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Herbarium UTEP

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The herbarium of the Centennial Museum, The University of Texas at El Paso, was founded in the 1970s from small holdings of student collections and gift material from Elsie M. Slater and John S. Williams. It was housed in the Department of Biological Sciences as part of the Museum of Arid Land Biology and the first curator was A.H. Harris (1971-1976). Shortly after its creation a SELGEM program was used to data-base the collection. Limited funding was available over the years to keep the data entry going. Significant collection growth started in the late 1970s when Richard Worthington started sampling the flora of the nearby Franklin Mountains and expanded to sampling more than 20 mountain masses in the region. Worthington became the curator in 1980, replacing Bill Reid (1976-1980). Exchange programs were started for specimens and literature. Collection growth through the 1980s and 1990s has been significant, bringing the present total count to 56,000 specimens. Regional coverage of the flora is now quite good. The old SELGEM files were converted to a modern Lotus Approach Database for Windows. The complete collection is data-based, making it easy to describe and search the collection for coverage and specific holdings. More information about the herbarium can be found on the WWW (http://www.utep.edu/~leb/).

The philosophy of collection development at Herbarium UTEP has been to document the regional flora from the perspective of floral diversity. The collection is viewed as an environmental collection that documents populations with precise data. A feature for most of the regional collections is a topographic locality map on each sheet. In the area of central Trans-Pecos Texas, across south New Mexico, to Arizona, the average common species is represented by 20-40 sheets. The collection has also been developed to represent Mexico and to develop a modest worldly component for its instructional and conceptual value. Collecting has also included lichens, mosses, and liverworts. The collection has an excellent regional documentation of the cryptogams.

A partial characterization of the holdings at UTEP using the searching capability of the Lotus program is as follows:

Sorted by country: USA 44243 Mexico 4839 Malaysia 1097 Australia 618 Belize 439 Trinidad & Tobago 406 Costa Rica 376 Indonesia 240 Philippines 208 Grenada 170

Sorted by states: Texas 16049 New Mexico 7011 California 3957 Arizona 3251 Colorado 1382 Durango 1124 Chihuahua 813 Wyoming 754

Sorted by counties in New Mexico and Texas: Hidalgo 1849 Dona Ana 1822 Hudspeth 1602 Luna 1465 Presidio 730 Culberson 673 Sierra 364 Grant 343 Otero 281 Lincoln 250

Sorted by taxonomic groups in New Mexico: Compositae 1094 Poaceae 587 Lichens 576 Fabaceae 396 Bryophytes 328 Cactaceae 145 Orchidaceae 46 Liverworts 38

Sorted by mountain masses: Franklin Mts. 3984 Hueco Mts. 1437 Organ Mts. 1180 Davis Mts. 951 Florida Mts. 778 Peloncillo Mts. 545 Black Range 517 Potrillo Mts. 441 Guadalupe Mts. 408 Bishop Cap Hills 394 Tres Hermanas Mts. 367 Little Hatchet Mts. 335 Big Hatchet Mts. 265 Apache Hills 217 Pyramid Mts. 178 Animas Mts. 126

Sorted by collector: Worthington, R.D. 18833 Pringle, C. 140 Fosberg, F.R. 100 Wooton, E.O. 1

The primary project based at Herbarium UTEP is the Floristic Inventories of the Southwest Program. The program is structured to document the floristic diversity on island mountain masses of different sizes. The floral inventories of the Organ, Franklin, Hueco, Florida, and Little Hatchet Mountains are essentially complete as well as some smaller inventories for the Bishop Cap Hills and the Tres Hermanas Mts.. A private publishing program will make these available to interested parties.

Herbarium UTEP handles routine loan requests and receives visitors as do other herbaria. Although listed in Index Herbariorum, we do not receive many requests for loans. We have started an international exchange program offering a representation of the Chihuahuan Desert flora.

Standards for the Writing of Floras

by Michael W. Palmer, Gary L. Wade, and Paul Neal

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Government agencies, private organizations, educational institutions, and the general public are increasingly interested in the preservation, restoration, and use of biodiversity (Harris 1984, Levin 1992, McNeely 1990, Norse et al. 1986, OTA 1987, Orr 1992, Tangley 1990, West 1993, Wilson 1988). This interest has created important new constituencies for the products of floristic research.

Floristic data are becoming more important for regional biological inventories, impact assessment, research, management decisions, and policy formulation. Taxonomic, site and ecological data are necessary to link floristic data with their environments to support objective decision making and validation of theoretical models that guide biodiversity management.

What is a flora?

The most common product of floristic research is the flora. We emphasize that the word flora has been variously defined (Morin 1989). Some botanists (e.g., Davis and Heywood 1973, Morin 1989) prefer to capitalize Flora to refer to a publication, while the lowercased flora refers to the actual plants existing in the region. However, we follow Lawrence (1951) who uses flora in a broad sense (and arguably the most widely accepted sense) to be an "inventory of the plants of a definite area." We consider an inventory to be a published, unpublished, or computer listing of species from a region of any spatial scale. Lawrence used the word manual for a flora with the addition of keys and descriptions for identifying and naming all the taxa of the area covered. To some others, floras must contain illustrations of species, while manuals do not. A plant atlas, which includes maps of specimens or county dot maps, can be considered a special case of a flora.

Some botanists limit use of the word flora to comprehensive works that include description and keys for large regions, as distinct from species lists for smaller regions, which are called florulas, checklists, species lists, inventories, botanical surveys, or assessments. We believe these distinctions are arbitrary. After examining several thousand floras, we have concluded that there is an uninterrupted continuum between simple checklists for small areas and multivolume, illustrated floras for very large regions.

Floras have been written for many purposes, including guides for identification, authorities for nomenclature, assessments of biological resources, and baselines for monitoring. Regardless of the comprehensiveness, the size of the region covered, or the intended purpose of the work, authors of floras (as described by Lawrence 1951) should adhere to a set of minimal standards, so future work can be more widely applicable.

Use of floristic data

The amount of data available in published floras is substantial. Based on an initial survey of the literature, we estimate that there are approximately 8000 different published floras describing areas of North America north of Mexico. With a conservative estimate of 500 person hours devoted to each flora, there have been at least 4,000,000 person hours invested in floristic research.

The data included in floras have already proved valuable. For example, floristic data have been used to test premises of island biogeography theory (Deshaye and Morisset 1988, Heatwole 1991), to study plant migrations and dispersal (Gates 1939, Heatwole and

Walker 1989, Morton and Hogg 1989), to test abundance distributions for species within genera (Simpson and Todzia 1990), to evaluate the success of ecological restoration attempts (Thompson and Wade 1991), to evaluate phytogeographic patterns (Jurgens 1991, McLaughlin 1992, Morefield 1992, Shmida and Werger 1992, Thompson 1980, Wheeler et al. 1992), to reassess the biological species concept (Mayr 1992), to determine the expected number of species in unstudied regions (DeWolf 1964), and to evaluate the environmental determinants of biodiversity (Heikkinen and Kalliola 1990, Linder 1991).

The potential scientific uses of floristic data go far beyond academia. Wilken et al. (1989) list some potential users of floras in applied biology, including environmental consultants and engineers, silviculturists, farmers, lawyers, real estate appraisers, municipal planners, weed controllers, landscape architects, seed and feed companies, dermatologists, and customs officials.

Limitations of floras

We are currently compiling a database of floras from the United States and Canada. Our research has revealed that there is immense potential for the use of floras in comparative research. However, there are common shortcomings in otherwise well-implemented floras that greatly diminish their comparability to other floras. Although the missing data might have been considered irrelevant for the intended function of the flora, the data would in most cases have been easy for the authors to obtain and would certainly not have detracted from the intended function. These shortcomings limit biologists' ability to perform comparative research vital to understanding biodiversity.

We are not the first to note shortcomings in floras. Blake and Atwood (1942) were prompted to outline a set of essential features for floras, including an accurate title, an unambiguous delineation of the study area, a thorough exposition of methodology, and a statistical summary.

Several authors (e.g., Davis and Heywood 1973, Lawrence 1951, Wilken et al. 1989) have repeated, expanded, and/or commented on the necessity of including these and other basic pieces of information in a flora. Nevertheless, many authors continue to omit essential information when publishing otherwise well-implemented floras.

Proposed standards

Table 1 lists what we consider to be minimal standards for all floras.

Table 2 lists nonessential but desirable information. We strongly recommend that editors and reviewers for journals, books, and government agencies use Table 1 as a guide when evaluating submitted manuscripts. Please note that we are asking authors to be diligent in preparing manuscripts; we are not suggesting that they follow a precise formula — the author should employ whatever format best suits the intended purpose.

Title. As floras come to be used by people who are not intimately familiar with the floristic literature, it is increasingly important that the title of the flora be clear, descriptive, and unambiguous. In addition, an unambiguous title would facilitate searches for titles in computer databases, which are now widely available and often include regional scientific publications.

The title should include a term or keyword indicating that the publication does indeed comprise a species list for a given area. We suggest that titles include the terms flora or vascular plant checklist, which are both descriptive and already in frequent use. The term vegetation is widely used for ecological purposes and does not necessarily imply the presence of a species list. While titles that include the phrases an assessment of the plants of... or species composition of... do suggest the presence of a species list, it is difficult to retrieve such ambiguous titles with a bibliographic search. Some terms (e.g., survey and inventory) are not ambiguous, but they are not commonly found in titles of other types of publications and, hence, are not likely to be used as keywords in computerized searches.

If the list of taxa is not the primary purpose of the publication, we suggest including a subtitle that contains the terms flora or vascular plant checklist. It is crucial that the title unequivocally specify the taxonomic scope of the flora (e.g., the vascular flora, woody plant checklist, angiosperm flora, cryptogam, and vascular plant flora). If the flora is limited to a particular season (e.g., spring flora), it should be noted in the title.

For the flora of a small area, both the specific site name and the general location should be included in the title. Although a specific site name may seem sufficient in a regional publication, the lack of a general location in the title makes the site difficult for researchers from outside the region to locate. The general locations are typically to be political designations such as counties, states, or provinces. Depending on the size of the area covered, the title should hierarchically include the county(ies), state(s) or province(s), country(ies), or other relevant political divisions that contain the surveyed region.

In the title, the site can be delineated by political (e.g., preserve, county, or park) or physiographic (e.g., watershed, island, or mountain range) boundaries. Although the latter might lead to some ambiguity about the specific boundaries of the coverage, the boundaries can and should be more clearly delimited in the text or a map.

The following are examples of well-formed flora titles: "Vascular plant flora of the Wager Bay Region, District of Keewatin, Northwest Territories" (Cody et al. 1989), "Checklist of vascular plants for the Bighorn Canyon National Recreation area, Wyoming and Montana" (Lichvar et al. 1985), and "The vascular flora of Cunningham Brake, A Cypress-Gum Swamp in Natchitoches Parish, Louisiana" (Mathies et al. 1983).

Location information. We have found that site information is often incomplete in floras (including, perhaps by oversight, large comprehensive floras). The site should be unambiguously delineated. At a minimum, the document should give the site name, state(s), county(ies), or other relevant political division, and latitude and longitude. If the

site is small and not well known, unambiguous directions for reaching it should be given, or a map showing its location with respect to prominent landmarks should be included. If the area is greater than 25 km in maximal dimension, latitude and longitude to degrees and minutes (alternately, to hundredths of degrees) of the north-south and east-west boundaries, respectively, are desirable. In much of the western United States, township, range, and section unambiguously denote the location of a piece of property but should be presented in addition to, not instead of, latitude and longitude. No matter the size of the region, a map indicating its boundaries is highly desirable.

The length of a taxon list is so strongly determined by area (Williams 1964, Williamson 1988) that the area (in hectares or square kilometers) is one of the most important pieces of data to include. Comparative research is almost impossible without an assessment of area — one flora could contain more species than another simply because it was from a larger region and thus had a larger sample size (Palmer in press, Palmer and White 1994b). Knowing the area covered by a flora allows an objective evaluation of the relative richness of the flora compared with other floras of similar area in a region. A comparatively low richness for a given area might also indicate that additional floristic research may prove fruitful.

If the site is an island, a group of islands, or multiple, separate tracts, the total number of these locations and their separate areas should be given. For true islands, a matrix of shore and interisland distances is desirable, and the name of the body of water should be stated.

Environmental information. Just as it is impossible to have an absolutely complete flora, it is difficult to fully describe the environment of any region. Nevertheless, it is essential that at least a brief evaluation of the environment be given. When specific information is not available, as might be expected from some tropical locations, a brief summary of the current status of knowledge of the site or region would be helpful.

Essential data include the minimal and maximal elevations (in meters), physiographic region(s) as defined by standard geographic works, names of river systems draining the site, major impoundments, and major habitat or ecosystem types. The area covered by bodies of water should be presented if it is a significant portion of the total area.

Habitat and ecosystem descriptions may be arbitrary (Palmer and White 1994a), but where available, the use of a widely known habitat or ecosystem classification scheme is preferable (e.g., Kuchler 1964). If available, the absolute or relative fraction of the study site in each habitat/ecosystem type can be given. A brief description of geomorphology, surface geology, and soils should be included in both large and small floras. The number of identified soil series present is potentially useful as an index of environmental diversity present in the site. The references used to describe the physiography, geology, and soil must be cited.

Climatic data are desirable but difficult to standardize, especially for large regions. The nearest weather station(s) should be named, and its precise location (including elevation)

relative to the site should be given. Desirable data include annual precipitation, temperature, and for regions outside the tropics, the mean dates for the first and last freeze. For large areas, if data are available, the spatial and temporal variation of these factors should also be given.

Past and present disturbance and human impacts on the study area such as history of glaciation, hurricanes, fire, logging, agriculture, mining, and recreational use should be described. The proportion of each study area that has been impacted by each type of disturbance should be given whenever practical.

Because human activities can have a strong impact on biodiversity, the human population density of the study area (or the surrounding county or counties, if the region is small) should also be given. There is admittedly some ambiguity in listing population density. The flora should note special situations. For example, a park in a region with low population density (e.g., the Great Smoky Mountains National Park) may experience intense recreational use. A county with high overall population density might contain some regions with low density.

Taxonomic scope. The taxonomic scope of the flora must be clearly delineated. Nomenclatural authority and principle sources used for identification must be cited. This information is extremely important — the quality and usefulness of a flora depend upon accurate identification and the proper use of names. It should be stated if the flora is intended as a nomenclatural authority. Where possible, nomenclature should follow modern synonymy, such as that provided by Kartesz (1994) or the Flora of North America editorial committee (1993a,b, other volumes in preparation), and relevant monographs should be consulted. It must be clearly stated whether or not there was an attempt to delineate taxa to an infraspecific (i.e., subspecific or varietal) rank; it is often not clear whether the infraspecific taxa are not known from the site or simply not recorded. Omission of particular taxonomic groups (sometimes done for pteridophytes and graminoids) should be avoided or must be stated explicitly early in the text.

The taxonomic breadth (e.g., vascular flora, woody flora, and angiosperm flora) must be stated in the title. Vascular floras are the most common and should be attempted wherever possible to allow comparability with other studies. However, there is also value in published work with a more limited scope.

Occasionally, published floras are even broader in scope than a vascular flora and include bryophytes, algae, and/or fungi (e.g., Bird 1975, Glaser 1992, Jordan 1874, Murray and Murray 1978). Such publications are rare, but they are of immense value in assessing biodiversity. Because they are rare, it is desirable that the broad nature of the publication be obvious from the title and that any summary of the taxa included should be assessed separately by major taxonomic groups.

Voucher specimens. The importance of voucher specimens cannot be understated (Goldblatt et al. 1992). Voucher specimens for all included taxa must be prepared, and the repositories of these specimens must be identified. Vouchers are not necessary if

circumstances such as toxicity (e.g., Toxicodendron radicans) and endangered status prevent collection; the reasons for not documenting occurrence must be indicated in the text. If collection is impossible, a photographic record is desirable.

Botanical effort. For a small area, the collecting effort should be stated, though not necessarily in excessive detail (e.g., "John Doe collected vascular plants at two- to three-week intervals in 1984, and Jane Jones collected grasses several times per year from 1980 to 1990"). It should also be stated whether the species list is compiled from a limited number of sampling stations or whether an attempt was made to cover the entire region. If herbaria were searched for occurrences that are included in the published flora, the names and locations of these herbaria must be given. It also must be stated if the flora includes records from other published or unpublished floristic work. Taxa for which the authors have not seen living or pressed specimens should be listed separately, if at all.

Methods employed in the production of large, comprehensive floras are generally quite different from the methods for floras of small regions. For large floras, the most important collectors and methods used in compiling the floristic data should be described in the preface, introduction, or an early chapter.

There is currently no widely accepted method to predict the completeness of a species list (Palmer in press). Nevertheless, most people performing floristic research have an informal assessment of how complete they believe their list to be. Even though such an estimate of completeness has no absolute comparative value, it may be of interest to the reader. If a scientist has an objective way of estimating the completeness of a list, for example, a collector's curve or rarefaction curve (Brewer and Williamson 1994, Grassle 1991), it should be stated.

Exotic or native origin. The origin of each species (i.e., whether it is native to the region or exotic) must be clearly indicated. We recommend that the ideal flora consists of all vascular plants growing spontaneously (i.e., the individual plants were not planted by humans). However, if other guidelines are employed (such as exclusion of taxa considered accidental, waif, persistent after cultivation, or exotic), they must be carefully stated and the terms defined. Exotic (alternatively, alien, naturalized, nonindigenous, nonnative, or introduced) species should be explicitly defined to indicate whether the classification represents, for example, "not native to the continent" or "not native to the eastern United States." The geographic origin of exotic species may also be useful to some flora users. In all cases, the source of data for determining status or origin must be cited.

The checklist. This checklist is the core of the flora. Taxa must be hierarchically listed by family in a logical order (e.g., in alphabetical order or in a standard taxonomic sequence such as that presented by Gleason and Cronquist [1991]). We recommend alphabetical order because standard sequences vary widely; if sequences are used they must be identified. The listing for each species must include the Latin binomial with authority. Punctuation, capitalization, and italicization should be in accord with Scientific Style and Format (CBE 1994) or Radford et al. (1974). If a standard synonymy is followed, the

authorities are not necessary, but they are still highly desirable. The exotic origin of each species must be clearly indicated. Indications of new county or state records, endemism, and presence on state or federal protection lists are highly desirable. For floras of small scope, the collectors and collection numbers for each species included are desirable.

An assessment of the abundance of each species (ideally indexed by location or habitat) could increase the usefulness of a flora. There are potentially an infinite variety of abundance scales, and many such scales have been used in the past. The most desirable approach is to use a scale that has already been employed for the same or similar sites. In regions where no such abundance scale has been used, a proposed scale is given in Table 3. This scale is similar to, and easily reconciled with, the scales used in many published floras, and it therefore enhances comparative value. Admittedly, the assignment of many species to the correct abundance categories is highly subjective, but because the categories are so broad, putting species in the wrong category would probably be infrequent. A two-category change in species' abundance between different surveys of the same region may indicate an important change in that species' population.

Vernacular names are optional, but they do make floras more useful to the public. If they are included, it is desirable to list the names as used in a specific taxonomic flora or manual (if available), which then must be cited as the source of the names. It may also be of ethnobotanical interest to seek out the names in general use by local residents, in which case the methods (even if not systematic) must be stated.

The precise format of coding all of the above information is unimportant, but it should be clear and concise. Superscripts, prefix codes, asterisks, and use of different fonts are useful for indicating exotic status, threatened status, and abundance measures. Any format employed must be fully explained in the text.

Context. The author of a flora may want to describe where the work stands in relation to other published works. The context of a published flora includes defining relationships with published floras of smaller included areas, earlier floras of the same area, floras of neighboring areas of both similar and contrasting environments, floras of larger areas that include the area covered by the new flora, and ecological works on the vegetation of the area.

Summary statistics. A table must be included that lists, at minimum, the total number of families, genera, and species and the percentage and/or number of exotic and native species. Listing the number of subspecific taxa is optional but desirable if they were identified. Tabulation using other subdivisions (e.g., classification by major taxonomic group, life form, or biogeographic affinities) may be desirable if it assists the overall objectives of the publication. Table 4 presents a hypothetical example of a table meeting the standards.

The phrase total number of taxa is widely but inconsistently used. For example, it has variously designated the total number of species, the number of species plus subspecies and varieties (sometimes thereby counting a variety that is the sole representative of a

species twice), or the number of species plus genera plus families. This inconsistency makes it difficult to use floras comparatively. Because of its ambiguity, the phrase total number of taxa should be abandoned unless its meaning is clearly defined.

Because the number of higher-level taxa varies substantially depending upon the taxonomic treatment used, summary tables may be difficult to use comparatively. However, if the taxonomic treatment is listed, a scientist performing comparative work is likely to be able to make the appropriate adjustments.

Electronic copies. Floras typically possess hundreds to thousands of species. This size makes the input of data into computers one of the most time-consuming aspects of comparative floristic research. Such research would be greatly assisted if authors made their floras available also in electronic form. This format should not be difficult because most authors now prepare manuscripts using word processors. At the end of the list of taxa, authors should state whether the list is electronically available, and if so, which author to contact, the nature of the file (e.g., ASCII, word processor, database, or spreadsheet), the medium (e.g., tape or diskette), the operating system used, and the cost.

How well do floras meet the criteria?

The proposed standards in Table 1 appear modest. Nevertheless, it is surprising how many floras do not meet many of these basic criteria. From our growing collection of more than 1800 floras from the western United States and Canada, we randomly selected 100 floras published after 1969 to check for conformation to our proposed standards (Table 5). Floras included standard, widely available journals and books. Reports from governmental agencies or private organizations and unpublished lists were not considered because they are less likely to be peer-reviewed than other floras.

Evaluation of conformation to the criteria was adjusted to account for the scale of the flora. For example, a large, comprehensive flora intended as a nomenclatural authority would automatically conform to the criterion of nomenclatural authority cited. We found that large comprehensive books are not necessarily more complete or informative than short journal papers.

The future of floras

Floristic research has entered the computer age. Whenever possible, botanists writing floras should take advantage of new tools such as specimen-based computer databases (Allen 1993, Morain 1993, Morin and Gomon 1993).

At first, it might seem that current trends are likely to obviate the need for written floras. However, it is unlikely that floras will be made obsolete in the indefinite future. Computerized plant databases have some serious limitations (Allen 1993). Also, people responsible for managing biodiversity are always likely to have a need for a site-based presentation of taxa (i.e., a flora) in addition to specimen-based presentation of taxa. We

envision a bright future for floras in which specimen-based databases assist the development of floras and vice versa.

Conclusions

We hope that the worldwide concern for management and preservation of biodiversity brings about a resurgence of floristic research. By expanding the scope of their already valuable research, botanists are likely to increase the completeness and use of the floras they produce. This expansion should not require much additional effort, because the basic data are in most cases easily available to the authors — the data are certainly more likely to be available to the authors than to the readers. The necessary information is easily presented in short paragraphs or small tables, so publication costs should not be substantially increased. The modest standards proposed here should not interfere with the many purposes that authors have intended for their work.

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New Plant Distribution Records

New records for New Mexico are documented by the county of occurrence and the disposition (herbarium) of a specimen.

— McIntosh (Phytologia 81:365-368. 1996)

Baccharis havardii A. Gray (Asteraceae): Otero Co. (NMC).

Gnaphalium leucocephalum A. Gray (Asteraceae): San Miguel & Hidalgo Cos. (NMC).

Brassica tournefortii Gouan. (Brassicaceae): Dona Ana Co. (NMC).

Plantago bigelovii a. Gray (Plantaginaceae): Hidalgo Co. (NMC).

Valeriana sorbifolia H.B.K. (Valerianaceae): Hidalgo Co. (NMC).

Bouchea prismatica O. Kuntze var. brevirostra Grenz. (Verbenaceae): Hidalgo Co. (NMC).

Verbena gracilis Desf. (Verbenaceae): Hidalgo Co. (NMC,SNM); Mora Co. (NMC).

— Zander & Weber (The Bryologist 100:237-238)

Didymodon anserinocapitatus (X.-j. Li) Zand. (Pottiaceae): San Miguel Co. (DUKE).

— Roger Peterson (1750 Camino Corrales, Santa Fe, NM 87505).

Bromus sterilis L. (Poaceae): Santa Fe Co. (pers. herb.).

— Robert Sivinski (P.O. Box 1948, Santa Fe, NM 87504) - interesting second records for these species:

Prenanthella exigua (Asteraceae): San Juan Co. (UNM).

Cryptantha oblata (Boraginaceae): Hidalgo Co. (UNM).