.G. 2016. BLM.	*Astragalus proimanthus*		X		
Marriott, H. J. 1989. BLM.	*Astragalus proimanthus*		X		
Marriott, H. J. 1989. BLM.	*Astragalus proimanthus*		X		
Heidel, B. 2003. BLM.	*Astragalus racemosus* var. *treleasei*				X
Dorn, R.D. 1989. USFWS.	*Astragalus shultziorum*				X
Marriott, H. J. 1986. USFWS.	*Boechera pusilla* (*Arabis pusilla*)		X		
Marriott, H. J. 1986. BLM.	*Boechera williamsii* (*Arabis williamsii*)		X		
Fertig, W. 1995. BLM.	*Cirsium pulcherrimum* var. *aridum* (*Cirsium aridum*)		X		
Fertig, W. 1999. BLM.	*Cirsium ownbeyi*		X		
Marriott, H.J. 1992. BLM.	*Claytonia lanceolata* var. *flava*, *Cryptantha subcapitata*, *Shoshonea pulvinata*		X		
Dorn, R.D. 1989. USFWS.	*Cryptantha subcapitata*				X
Marriott, H.J. 1992. BLM.	*Cryptantha subcapitata*, *Shoshonea pulvinata*, *Claytonia lanceolata* var. *flava*		X		
Fertig, W. 1993. BLM.	*Cryptantha subcapitata*, *Physaria eburniflora*, *Artemisia simplex* (*Sphaeromeria simplex*)		X		
Fertig, W., L. Welp, and S. Markow. 1999. BLM.	*Cymopterus evertii*		X		
Dorn, R.D. 1989. USFWS.	*Descurainia torulosa*				X
Marriott, H. J. 1992. BLM.	*Descurainia torulosa*		X		
Marriott, H. J. 1992. BLM.	*Descurainia torulosa*		X		
Fertig, W. and H. Marriott. 1993. USFS.	*Draba borealis*, *Astragalus paysonii*		X		
Heidel, B. 2012. BLM.	*Elymus simplex* var. *luxurians*		X		

Author. Year. Agency.	Species[4]	Point	Line	Poly	TRS
Heidel, B. 2010. BLM.	*Ipomopsis aggregata* ssp. *weberi* (no longer accepted as taxonomically valid)		X		
Heidel, B. 2004. BLM.	*Lepidium integrifolium* (*Lepidium integrifolium* var. *integrifolium*)				X
Dorn, R.D. 1989. USFWS.	*Lomatium attenuatum*				X
Fertig, W. 2002. BLM.	*Penstemon caryi*				X
Fertig and Welp. 2001. BLM.	*Penstemon acauli*			X	
Dorn, R.D. 1989. USFWS.	*Penstemon gibbensii*				X
Fertig, W. and M. L. Neighbours. 1996. BLM.	*Penstemon gibbensii*		X		
Heidel, B. 2009. BLM.	*Penstemon gibbensii*		X		
Fertig, W. 2001. BLM.	*Penstemon haydenii*		X		
Heidel, B. 2005. BLM.	*Penstemon haydenii*		X		
Heidel, B. 2012. BLM.	*Penstemon haydenii*		X		
Fertig, W. 2000. BLM.	*Peritoma multicaulis* (*Cleome multicaulis*)			X	
Fertig, W. 1993. BLM	*Peritoma multicaulis* (*Cleome multicaulis*), *Cymopterus williamsii, Sullivantia hapemanii*		X		
Heidel, B. 2015. BLM.	*Peritoma multicaulis (Cleome multicaulis), Antennaria arcuata, Astragalus diversifolius*	X			
Fertig, W. 1999. BLM.	*Phacelia glandulosa* var. *deserta)*		X		
Fertig, W. 1996. BLM.	*Phlox opalensis*			X	
Dorn, R.D. 1990. USFWS.	*Phlox pungens*				X
Marriott, H. J. 1992. BLM.	*Physaria arenosa* var. *argillosa* (*Lesquerella arenosa* var. *argillosa*), *Symphyotrichum molle* (*Aster mollis*), *Astragalus barrii*		X		
Heidel, B. 2010. BLM.	*Physaria arenosa* var. *argillosa* (*Lesquerella arenosa* var. *argillosa*)		X		
Fertig, W. 2002. BLM.	*Physaria condensata*		X	X	
Fertig, W. 1998. BLM.	*Physaria dornii*		X		
Fertig, W. 1993. BLM.	*Physaria eburniflora, Artemisia simplex* (*Sphaeromeria simplex*), *Cryptantha subcapitata*		X		
Fertig, W. 1995. BLM.	*Physaria fremontii* (*Lesquerella fremontii*)		X		
Fertig, W. 1995. BLM.	*Physaria macrocarpa* (*Lesquerella macrocarpa*)		X		
Fertig, W. 2000. BLM.	*Physaria prostrata* (*Lesquerella prostrata*)			X	
Heidel, B. 2014. BLM.	*Physaria saximontana* var. *saximontana*		X		
Fertig, W. and L. Welp. 1998. BLM.	*Rorippa calycina*		X		
Lichvar, R. 1981. BLM.	*Rorippa calycina*				X
Dorn, R.D. 1989. USFWS.	*Shoshonea pulvinata*				X
Heidel, B. 2011. BLM.	*Shoshonea pulvinata*		X		
Marriott, H.J. 1992. BLM.	*Shoshonea pulvinata, Claytonia lanceolata var. flava, Cryptantha subcapitata*		X		
Marriott, H. J. 1992. BLM.	*Symphyotrichum molle* (*Aster mollis*), *Astragalus barrii, Physaria arenosa* var. *argillosa* (*Lesquerella arenosa* var. *argillosa*)		X		

Author. Year. Agency.	Species[4]	Point	Line	Poly	TRS
Fertig, W. 1995. BLM.	*Thelesperma caespitosum*		X		
Fertig, W. 1999. BLM.	*Thelesperma caespitosum*		X		
Marriott, H. J. 1988. BLM.	*Thelesperma pubescens*		X		
Dorn, R.D. 1989. USFWS.	*Thelesperma pubescens*				X
Fertig, W. 1995. BLM.	*Townsendia microcephala*		X		
Heidel, B., J. Handley, and M. Andersen. 2011. BLM.	*Yermo xanthocephalus*		X		

Table 3. Species with hand drawn survey routes on topographic maps as negative survey data, from Robert Dorn

Species	Point	Line	Polygon
Artemisia porteri			X
Astragalus jejunus var. *articularis*			X
Astragalus shultziorum	X		
Boechera pusilla	X		X
Cryptantha subcapitata			X
Descurainia torulosa	X		
Lomatium attenuatum			X
Penstemon absarokensis			X
Penstemon gibbensii			X
Phlox pungens		X	X
Shoshonea pulvinata			X
Thelespermum pubescens	X		

DISCUSSION

How to use the negative database

The attributes of the GIS products accompanying this report can be used for selecting all negative surveys for a given species. The GIS layers can also be used for querying a given area to determine whether or not there has been negative survey work conducted.

As mentioned earlier, the negative survey products are particularly useful in combination with potential distribution models in simultaneously determining whether or not negative surveys have been conducted in an area flagged or not as potentially suitable habitat.

The work of compiling negative survey records for one species in particular, Ute ladies'tresses (*Spiranthes diluvialis*) has special caveats and greater volume of information than all other species in Wyoming, so it is treated separately (Handley In progress).

A good use of the negative database would be identifying areas that have not yet been surveyed for a given species, but which have high probabilities of potential habitat by combining the use of predictive distribution models with the negative database.

Negative database caveats

Detection probability is never 100% certain. So, the negative data compiled for this project can provide an indication of which areas have not yet been searched for setting priorities, or have been searched. But they probably should not be used in making any management decisions that would depend on the species being absent. The details of the survey, the surveyor, and the detectability of the species all warrant consideration.

Detection probability is hampered in cases of species that are cryptic, including species of very small stature, those that are otherwise very inconspicuous, or those that are growing in very obscure microhabitats where they may be overlooked. It also includes cases of species that are recognizable and verifiable for only a short time in the growing season. This is particularly relevant in the case of annuals with short times in flower or in fruit, or plants that are submerged. There is also a special case of plants that have seasonal dormancy, in which the entire plant individual does not appear aboveground (Heidel 2020). Generally speaking, entire populations do not simultaneously go seasonally dormant, so that the species remains detectable even if any given individual does not. Finally, detection can be impaired by climate conditions as in the case of species that do not flower in drought years, or under the adverse weather conditions of any given survey day.

Detection probability is also impeded by setting the habitat survey target too broadly or narrowly, or not having enough information to define or scale the habitat survey. The species themselves may have particularly narrow or broad terms of occupied habitat that represent challenges.

Finally, even if plant populations tend to remain stable over time, habitat is never truly static. This is particularly true for species occupying successional habitation, including conditions associated with disturbance, with transient conditions, or in cases for which the species is episodic in its associated life history.

Future directions

Since the start of Wyoming botanical surveys, WYNDD has a new central database and homepage that directly links to the database. In additions, new tools have become available for more effective survey work, tools that continue to evolve (next page):

- GIS software
- GPS technology
- Models of potential distribution

WYNDD plans to implement a "sampling" or "survey" subsystem into our central database. This new subsystem will allow us to store more robust and complete information related to structured surveys. Information compiled as a result of this project ultimately will be made available from within WYNDD's central database. As new survey information for plant species of concern becomes available, this will be added to the database, ultimately resulting in a more robust picture of areas that have been surveyed for species of concern in the State.

This is also an opportunity to invite input from all readers and users before we consider gaps to fill and new project survey results to add.

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