Boulder County Purchasing
1325 Pearl Street
Boulder, CO 80302
purchasing@bouldercounty.org

SOLICITATION OF QUALIFICATIONS COVER PAGE

SOQ Number:	7433-23
SOQ Title:	**ANNUAL VEGETATION MONITORING AND MAPPING SERVICES**
SOQ Questions Due:	FEBRUARY 23, 2023 – 2:00 p.m.
Submittal Due Date:	**MARCH 3, 2023 – 2:00 P.M.**
Email Address:	purchasing@bouldercounty.org
Documents included in this package:	Proposal Instructions Terms and Conditions Data Requirements Specifications Insurance and W-9 Requirements Submittal Checklist Proposal Section Evaluation Criteria Signature Page

Attachments:
A: Vegetation Mapping BCPOS Protocol
B: Vegetation Mapping Data Sheet
C: BOCO Plant Species Special Concern
D: National Vegetation Classification
E: Prairie Dog Vegetation Monitoring
F: Rangeland Vegetation Monitoring
G: GIS Data Deliverables
H: Exporting CAD to GIS Data
I: Purchase Order Terms
J: Sample Contract

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PROPOSAL INSTRUCTIONS

BACKGROUND:

Boulder County Parks and Open Space (BCPOS) is seeking qualifications from consulting firms for vegetation monitoring and vegetation mapping services. The County is seeking qualified contractors to retain for future projects of the discipline as described in the Specifications section. All specific projects will be sent out to the selected continuing services contractors by the County's informal bid process. Each contractor on the list will have the opportunity to bid on the individual projects.

Selected consulting firms must have experience in completing Line Point Intercept vegetation monitoring, and vegetation mapping using the United States National Vegetation Classification (USNVC) System. Qualifying firms must have the ability to identify species to specific epithet, including plants at vegetative or early basal life stages. The vegetation mapping requires identification of plant communities to the association level and field verification of the designation. The vegetation mapping requires a minimum mapping unit of 1/4th acre for upland areas and 1/10th of an acre for wetlands. The vegetation mapping also requires identification of the dominant species by structural level, including tree, shrub, subshrub, gram, and forb. All field data for both the monitoring and mapping must be submitted to the County along with final reports and final GIS data based upon the County's requirements for individual projects awarded.

CONTRACT LANGUAGE:

The successful proposer will be required to enter into a Contract for Services and meet all insurance requirements as required prior to any work beginning. The County retains the right to select more than one contractor. The selected Contractor(s) will be required to enter into a Continuing Services Contract, for the current year with an option to renew, in writing, for four (4) additional years. The Contractor acknowledges that a Contract does not constitute a guarantee that Contractor will receive any Projects or Work of any kind under this Contract, if selected, and in such event, Contractor would not receive any payment from County. Projects will be awarded, on a Project-by-Project basis. Each Project will include a separate Scope of Work and bids/proposals will be solicited from the approved contractor list compiled from this solicitation.

Work will not commence for any Project awarded until the County has issued a Notice to Proceed to the awarded Contractor.

Proposers should list the Boulder County and Colorado professional and/or contractor licenses held by the company and the key personnel who will be assigned to County awarded projects. Proposers are to provide the license number and explain if held by an individual or the company. All workers shall be certified by the County and/or the State of Colorado for these types of projects, if required.

The evaluation of the qualifications shall be based on the requirements described in this SOQ. All properly submitted qualifications will be reviewed, evaluated, and selected by the Evaluation Committee. Qualification submittal information must include information regarding company fees, in detail and including personnel hourly rates, equipment, meetings, reports, administrative costs, mileage, travel, and/or other cost information relevant to do business with the County.

Boulder County reserves the right to reject submittals that do not include evidence of prior experience and current capabilities, including manpower and equipment, necessary to provide the required services and to successfully complete this type of work.

All proposers are instructed to thoroughly review all the stated insurance requirements for this Project, the insurance requirements stated are the minimum and standard for Boulder County Government, for this Project. All hired contractors are required to meet the insurance requirements, as stated, for contracted services as part of the Boulder County contracting process. Owner/Sole Proprietors/Officer are not Exempt from the county's insurance requirements and coverage limits. Please refer to the Insurance Requirements in this SOQ.

Additionally, the Contractor is aware all insurance requirements, as stated, are required to be active for the duration of the contract, or as otherwise stated, whether Projects or Work are awarded from the County.

PAYMENT FOR SERVICES:

Contractors are instructed to review the Data Requirements section specifically for all data related deliverable requirements. Payment will be retained until the data submitted is 100% compliant with the County requirements as detailed in each awarded Project.

Payment is subject to the terms of each individual Project. In general, progressive payments will be made based upon milestones completed as follows:

1. Completion of field work; and
2. Submission and County approval of deliverables.

Contractor shall submit, in writing, to Boulder County, a request for payment. Invoices shall be submitted on company letterhead and include, but not limited to, depending on the activity completed, designated project name, date(s), type of work performed. Additionally, all invoices should contain the current date, invoice number, amount due and current return address.

Additionally, payment for Project awarded is subject to the terms and conditions of the Boulder County issued Purchase Order.

ATTACHMENTS:

The following documents are part of this SOQ:

1. Attachment A: Vegetation Mapping BCPOS Protocol
2. Attachment B: Vegetation Mapping Data Sheet
3. Attachment C: BOCO Plant Species Special Concern
4. Attachment D: National Vegetation Classification
5. Attachment E: Prairie Dog Vegetation Monitoring
6. Attachment F: Rangeland Vegetation Monitoring
7. Attachment G: GIS Data Deliverables
8. Attachment H: Exporting CAD to GIS Data
9. Attachment I: Purchase Order Terms and Conditions
10. Attachment J: Sample Contract

WRITTEN INQUIRIES:

All inquiries regarding this SOQ will be submitted via email to the Boulder County Purchasing Office at purchasing@bouldercounty.org on or before 2:00 p.m. **FEBRUARY 23, 2023**. A response from the county to all inquiries will be posted and sent via email no later than **MARCH 1, 2023**.

Do not contact any other county department or personnel with questions or for information regarding this solicitation.

SUBMITTAL INSTRUCTIONS:

Submittals are due at the email box only, listed below, for time and date recording on or before **2:00 p.m. Mountain Time on MARCH 3, 2023**. **Please note that email responses to this solicitation are limited to a maximum of 50MB capacity.**

NO ZIP FILES OR LINKS TO EXTERNAL SITES WILL BE ACCEPTED. THIS INCLUDES GOOGLE DOCS AND SIMILAR SITES. ALL SUBMITTALS MUST BE RECEIVED AS AN ATTACHMENT (E.G. PDF, WORD, EXCEL).

Electronic Submittals must be received in the email box listed below. Submittals sent to any other box will NOT be forwarded or accepted. This email box is only accessed on the due date of your questions or proposals. Please use the Delivery Receipt option to verify receipt of your email. It is the sole responsibility of the proposer to ensure their documents are received before the deadline specified above. Boulder County does not accept responsibility under any circumstance for delayed or failed email or mailed submittals.

Email purchasing@bouldercounty.org**;** identified as **SOQ #7433-23** in the subject line.

All SOQs must be received and time and date recorded by authorized county staff by the above due date and time. Sole responsibility rests with the proposer to see that their SOQ response is received on time at the stated location(s). Any responses received after due date and time will be returned to the proposer.

The Board of County Commissioners reserves the right to reject any and all responses, to waive any informalities or irregularities therein, and to accept the proposal that, in the opinion of the Board, is in the best interest of the Board and of the County of Boulder, State of Colorado.

Contractors and their employees, subcontractors, and agents must comply with all federal, state, and local laws, regulations, ordinances, orders, and codes, as well as Boulder County policies, guidelines, and protocols.

AMERICANS WITH DISABILITIES ACT (ADA): If you need special services provided for under the Americans with Disabilities Act, contact the ADA Coordinator or the Human Resources office at (303) 441-3525 at least 48 hours before the scheduled event.

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TERMS AND CONDITIONS

1. Proposers are expected to examine the drawing, specifications, schedule of delivery, and all instructions. Failure to do so will be at the proposer's risk.

2. Each proposer will furnish the information required in the Request for Proposals.

3. The Contract/Purchase Order will be awarded to that responsible proposer whose submittal, conforming to the Request for Proposals, will be most advantageous to the County of Boulder, price and other factors considered.

4. The County of Boulder reserves the right to reject any or all proposals and to waive informalities and minor irregularities in proposals received, and to accept any portion of or all items proposed if deemed in the best interest of the County of Boulder to do so.

5. No submittal will be withdrawn for a period of thirty (30) days subsequent to the opening of proposals without the consent of the County Purchasing Agent or delegated representative.

6. A signed purchase order or contract furnished to the successful proposer results in a binding contract without further action by either party.

7. Late or unsigned proposals will not be accepted or considered. It is the responsibility of proposers to ensure that the proposal arrives at the Purchasing email address prior to the time indicated in the "Request for Proposals."

8. The proposed price will be exclusive of any Federal or State taxes from which the County of Boulder is exempt by law.

9. Any interpretation, correction or change of the SOQ documents will be made by Addendum. Interpretations, corrections and changes of the SOQ documents made in any other manner

will not be binding, and proposer will not rely upon such interpretations, corrections and changes. The County's Representative will not be responsible for oral clarification.

10. Confidential/Proprietary Information: Bids submitted in response to this "Invitation to Bid" and any resulting contract are subject to the provisions of the Colorado Open Records Act, 24-72-201 et seq., C.R.S., as amended. Any restrictions on the use or inspection of material contained within the bid or resulting contract should be clearly stated in the bid and contract itself. Confidential/proprietary information should be readily identified, marked and/or separated from the rest of the bid. Co-mingling of confidential/proprietary and other information is NOT acceptable. Vendors must answer whether line-item pricing information submitted with a bid is confidential or closely held. Bids that do not identify confidential/proprietary information may be released in their entirety. Pricing totals contained in a bid are not considered confidential.

    The Boulder County Attorney's Office retains sole authority for determining whether the Colorado Open Records Act requires or permits Boulder County to disclose proposal or bid documents, or any information contained therein, pursuant to an open records request.

11. Boulder County promotes the purchase/leasing of energy efficient materials and products with low toxicity levels when availability, quality and budget constraints allow. Proposers are expected whenever possible to provide products that earn the ENERGY STAR and meet the ENERGY STAR specifications for energy efficiency with power management features enabled. Proposers are encouraged to offer products and equipment with post-consumer recycled-content materials. Products should be packaged and delivered with a minimum amount of recycled packaging that adequately protects the product but is not excessive.

12. Pursuant to Colorado law (House Bill 1292), in any bidding process for public works in which a bid is received from a non-resident bidder who is from a state that provides a percentage bidding preference, a comparable percentage disadvantage shall be applied to the bid of that bidder. Bidders may obtain additional information from the Department of Personnel's website: http://www.colorado.gov/dpa/.

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DATA REQUIREMENTS

Contractors are required to meet 100% compliance for all data deliverables. Payment will be retained until the data submitted is 100% compliant with the County's requirements as detailed:

GEOGRAPHIC INFORMATION SYSTEM (GIS) DATA DELIVERABLE REQUIREMENTS:

Contractor's Note:
In order for Contractors to access the Boulder County Secure FTP site to download the files, Contractors will need to install and use the WinSCP freeware program (Appendix B) to connect to Boulder County SFTP server. Site Instructions pertaining to this solicitation will be disclosed to the selected Contractor after the Project Bid Award process has been completed.

a. Any contracted GIS data, such as monitoring, inventories or species mapping will be delivered, by Contractor, in GIS format.

b. All GIS data (including high-accuracy PLSS monuments and survey plat) are required to be delivered, by Contractor, in an ESRI 10.x compatible format, either shapefile or file geodatabase feature class.

c. All spatial or georeferenced (both GIS and CAD) data are required to be provided, by the Contractor, in the following coordinate system:

Name: NAD 1983 HARN State Plane Colorado North FIPS 0501 Feet
Unit: Foot US
Projection: Lambert Conformal Conic
Horizontal Datum: North American Datum 1983 HARN
Vertical Datum: North American Vertical Datum 1988
Spheroid: GRS 1980

NON-SPTIAL DATA REVIEW:

1. Non-spatial data is a tabular representation of facts, concepts, or instructions. While this data may contain spatial location (such as latitude and longitude coordinates) it is not contained within a spatial enabled format, such as an Esri geodatabase or geoJSON file.

Common tabular data formats include Excel spreadsheets, CSV files, or SQL database tables.

2. Data contained within reports is not sufficient for BCPOS usage. Any data presented within a report will also be delivered as a tabular data file.

3. Some BCPOS examples of non-spatial data include regularly repeated monitoring point observational data, survey results, or small grant research results.

4. Tabular data delivered to BCPOS must adhere to the following best practices:

a. Only include data in a data file; do not include figures or analyses.

b. Aggregate like data into fewer large files, rather than many small ones or separate tabs within a spreadsheet.

c. Column headers only use alphanumeric characters or underscores. Column headers do not include spaces. Use only the first row to identify a column header.

d. All cell data format type is formatted properly. Date fields should be in a consistent date format throughout the dataset.

e. Do not rely on special formatting for tables.

f. Do no hide columns or rows.

g. Do not use zeros or blanks to represent missing data. Common alternative conventions include: -9999, NA, or NULL.

h. Table must contain a unique identifier for each record in the table.

i. Tabular data linking to geospatial data must contain the foreign key or identifier for the spatial feature.

j. Metadata (information that includes data about the data) will accompany data file(s). It will be in a separate, associated word or text document, except in the case of Excel, where it should be included in an additional sheet within the workbook.

OWNERSHIP OF WORK PRODUCT:

All work product, property, data, documentation, information or materials conceived, discovered, developed or created by the selected Contractor pursuant to this proposal and subsequent Contract will be owned exclusively by the County. To the extent possible, any Work

Product will be deemed to be a work made for hire. The selected Contractor unconditionally and irrevocably transfers and assigns to the County all right, title and interest in and to any Work Product.

The selected Contractor will agree to keep confidential all County Data, and will agree not to sell, copy, modify, reproduce, republish, assign, distribute, data mine, search or disclose any such confidential information to any other person or entity without the County's written permission, including metadata (e.g. aggregations of county data or analysis of county data content).

The Contractor shall not access County accounts or County Data, except in the event as required by the express terms of a written contract between the mutual Parties and/or at the express written request of the County. All data obtained by the Contractor in the performance of this solicitation resulting in a contract shall become and remain the property of the County. The Contractor shall not use any information collected in connection with the service issued from this solicitation for any purpose other than fulfilling a County contract for this SOQ.

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SPECIFICATIONS

SPECIFICATIONS:

This SOQ includes two (2) distinct tasks vegetation monitoring and vegetation mapping. Contractor responsibilities for both vegetation monitoring and mapping include but are not limited to:

a. participating in project meetings with BCPOS Agriculture or Plant Ecology staff
b. coordination with GIS staff
c. field data collection
d. data compiling
e. data verification and analysis
f. report writing
g. photo documentation and
h. GIS/GPS mapping

Additionally, both tasks require the following:

1. Contractor must be able to identify plants to specific epithet, in both flowering and vegetative states, including at early basal life stages.

2. Contractor must be able to use GPS-enabled devices for navigation, including navigating to specific transect points, and to record spatial data.

3. Contractor must be familiar with vegetation monitoring techniques and the USNVC protocol for documenting vegetation associations.

4. Contractor must be able to travel on foot to remote portions of BCPOS properties.

5. Contractor must submit GIS deliverables (including shapefiles or in gdb format) and other written and tabular deliverables by the end of the calendar year in which the fieldwork is scheduled.

For example, deliverables from fieldwork conducted in the 2023 field season must be completed and submitted before the end of 2023. See specific project deliverable dates.

I. Vegetation Monitoring Specifications:

The vegetation monitoring will occur on multiple Boulder County Open Space properties located mainly east of Highway 36. The exact property locations for vegetation monitoring will be released within the specifications of each project and will vary year to year. The contractor may be asked to complete as many as forty (40) vegetation monitoring transects during the growing season. There are two (2) vegetation monitoring categories the contractor may be asked to perform, but both categories use the same general protocol with minor exceptions.

1. Rangeland Monitoring:

Complete Vegetation Monitoring as part of the BCPOS Agricultural Division's Rangeland Monitoring Program. This monitoring is intended to track changes in vegetation on grazing parcels.

2. Prairie Dog/Native Grassland Vegetation Monitoring:

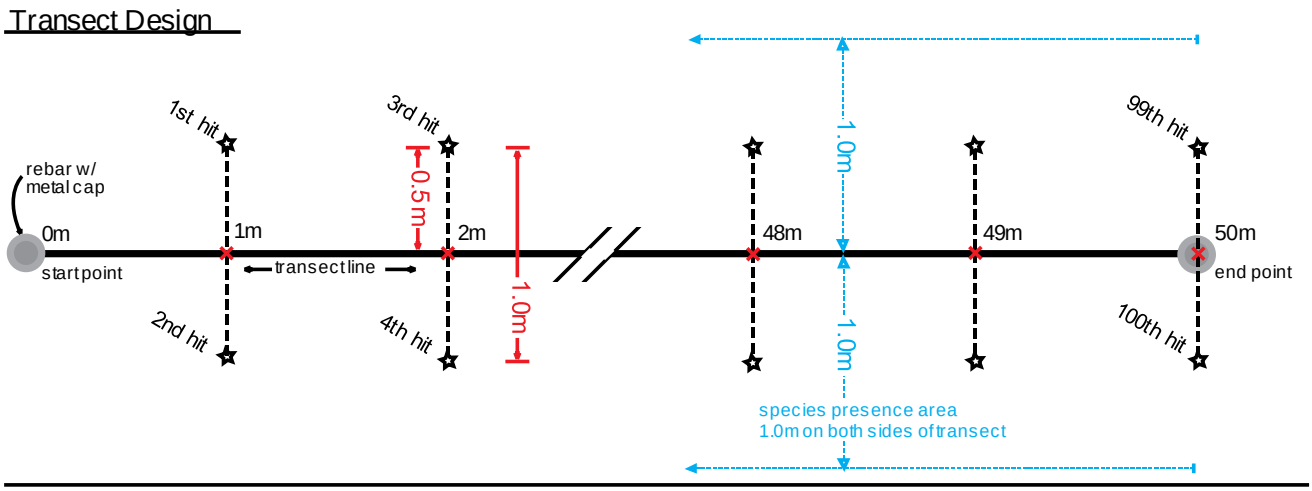
Complete Vegetation Monitoring as part of the BCPOS Plant Ecology Division's Prairie Dog Vegetation Monitoring. This monitoring is intended to track the vegetation changes associated with prairie dog occupation compared to unoccupied native grasslands.

The following methodology will be used:

a. The method of monitoring is to locate the pre-existing transects (GPS information will be provided). Transects are fifty (50) meters long each and have a rebar pin and 2 ½" aluminum cap placed at the origin (start) point and end point.

b. The data collected will include species composition, frequency, foliar cover, and species richness data using the line point intercept (LPI) method using a Cover Point Optical Projection Device or other equivalent device. Starting at the 1.0-meter mark, a pair of points will be sampled on opposite sides of the transect, 0.5 meter from the transect center line. First and second hits on live plants, plant litter, bare soil, and rock will be noted. Second hits are only recorded when a different species is encountered below the first hit species. In addition, the Rangeland monitoring will include 'Standing Dead' as an additional category. One hundred '1st' hits will be recorded for each transect.

Figure 1. Transect design for line point intercept and species presence.



c. Additionally, the presence of all species not hit during LPI will be identified and recorded within a 2x50-meter belt transect (1 meter on either side of tape). A list of these species will be appended to the list of 'hit' species, creating a complete list from which species richness can be determined for the transect.

d. Photographic documentation will be collected for each transect. Photos should be georeferenced and utilize a photo labeling app, that can embed date, UTM or lat/long coordinates, orientation, transect ID and other descriptors as needed. Examples include Survey Cam or Time Stamp Photo for Android or Context Cam for iOS. Each photo will be named with existing BCPOS nomenclature: Boulder Parks property name initials and transect number (i.e. BPRB1, start and end). Any missing monuments should be noted and flagged, and the County can replace with appropriate monument. A photo will be taken from the origin point, oriented towards the end point of each transect and a photo will be taken from the end point towards the origin point. The transect photos must be high quality digital photos.

Figure 2. Example of transect photo embedded with data.

PHOTO 1. DEB01 ORIGIN. AUGUST 25, 2022.

II. Vegetation Mapping Specifications:

The Contractor will follow the BCPOS Vegetation Mapping Protocol (Attachment A), which is adapted from the USNVC mapping protocol. Vegetation mapping may occur on any BCPOS property but is most likely needed in foothill and montane properties. The Contractor will map vegetation communities to the Association level in the USNVC system. One (1) kick off meeting, one (1) wrap-up meeting and a no less than two (2) field verification meetings are required. The Contractor is expected to determine the exact number of necessary meetings as part of the submitted quote. Field data can be collected using the attached field data sheet (Attachment B), or it can be collected using another data form provided by the Contractor.

The vegetation mapping requirements below are excerpted from the BCPOS Vegetation Mapping Protocol (Attachment A) to provide a summation of mapping requirements, but the Contractor is expected to follow the protocol in full.

a. Mapping is to occur to the lowest classification of the USNVC, Level 8 – the Association, with a minimum mapping unit of 1/4 acre for all sites and 1/10 of an acre for wetland sites and sites with a community rank of G1-G3 or S1-S3 by the Colorado Natural Heritage Program (CNHP).

b. Contractor shall create polygons to delineate the boundaries of individual vegetation associations as defined by the USNVC system in digital format (shapefiles or in gdb). Each polygon will be accompanied with a geo-referenced photo that represents the vegetation community of that polygon.

c. Mapping shall include a comprehensive list of overstory and understory vegetation, documenting a minimum of fifteen (15) dominant plant species per polygon. The USNVC protocol requires percent cover estimates and dominance ranking in each stratum. The five (5) most abundant species in each stratum will be ranked.

d. Documentation of rare plants and noxious weeds, as listed in both the Boulder County Comprehensive Plan – Environmental Resources Element (Attachment C) and in the Colorado State Noxious Weed list, respectively, should include an element of occurrence record to BCPOS. GPS data of weed infestations or rare plant occurrences should be included in the final submittals and provided in digital format to BCPOS.

This element of occurrence record will include:

1. Date and time of the observation
2. GPS coordinates
3. Estimate of population size
4. Current phenological status
5. Any other pertinent field observations related to the occurrence

e. If the Contractor identifies vegetation communities (i.e., Associations) that are not currently described in the USNVC framework and that cannot be lumped into an existing Association due to conflicting data between the observed vegetation community and an existing USNVC Association description, the Contractor will write a brief description of up to ten (10) provisional Associations. If more than ten (10) provisional Associations are found to occur in the property, the Contractor is only responsible for writing ten (10) descriptions, prioritizing provisional Associations that either comprise the greatest area within the property, or that have the greatest conservation importance, at the discretion of the Contractor. Any remaining vegetation communities that would necessitate a new provisional Association description can instead be specified to the Alliance level, with a note explaining that no existing USNVC Association currently exists within the USNVC framework that would be suitable to describe the observed vegetation community. At minimum, the provisional Associations must include the following information (complete standard for describing and classifying natural vegetation can be found in Attachment D – National Vegetation Classification Standard Version 2):

1. Provisional title of the Association
2. Name and Element Code of the Alliance under which the Provisional Association is to be nested
3. Species composition of the stand of vegetation, including:
   a. Names of dominant taxa
   b. Dominant taxa cover values

c. The stratum for each species (i.e. tree, shrub, herbaceous, nonvascular, etc.)

4. Vertical structure and physiognomy of the plot

5. Physical data of the plot

a. Elevation, slope, aspect, topographic position, landform, substrates, or geologic parent materials

b. Soil and water features, including soil moisture, drainage, hydrology, depth of water

c. Soil surface cover of litter, rock, bare ground, coarse woody debris, or other important surface features.

d. General vegetation conditions, including landscape context, homogeneity of the vegetation, stand maturity, successional status, and evidence of disturbance

6. Geographic data

a. Location of stands (accomplished via mapping process)

COUNTY RESPONSIBILITIES:

1. Project Setup and Coordination:

a. BCPOS will provide maps and GIS layers as necessary, including property boundaries, transect points, imagery, topography, and other pertinent layers needed for this project. BCPOS will also provide data sharing tools to receive deliverables.

b. BCPOS will provide monitoring and mapping protocols, data sheets, pre-formatted tables, prior monitoring reports, species lists, and other reference materials as needed.

c. BCPOS will coordinate with agricultural tenants as needed to ensure access to monitoring sites as well as provide up to date grazing information.

CONTRACTOR RESPONSIBILITIES:

1. Project Setup and Coordination:

Before any work begins, the Contractor will meet with the County to develop a detailed schedule to effectively complete the mapping or data collection.

a. The Contractor will coordinate with the County throughout the process.

b. Progress updates will be completed by email detailing field data collection, mapping and data entry progress.

c. The Contractor will coordinate with BCPOS GIS staff to determine data transferring procedures.

d. There may be wildlife closures that will limit access to open space properties during the project period.

2. Meetings:

The consultant should expect to attend the following meetings:

a. Project Kick-off, one (1)

b. Staff Review Meeting, one (1)

c. Coordinated site visits (as determined by BCPOS or Contractor)

3. Data Deliverables:

a. All data deliverables as outlined in this document and supported by the attached documents must be submitted according to the Deliverable Dates below.

b. All deliverables will be submitted to the County on a provided file share website or a secure SFTP site. Site Instructions pertaining to this solicitation will be disclosed to the selected Contractor after the contract process has been completed.

DELIVERABLES:

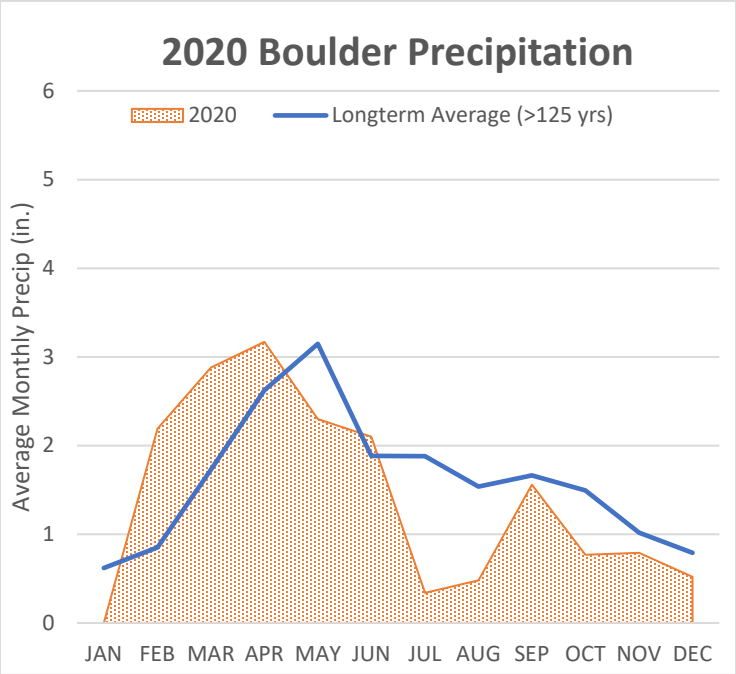
In general, Projects awarded for annual monitoring and mapping projects begin and end in the same calendar year. Unless otherwise noted in future Projects, deliverable due dates will remain the same each year. Fieldwork may begin as soon as conditions allow for it. In general, field data collection must be completed by September 30, annually. In general, all data and draft reports must be submitted by November 2, annually. In general, after a preliminary review by BCPOS staff, adjustments to any inconsistent or inaccurate data must be corrected and resubmitted by December 12, annually.

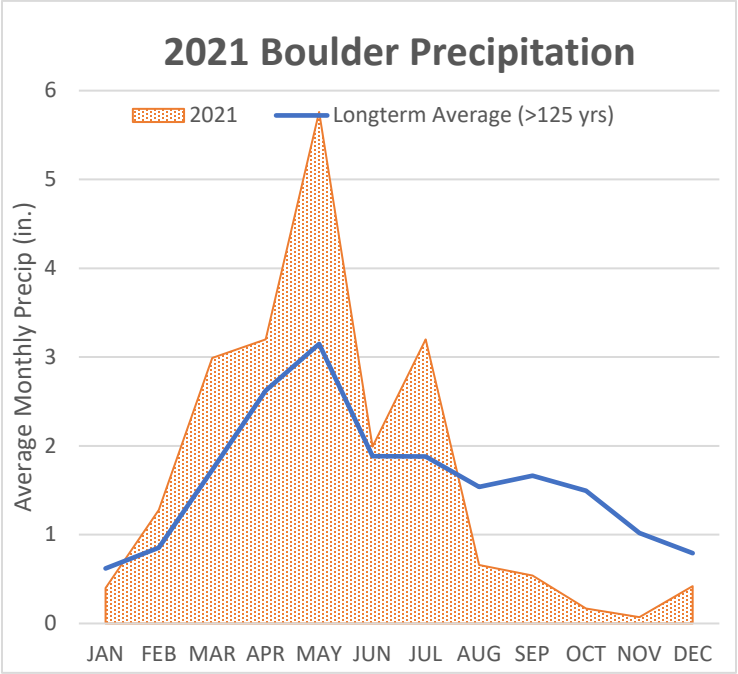
Vegetation Monitoring Deliverables:

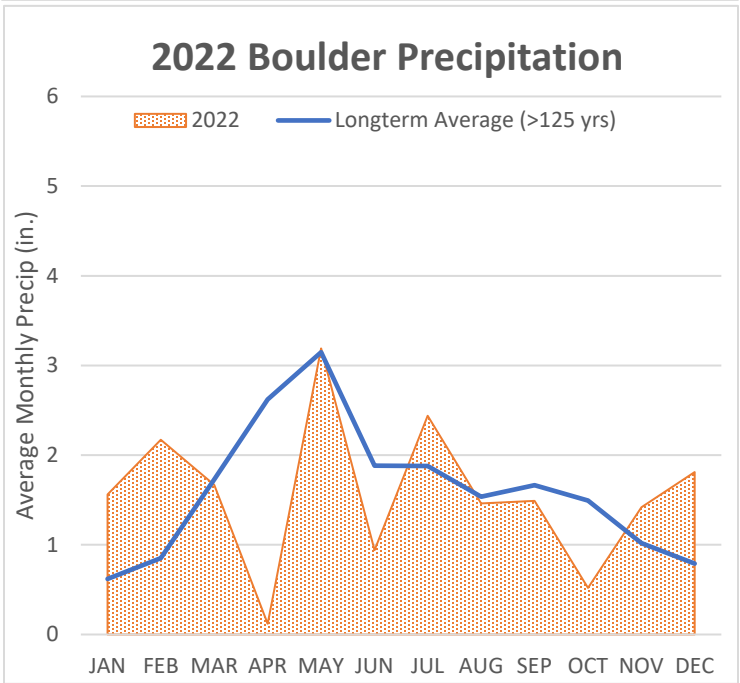
1. A monitoring report for each property will be produced (see samples- Attachment E (Prairie Dog Monitoring Report) and Attachment F (Rangeland Monitoring Report); note that these reports are general examples of rangeland and prairie dog monitoring reports, but the content written therein may differ from the requirements outlined in this SOQ, and may differ slightly still in future project work). Reports will include but are not limited to: objectives, methodology, results, discussion and interpretation of the results, and other observations of non-quantitative changes at the site, including observable trends and changes since the date of the last monitoring event.

2. A graphic representation of monthly precipitation for the current year plus each prior year back to and including the previous monitoring year, with a 125-year-long term average line for reference will be included. Local and updated precipitation data can be found from: https://psl.noaa.gov/boulder/. See below for example.

Figure 3. Precipitation diagrams from 2020-2022 illustrating monthly average precipitation and long term (>125-year) precipitation in Boulder, Colorado.







Vegetation Mapping Deliverables:
The following data should be uploaded to the BCPOS ftp site at the conclusion of awarded project:

1. Digital ArcMap shapefile or feature class of the spatial data, and attributes for that polygon including the macrogroup (by code), alliance (by code) and the association (by code), Polygon ID, and classification confidence ranking (high, moderate, low) for each polygon mapped in the field.

2. Tabular information that can be easily appended into BCPOS GIS tables. Formats may include Excel worksheets, or gdb tables. Data in the tables must include all information from the datasheet, including the Polygon ID (to link to the spatial data in GIS), plant species list (using the BCSpeciesID) to link data, ranking, percent cover, state listed weeds presence/absence, etc.

3. All digital or paper datasheets.

4. A list of all new alliances, associations, and/or species that were found in the field which are not currently in the Boulder County database.

5. Any other GPS data that is collected in the field such as GPS tracks and waypoints.

6. Scanned copies of all field data-forms.

7. Georeferenced photographs, ideally labeled with Polygon ID and short description of vegetation type.

8. Static PDF copies of all vegetation association descriptions as downloaded from NatureServe. This is to ensure that as vegetation classifications change, a static copy of the current description is kept in perpetuity.

PERMITS, LICENSES AND CODES:
The selected Contractor shall have full responsibility for identifying and obtaining, prior to the start of work, and for maintaining throughout the term of the Project, any permits and licenses which may be required in order to carry out the work. The Contractor shall also be responsible for following all State and County codes, which may be required in order to carry out the Project.

CONTRACTOR LICENSING:
It is the responsibility of the selected Contractor to apply for and ensure the appropriate Contractor's license is obtained.

SUBCONTRACTORS:
Contractor is required to disclose to County the complete business name(s) of all potential subcontractors that will be assigned to awarded Projects, should the Contractor be selected. Contractor acknowledges that it is completely responsible for the actions or inactions of its subcontractors. Contractor shall be responsible for the compliance of all subcontracting parties

with the terms of the Contract and with any applicable local, state or federal laws or regulations. Contractor shall be solely responsible for timely payment of its subcontractors.

CONFLICT OF INTEREST:

Any party that has developed, designed or drafted specifications, requirements, statements of work and/or has participated in planning activities for this SOQ may be excluded from consideration for the award of this SOQ. Additionally, any party that has developed, designed or drafted specifications, requirements, statements of work and/or has participated in planning activities for future Projects may be excluded from consideration for the award of those Projects.

CHANGE ORDERS:

Any unplanned, change orders, modifications or additional services to this Project, shall be submitted by the Contractor, in a separate, written document, including a fee schedule and completion schedule and presented to the County for review. Approval from the County, in writing, must accompany all change order requests.

OVERNIGHT CAMPING:

Boulder County prohibits any overnight camping for awarded Projects; all operational staff, including designated security staff, are not authorized to be present at Project sites from sunset to sunrise, the open space property will remain closed during these hours to the contractor and its subcontractors and/or designated representatives and/or agents, unless specifically authorized by a BCPOS representative.

HOURS OF OPERATION:

Contractor work hours shall be designated in accordance with each project awarded, in general Monday through Friday, from sunrise to sunset. Unless specified otherwise in individual awarded Projects. Work on Saturdays and Sundays, nights, and designated Federal Holidays shall not be allowed unless approved, in writing, by the County.

Boulder County Purchasing
1325 Pearl Street
Boulder, CO 80302
purchasing@bouldercounty.org

INSURANCE AND W-9 REQUIREMENTS

INSURANCE REQUIREMENTS:

Commercial General Liability	$1,000,000 Each Occurrence $2,000,000 General Aggregate $2,000,000 Products Completed Operations Aggregate 3 years Products/Completed Operations
Automobile Liability	$1,000,000 Each Accident *Including Hired & Non-Owned Auto
Worker's Compensation and Employer's Liability	Statutory limits
Professional Liability or Errors and Omissions	$1,000,000 Per Loss $1,000,000 Aggregate Coverage maintained or extended discovery period for 2 years

***In regards to General Liability, Umbrella/Excess Liability, and Pollution Liability:**
If any or all of these coverages are required above, additional insured status will be required at the time a contract is executed.

Note that the above insurance amounts are the minimum required for this project. Proof of current insurance must be provided with your proposal in the form of a sample certificate. You are NOT required to include additional insured status until the time a contract is executed.

If you require a waiver of insurance requirements you may request one in your response with an explanation.

W-9 REQUIREMENT:

Provide a copy of your business's W-9 with your proposal.

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Boulder, CO 80302
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SUBMITTAL CHECKLIST

The proposer's attention is especially called to the items listed below, which must be submitted in full as part of the PROPOSAL. Failure to submit any of the documents listed below as a part of your PROPOSAL, or failure to acknowledge any addendum in writing with your PROPOSAL, or submitting a proposal on any condition, limitation or provision not officially invited in this Solicitation of Qualifications (SOQ) may be cause for rejection of the PROPOSAL.

THIS CHECKLIST MUST BE SUBMITTED AS PART OF YOUR PROPOSAL PACKAGE:
Proposer will check each box indicating compliance:

INCLUDED	ITEM
	Name and Address of firm/Organization
	Telephone and Email address of firm/Organization
	Name and Address of the Partners and Subcontractors – IF APPLICABLE
	Resumes for the relevant experience of key personnel
	Provide a sample vegetation monitoring report and a graphic example of vegetation mapping end product.
	Provide a list of three (3) projects showcasing your experience with vegetation monitoring and vegetation mapping using the USNVC protocol, along with three (3) references for those projects.
	State your compliance with the Terms and Conditions in the Sample Contract contained in this SOQ. **Specifically list any deviations and provide justification for each deviation.**
	State your compliance with the Data Requirements contained in this SOQ. **Specifically list any deviations and provide justification for each deviation from Data Deliverables Section requirements.**
	Insurance Certificate – Proof of Insurance - SAMPLE
	Copies of Professional certifications and/or license for key staff- IF APPLICABLE
	W-9 from current year
	Current Year Rate Sheet (including mileage and positions)
	Signature Page
	Addendum Acknowledgement(s) – IF APPLICABLE

THIS QUESTION MUST BE ANSWERED AS PART OF YOUR BID PACKAGE: Proposer will answer Yes or No indicating compliance:

YES OR NO	ITEM
	Do you customarily keep line-item pricing information, such as the information being submitted with this proposal, confidential or closely-held?

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PROPOSAL SECTION

VEGETATION MAPPING AND MONITORING (RANGELAND AND PRAIRIE DOG)

Item Number	Item Description	Cost
1.	**Vegetation mapping on BCPOS foothill or montane property (per acre)** Vegetation mapping at foothill or montane Open Space property and all associated costs, (project kickoff; travel; post-fieldwork rectification to BCPOS format; entry and analysis of data; identification of USNVC Associations; GIS processing; project closure; submission of all draft and final data products; administrative costs)	**$_____**
2.	**Vegetation monitoring (Rangeland and Prairie Dog) (per transect)** Monitoring and all associated costs, (project kickoff; travel; post-fieldwork data analysis; comparison with previous year's data; creation of graphics; report writing for all transect data; submission of all draft and final data and reports; administrative costs)	**$_____**

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EVALUATION CRITERIA

The proposals will be reviewed by a selection committee. The committee may request additional information from vendors or request interviews with one or more vendors. Final evaluation and selection may be based on, but not limited to, any or all of the following:

A. **Information presented in proposal**
B. **Qualifications and experience of Contractor**
C. **Total cost -or- Proposed pricing for VEGETATION MONITORING**
D. **Total cost -or- Proposed pricing for VEGETATION MAPPING**

A scoring matrix with the order and priority of criteria to be used by the county in its evaluation and selection process is shown below:

DESCRIPTION	POINTS
Information presented in proposal	20
Qualifications and experience of Contractor	40
Total cost –or- Proposed pricing for vegetation monitoring	20
Total cost –or- Proposed pricing for vegetation mapping	20
TOTAL POSSIBLE	**100**

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Boulder, CO 80302
purchasing@bouldercounty.org

SIGNATURE PAGE

Contact Information	Response
Company Name including DBA	
List Type of Organization (Corporation, Partnership, etc.)	
Name, Title and Email Address of Person Authorized to Contract with Boulder County	
Company Address	
Company Phone Number	
Company Website	

By signing below, I certify that:
I am authorized to bid on my company's behalf.
I am not currently an employee of Boulder County.
None of my employees or agents is currently an employee of Boulder County.
I am not related to any Boulder County employee or Elected Official.
(Sole Proprietorships Only) I am not a Public Employees' Retirement Association (PERA) retiree.

_____ _____

Signature of Person Authorized to Bid on Company's Behalf **Date**

Note: If you cannot certify the above statements, please explain in a statement of explanation.

Attachment A

BCPOS Vegetation Mapping Protocol

Vegetation Mapping provides the foundation for management of vegetation resources. The naming or classification of vegetation types follows the U.S. National Vegetation Classification System (USNVC) which is a central organizing framework for documentation, inventory, and monitoring of vegetation in the United States from broad scale formations like forests to fine-scale plant communities. The process for vegetation mapping and classification is outlined below.

Pre-Field Review

Prior to field reconnaissance, prepare a preliminary vegetation type map based on high quality aerial imagery, 2-foot or 1-foot contours, soil survey information, existing studies within or in the vicinity of the project site, and past field reconnaissance, if any. The preliminary vegetation polygons should be drawn around obvious meadows, shrublands, forests, and other distinct boundaries and can later be edited in the field. Digital elevation models (DEMs), light detection and ranging (LIDAR) datasets, and robust statistical models may also be used to aid in mapping as long as ground-truthing also occurs. Overlay the GridTile Feature/Shapefile over the preliminary vegetation type map and sequentially number each preliminary vegetation polygon starting with the Grid Tile number (i.e., 1157-01, 1157-02, 1157-03, etc.). This unique identifier for each polygon is then later recorded on the datasheet during field reconnaissance. Print out field maps with grid overlay at a scale that will allow you to clearly see changes in vegetation communities as well as enable you to draw additional polygons if needed.

Hierarchy for Natural Vegetation	**Example**
Upper Levels	
1 – Formation Class	**Scientific Name:** Mesomorphic Shrub and Herb Vegetation **Colloquial Name:** Shrubland and Grassland
2 – Formation Subclass	**Scientific Name:** Temperate and Boreal Shrub and Herb Vegetation **Colloquial Name:** Temperate and Boreal Shrubland & Grassland
3 - Formation	**Scientific Name:** Temperate Shrub and Herb Vegetation **Colloquial Name:** Temperate Shrubland & Grassland
Mid Levels	
4 – Division	**Scientific Name:** *Andropogon – Stipa – Bouteloua* Grassland & Shrubland Division **Colloquial Name:** North American Great Plains Grassland & Shrubland
5 – Macrogroup	**Scientific Name:** *Andropogon gerardii – Schizachyrium scoparium – Sorghastrum nutans* Grassland & Shrubland Macrogroup **Colloquial Name:** Great Plains Tall Grassland & Shrubland
6 - Group	**Scientific Name:** *Andropogon gerardii – Sporobolus heterolepis* Grassland Group **Colloquial Name:** Great Plains Mesic Tallgrass Prairie
Lower Levels	
7 – Alliance	**Scientific Name:** *Andropogon gerardii – (Calamagrostis canadensis – Panicum virgatum)* Herbaceous Alliance **Colloquial Name:** Wet-mesic Tallgrass Prairie
8 – Association	**Scientific Name:** *Andropogon gerardii – Panicum virgatum – Helianthus grosseserratus* Herbaceous Vegetation **Colloquial Name:** Central Wet-mesic Tallgrass Prairie

Figure 1. Hierarchy for Natural Vegetation under the US National Vegetation Classification System.

Prior to field work, also review the USNVC classification and determine which associations may be present. Determine if there is potential for rare (globally or state critically imperiled, imperiled, or vulnerable – G1, G2, G3, S1, S2, or S3) plant associations by reviewing their rank on Colorado Natural Heritage Program Website and/or NatureServe.

Field Reconnaissance

Traverse the project site and determine the vegetation community boundaries by walking as much of the area as possible, with special attention in changes to the topography, slope, aspect, soils or other environmental conditions. This is when a shift in vegetative structure is most likely to occur, though some changes are less predictable. If any preliminary vegetation types were pre-mapped, make sure to field verify each of these. Use a GPS device to record points and/or new boundaries of vegetation mapping polygons as appropriate. Draw updated boundaries on the field maps as well as each Polygon ID, each of which will correspond to a data form. Extend any polygon lines over the grid tile boundary, do not terminate a polygon on the grid tile boundary.

Fill out the vegetation mapping data form for each polygon mapped, including dominant plant species and abundance ranking by vegetation stratum (up to five (5) rankings per stratum), associated plant species, noxious weeds and other notes on relative plant vigor, insect damage, and/or disease. Accompany each polygon with a geo-referenced photo. To the greatest extent possible, map vegetation types to the association level or the most detailed level of classification to enable detection and tracking of rare plant communities. If an association cannot be determined, record the alliance level, or the next highest classification level. Please note, it is not always possible to determine the exact association in the field. Therefore, field data forms and all associations should be reviewed post-field.

The vegetation mapping requires a minimum mapping unit of 0.25-acre for upland areas and 0.10-acre for wetlands. The mapping also requires identification of a minimum of ten (10) of the dominant plant species by structural level, such as tree, shrub, sub-shrub and gram/forb in each polygon. Daily track logs of each person involved in the survey should be downloaded for quality control and to ensure that all representative locations of the property have been visited. It is also recommended that representative GPS points be taken in the field and these points be written on each data form corresponding to a particular vegetation association.

Determining Alliance and Associations – Helpful Hints

Classify the vegetation based upon vegetation condition at the optimal time during the growing season.

Alliance and Association Level Mapping - the general guiding factor in deciding which alliance and association a polygon fits into is the percent cover and/or dominance of one or two key species. Alliance and association descriptions are important to read in order to understand the general species composition and environmental characteristics of a described unit. However, sometimes indicator species and/or geographical location of the described alliance/association may not be specific to Boulder County or Colorado. It is still OK to use this alliance/association if one feels the description is close enough and there is not another more appropriate one to use. To the greatest extent possible, map to the association level as rare vegetation communities at this level are tracked by the CNHP. Again, it is helpful to read the association descriptions within each alliance, in order to match up with what is observed in the field. Association descriptions may give more examples of species that could occur in the alliance.

Percent Cover

1. Herbaceous Association-If trees cover less than 12% of the association, and herbs and shrubs cover more than 10% of the association, it is an herbaceous association. These are often described as Grasslands or Meadows in current NatureServe/USNVC Association and Alliance names.

2. Shrubland Association-If shrubs cover more than 10% of the association, it is a shrubland. However, if herbaceous plants cover a large percentage and shrubs are found to cover less than 25% of the area, the association is a shrub herbaceous or shrub grassland association.

3. Woodland Association-Sometimes it can be difficult to decide between a woodland and a shrubland. Woodlands have trees with crowns not usually touching generally forming 25-60% cover, this canopy cover can be less than 25% when it exceeds the other lifeforms.

4. Savannah Association –Savannahs have widely spaced trees averaging 12-25% cover. In the current USNVC classification system, this is currently known as Open Woodland.

5. Forest/Woodland Association – Sometimes woodlands and forest are grouped together in the classification systems. But if not, a woodland typically has 25-60% tree cover and forests have 60-100% tree cover.

When determining the association, the percent cover should be observed in order of the hierarchy: from trees>>shrubs>>subshrubs>>forbs/grams. If the tree cover is <12%, then go to the shrub cover. If it is less than 10%, then go to the subshrub cover, and if that is less than 10%, then go to the herbaceous cover. For example, even if the shrub cover is 45% and the herbaceous cover is 49%, the association should be considered a shrubland. Vines will be considered part of the shrubland component.

Riparian and Wetland Associations

These associations represent riparian and/or wetland areas. Specific terminology in the association names are as follows. Please enter the water regime on the data form when documenting wetland and riparian vegetation communities.

1. Intermittently Flooded- surface water present for variable periods without detectable seasonal patterns.

2. Temporarily Flooded - flooded for brief periods in the growing season, but otherwise the water table is well below the surface.

3. Seasonally Flooded - flooded for extended periods in the growing season, but with no surface water by the end of the growing season.

4. Semi-Permanently Flooded - wetlands that are flooded in the growing season most years.

Cultural Vegetation Associations

Cultural vegetation has typically been planted or treated, and has relatively distinctive physiognomic, floristic, or site features when compared to natural vegetation. Distinctive physiognomic and structural attributes typically include one or more of the following:

> a. Dominant herbaceous vegetation that is regularly-spaced and/or growing in rows, often in areas with substantial cover of bare soil for significant periods of the year, usually determined by tillage or chemical treatment.

b. Dominant vegetation with highly-manipulated growth forms or structure rarely found as a result of natural plant development, usually determined by mechanical pruning, mowing, clipping, etc.

c. Dominant vegetation comprised of species not native to the area that have been intentionally introduced to the site by humans and that would not persist without active management by humans.

Additional details on Cultural Vegetation Associations may be found on the USNVC website.

Sparsely Vegetated Association

. Associations that have less than 10% or less vegetation cover

Provisional Association

. In the event that a vegetation community (i.e., Association) is identified that is not currently described within the USNVC framework and that cannot be lumped into an existing Association due to conflicting data between the observed vegetation community and an existing USNVC Association description, a Provisional Association must be developed. The provisional data must include, at minimum:

1. Provisional title of the Association
2. Name and Element Code of the Alliance under which the Provisional Association is to be nested
3. Species composition of the stand of vegetation, including:
    a. Names of dominant taxa
    b. Dominant taxa cover values
    c. The stratum for each species (i.e., tree, shrub, herbaceous, nonvascular, etc.)
4. Vertical structure and physiognomy of the plot
5. Physical data of the plot
    a. Elevation, slope, aspect, topographic position, landform, substrates, or geologic parent materials.
    b. Soil and water features, including soil moisture, drainage, hydrology, depth of water
    c. Soil surface cover of litter, rock, bare ground, coarse woody debris, or other important surface features.
    d. General vegetation conditions, including landscape context, homogeneity of the vegetation, stand maturity, successional status, and evidence of disturbance
6. Geographic data
    a. Location of stands (accomplished via mapping process)

Filling out the Data Sheet

Polygon ID. Create a unique number for each Data Form. The number should be the Grid Tile Number followed by a sequential number. This unique number will then be entered in the geodatabase table for the vegetation mapping polygons. Note, a full species list is not needed for each vegetation polygon. If there are two polygons with a similar vegetation composition, fill out the Data On field. See below.

Data On. For multiple polygons that have the same species list as well as the same vegetation association it is not necessary to re-write the species list for a second, separate, polygon if the species list is the same. Instead, draw the separate polygon, give it a unique Polygon ID, fill out everything on the datasheet except for the species list, and fill in “Data On” which should reference what separate Polygon ID holds the species lit. Example: If there are two Ponderosa Pine Woodland Associations that are not connected, but are near one other and have the same species lists and rankings, then it is OK to fill in the Data On section of the

data sheet to reference. However, if the species list is different or the dominant species have different abundance rankings, then a new data sheet needs to be filled out.

Photo No. Enter in the photo number OR if photos are automatically numbered with Polygon ID and description, just indicate whether photos were taken. Ensure that all photos are georeferenced. It is highly recommended that the locational data (i.e. UTM coordinates), date, direction of photo, Polygon ID, the vegetation description, be imprinted on the photo. *Context Cam*, an apple software app for smartphones, is one example, of a easy to use method to accomplish the auto-naming of photos. On Android devices, the app *Survey Cam* can be used instead.

Slope and Aspect. Determine slope if possible and enter general aspect. Aspect can be determined from the aerial maps and/or a compass. A range of aspects can be used if the polygon covers several aspects (Example: N-SE). Aspects can also be written in average degrees for each polygon.

Percent Cover. Percent cover for trees, shrubs, subshrubs, graminoids and forbs should equal 100% for all strata combined. The rock, litter, and bare soil sections only need to be filled out if the association has a large coverage (60% or more) of this lack of vegetation, such as in the sparsely vegetated associations. The percentage of rock, litter, and bare soil should be included in the total percentage along with the lifeform percentages.

Species List & Rank. Mapping should include a comprehensive list of overstory and understory vegetation, documenting a minimum of fifteen (15) dominant plant species per polygon. On the datasheet, species should be listed in the associated columns for Grams/Forbs, Trees, Shrubs, Subshrubs, and Noxious Weeds (state listed weeds only, all other weeds included in appropriate life form). The top five species in each lifeform should be ranked, from most common o least common. Estimates are then made on over the percent cover of trees, shrubs, grams, and forbs. The list on the upper right portion of the datasheet indicates the percent covers that define savannah/open woodland (12-25%), woodland (25-60%), and forest (60-100%). These definitions are important for deciding what alliance and association to assign to a polygon. For species that are dominant or comprise the majority of the vegetation in a stratum, please * the species. This will aid in classifying the mapping unit.

Noxious Weeds. Listing A, B, & C Species: The Colorado Department of Agriculture has a list of noxious weeds for the state. The list is split into three sections according to their level of threat, abundance, and dispersal throughout the state. List B & C species are the most widespread, all control measures are mandated on a county-wide or local level. List A species are those that are not yet introduced or just recently introduced into the state and are mandated by law for eradication.

Recording Noxious Weeds. All 'A' List species are recorded in the noxious weed column and ranked in terms of dominance (1-5) among all noxious weeds. If any of these species is dominant among all plants, then it should <u>also</u> be recorded in the forb/herb/tree/shrub/subshrub column that it belongs to and ranked among all plant species.

Wildlife, Disturbance Factors, and Other Comments. This should be filled in where applicable. Prairie Dog activity or inactivity should always be noted when surveying areas impacted by prairie dogs.

Collecting and Identifying Unknowns. To collect species in the field for later identification in the office:

- Collect only if more than 10 specimens on site. Do not collect if it's a possible rare species.
- Collect all portions of the plant (roots, shoots, leaves, flowers, seeds)

- Plants may be put in plastic bags until a returned to the office, then the plant must be pressed with newspaper and blotter if specimen is not identified that day. Or use a field press!
- Specimens must be collected and treated in a manner that will allow inclusion into the herbarium
- If no specimen is collected, one may also upload photos to *iNaturalist* for confirmation on species identification. Make sure to take up to four photos showing the different parts of the plant at a scale that will allow for accurate photo identification.

Post-Field Data Review and GIS Data Entry

Review the field data and revise the preliminary vegetation mapping polygons in ArcGIS as necessary. Utilize the full-spectrum of available data when making changes including field photos, GPS points, various color and color-infrared imagery, and contours. Ensure all vegetation mapping polygons are "tight" and that there are no overlaps or missing slivers between polygons. Populate the BCPOS Vegetation Mapping geodatabase detailing the vegetation type name, USNVC association and/or alliance codes, the Polygon ID, and confidence ranking. Also enter in all associated site data and species data. If BCPOS geodatabase editing is limited by ArcGIS licensing issues, then work with the BCPOS GIS Specialist to provide the data in another format than can be easily appended to the BCPOS geodatabase.

Data Deliverables

The following data should be uploaded to the BCPOS ftp site at the conclusion of the study.

- Digital ArcMap shapefile or feature class of the spatial data, and attributes for that polygon including the macrogroup (by code), alliance (by code) and the association (by code), Polygon ID, and classification confidence ranking (high, moderate, low) for each polygon mapped in the field.
- Tabular information that can be easily appended into BCPOS GIS tables. Formats may include Excel worksheets, or gdb tables. Data in the tables must include all information from the datasheet, including the Polygon ID (to link to the spatial data in GIS), plant species list (using the BCSpeciesID) to link data, ranking, percent cover, state listed weeds presence/absence, etc.
- All digital or paper datasheets.
- A list of all new alliances, associations, and/or species that were found in the field which are not currently in the Boulder County database.
- Any other GPS data that is collected in the field such as GPS tracks and waypoints.
- Scanned copies of all field data-forms.
- Georeferenced photographs, ideally labeled with Polygon ID and short description of vegetation type.
- Static PDF copies of all vegetation association descriptions as downloaded from NatureServe. This is to ensure that as vegetation classifications change, a static copy of the current description is kept in perpetuity.

Future Growth of Vegetation Mapping Program

There is opportunity to grow BCPOS's vegetation mapping program. The following are recommended to further the growth of this program.

Map BCPOS properties that have not been previously mapped. The USNVC also includes "cultural" vegetation types so properties with agriculture can also be mapped.

Create a Master USNVC Alliance and Association List for vegetation types mapped on BCPOS parcels. Include pdf copies of the descriptions in an easily accessible location for future reference.

Consider collecting vegetation plot data which can be stored in VEGBank. Look to previous Vegetation Mapping work at Rocky Mountain National Park or Jefferson County for ideas on collecting verifiable quantitative plot-based data.

Attachment B

VEG MAP Data Sheet (rev. 221104)

Survey Date: _____ Surveyors: _____
Polygon ID: _____ Area Name: _____
GPS POI's/WPs: _____ Data on: _____
_____ Photo #'s _____
_____ _____

Rock: _____
Slope%:_____ Litter: _____
Aspect: _____ Bare soil: _____

Life form cover %:
Trees _____
Shrubs _____
Subshrub _____
Grams _____
Forbs _____

Tree % Cover for Alliance Classification
Herbaceous = <12%
Shrubland = >12%
--- Shrubs = >25%
Savannah = 12-25%
Woodland = 25-60%
Forest = 60-100%

Provisional Association:

Rank	TREES	Rank	SHRUBS	Rank	SUBSHRUBS	Rank	GRAMS/FORBS	Rank	GRAMS/FORBS	Rank	GRAMS/FORBS
Rank	NOXIOUS WEEDS										

WILDLIFE:

OTHER COMMENTS

DISTURBANCE FACTORS:

COWARDIN WATER REGIME MODIFIER
(wetland/riparian only)

List 10 most common species for each strata Star (*) any dominants

The top five species in each lifeform should be ranked from most common (1) to least common (5)
Percent cover for trees, shrubs, subshrubs, graminoids, and forbs should be listed as ABSOLUTE COVER (not relative) .
Rock, litter, and bare soil sections only need to be filled out if there is 60% or greater of non-vegetated cover (i.e. sparsely vegeated)

Attachment C

Boulder County Plant Species of Special Concern and Significant Natural Communities

As described in the recently updated Goals and Policies of the Environmental Resources Elements (the ERE) of the Boulder County Comprehensive Plan, Species of Special Concern include the flora and fauna in the county whose populations may be threatened or endangered, locally rare, experiencing long-term non-cyclical population declines, isolated or restricted to distinct local habitat types, or native species which have ceased to exist within Boulder County. As provided for in Goal B.2 of the ERE, the Boulder County Species of Special Concern List (SSC List) includes this compilation of rare plants and significant natural communities of special status that warrant protection in order to prevent population or habitat loss. The list was developed through consultation with botany and plant ecology professionals in federal, state, and local governmental agencies, non- governmental conservation organizations, local universities, and private consultants, as well as Boulder County conservation experts. The majority of species and communities appearing on this list are recognized by the Colorado Natural Heritage Program (CNHP). CNHP is a non-profit organization sponsored by Colorado State University that tracks and ranks Colorado's rare and imperiled species and habitats. The list comprises species CNHP ranks as critically imperiled, imperiled, or vulnerable to extirpation globally (G1-G3) or statewide (S1-S3). Species ranked as apparently secure or demonstrably secure (G4-G5, S4-S5) are excluded from the list, unless they satisfy other criteria below.

The SSC List is intended to comprehensively document Boulder County species and communities as they exist today. To be listed on the SSC List, a species/community must meet at least one of the required or two or more of the conditional criteria. In some instances, a species has been included on the list even though it does not meet the SSC List criteria. This is based on professional judgment and only occurs with species for which there is presently incomplete or uncertain information available. The list will be updated as more information is learned about individual species or communities including changes to their status. Areas where these resources are known to occur or have a likelihood of occurring are illustrated on the respective maps of the Environmental Resource Element.

Criteria for Designating Plant Species of Special Concern and Significant Natural Communities

<u>Required</u>

1. Species/Communities with Federal Status (listed or proposed threatened or endangered -- LT, LE, PT), candidates for listing -- C or under review for listing), e.g., Ute ladies'-tresses orchid (*Spiranthes diluvialis*) LT, G2G3/S2 (U.S. Fish and Wildlife Service 2013, CNHP 2013);

2. All G1-G2 and S1-S2 species that are not also federally listed;

3. Collectable/Harvestable: Species threatened by collection or harvest including showy varieties of orchids, lilies, penstemon, and cacti;

<u>Conditional</u>

4. Species/communities with U.S. Forest Service Region 2 (USFS R2) sensitive species,[1] National Park Service (NPS) sensitive species within Rocky Mountain National Park (RMNP)[2], or City of Boulder Open Space and Mountain Parks (OSMP) sensitive status;

[1] This criterion acknowledges that USFS R2 boundaries extend beyond Boulder County and encompass habitats that do not occur within the county, thus not all USFS R2 sensitive species appear on the SSC List.

5. Species/communities that could occur within Boulder County based on known records from adjacent counties or based on known suitable habitat in Boulder County for the species and that CNHP ranks as critically imperiled, imperiled, or vulnerable to extirpation either globally (G1 – G3) or statewide (S1 – S3), e.g., autumn willow (*Salix serissima*) – G4/S1 and American black currant (*Ribes americanum*) – G5/S2;

6. Relictual species/communities having undergone a documented long-term decline or having a critically low population size relative to their historic presence and/or relative abundance in a given ecosystem, e.g., American groundnut (*Apios americana*) – G5/S1 and big bluestem – prairie dropseed (*Andropogon gerardii – Sporobolus heterolepis*) Western Foothills Grassland – G2/S1;

7. Species/communities endemic to Boulder County or region,[3] e.g., Colorado aletes (*Aletes humilis*) – G2G3/S2S3 and Bell's Twinpod (*Physaria bellii*) – G2G3/S2S3;

8. Species/communities known or thought to be extinct or extirpated in Boulder County, i.e., species that historically occupied and are native to Boulder County, that may exist in surrounding regions, and that may be able to repopulate Boulder County, e.gmanyhead sedge *(*Carex sychnocephala) – G5/SH;

9. Species/communities whose populations in the County that are vulnerable to threats[4] affecting their populations either directly or indirectly, e.g. limber pine (*Pinusflexilis*);

10. Species/communities that have a disproportionately large effect on the diversity within the ecosystem(s) they inhabit e.g., montane riparian forests such as quaking aspen/thinleaf alder (*Populus tremuloides / Alnus incana*) Riparian Forest – G3/S4;

11. Species/communities that are either naturally rare,[5] at the edge of their range in Boulder County, or are isolated or imperiled, e.g., black spleenwort (*Asplenium adiantum-nigrum*) – G5/S1, montane willow carrs such as *Salix bebbiana Wet* Shrubland – G3?/S2, and alkali wetlands such as *Suaeda calceoliformisWet Meadow*–GNR/SU;

12. Species/communities that support sensitive wildlife, e.g., Western hops (*Humulus neomexicanus*), the only host plant for the Hops Azure (*Celestrina humulus*) – G2G3/S2 NorthwesternPlains Grassland (*Andropogon gerardii – Schizachyrium scoparium*) dominated by big and little bluestem, two native host plants for Arogos skipper (*Atrytone arogos*) – G2/G3/S2.

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[2] This criterion acknowledges that that NPS RMNP boundaries extend beyond Boulder County and encompass habitats that do not occur within the county, thus not all NPS RMNP sensitive species appear on the SSC List.

[3] Species/communities endemic to Boulder County region indicates a species occurring only in Boulder County and in an adjacent county or counties.

[4] Direct or indirect threats to the stability of species populations or communities include disturbances such as climate change, disease, residential or commercial development, fire suppression, mechanical forest thinning, prescribed fire, etc.

[5] Species or communities that are "naturally rare" normally occur in low abundance throughout their range. While their populations may be stable, species that are rare on the landscape are more vulnerable to extirpation compared to species with large populations.

State Scientific Name	State Common Name	CNHP Global Rank	CHNP State Rank	Other Agency Ranking
GYMNOSPERMS				
Pinus aristata	bristlecone pine	Unranked	Unranked	BCPOS
Pinus flexilis	limber pine	Unranked	Unranked	BCPOS
FERNS & FERN ALLIES				
Argyrochosma fendleri	Fendler's false cloak-fern	G3	S3	
Asplenium adiantum-nigrum (A. andrewsii)	black spleenwort	G5	S1	OSMP
Asplenium septentrionale	forked spleenwort	G5	S3S4	RMNP, OSMP
Asplenium trichomanes	maidenhair spleenwort	Unranked	Unranked	OSMP
Athyrium filix-femina	common lady-fern	Unranked	Unranked	OSMP
Botrychium campestre var. lineare	prairie moonwort	G3	S2S3	SWAP Tier 2, USFS
Botrychium echo	reflected moonwort	G3	S3S4	RMNP, OSMP
Botrychium furculatum	redbank moonwort	G4	S3	
Botrychium hesperium	western moonwort	G4	S3	RMNP
Botrychium lanceolatum var. lanceolatum	lanceleaf moonwort	G5T4T5	S3	RMNP
Botrychium minganense	Mingan moonwort	G5	S3	RMNP, OSMP
Botrychium pinnatum	northern moonwort	G5	S2	
Botrychium simplex	least moonwort	G5	S2	
Botrychium simplex var. compositum	least moonwort	G5T3T4	S1	
Botrychium simplex var. simplex	least moonwort	G5T3T4	S2	
Botrypus virginianus	rattlesnake fern	G5	S1	OSMP
Cheilanthes fendleri	hardy fern	Unranked	Unranked	OSMP
Dryopteris expansa	spreading woodfern	G5	S1	RMNP
Dryopteris filix-mas	male fern	Unranked	Unranked	OSMP
Equisetum variegatum (Hippochaete variegata)	variegated scouringrush	G5	S3	RMNP
Isoëtes occidentalis	western quillwort	G4G5	S1	
Isoëtes tenella (I.echiniospora)	spiny-spore quillwort	G5?T5?	S2	RMNP
Pellaea wrightiana	Wright's cliffbrake	G5	S2	OSMP
Polypodium hesperium	western polypody	G5	S1S2	RMNP
Polypodium saximontanum	Rocky Mountain polypody	G3?	S3	OSMP
Selaginella weatherbiana	Weatherby's spike-moss	G3G4	S3S4	OSMP
NONVASCULAR				
Anacolia laevisphaera	anacolia moss	G5?	S1S3	
Anacolia menziesii	Menzies' anacolia moss	G4	S1S3	
Andreaea rupestris	andreaea moss	G5	S1S3	RMNP
Anoectangium handelii		Unranked	Unranked	BCPOS
Aulacomnium palustre var. imbricatum	aulacomnium moss	G5TNR	S1S3	RMNP
Brachythecium hyalotapetum	brachythecium moss	Unranked	Unranked	BCPOS
Bryoerythrophyllum ferruginascens	bryoerythrophyllum moss	G3G4	S1S3	
Bryum alpinum (Imbribryum alpinum)	alpine bryum moss	G4G5	S1S3	
Campylopus schimperi	Schimper's campylopus moss	G3G4	S1S3	RMNP
Didymodon anserinocapitatus		G1	S1	
Grimmia mollis (Hydrogrimmia mollis)	grimmia dry rock moss	G5	S1S3	RMNP
Grimmia teretinervis	grimmia dry rock moss	G3G5	S1S3	RMNP
Gymnomitrion corallioides		G4G5	S1S3	RMNP
Hylocomiastrum pyrenaicum	hylocomiastrum moss	G5	S1S3	RMNP
Hylocomium alaskanum	splendid feather moss	G5	S1S3	RMNP
Leptopterigynandrum austro-alpinum	alpine leptopterigynandrum moss	G3G5	S1S3	RMNP
Mnium blyttii	Blytt's calcareous moss	G5?	S1S3	RMNP

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Nardia geoscyphus		G5	S1S3	RMNP
Oreas martiana	oreas moss	G5?	S1S3	RMNP
Plagiothecium cavifolium	plagiothecium moss	G5	S1S3	RMNP
Pleurozium schreberi	Schreber's big red stem moss, feathermoss	G5	S1S3	RMNP
Pohlia tundrae	tundra pohlia moss	G2G3	S1S3	RMNP
Ptilium crista-castrensis	knights plume moss	G5	S1S3	
Rhytidiadelphus triquetrus	rough goose neck moss	Unranked	Unranked	BCPOS
Rhytidiopsis robusta	robust rhytidiopsis moss	Unranked	Unranked	BCPOS
Roellia roellii	Roell's moss	G4	S1S3	RMNP
Sphagnum angustifolium	narrowleaf peatmoss	G5	S2	USFS
Sphagnum contortum	contorted sphagnum	G5	S1S3	RMNP
MONOCOTS				
Acorus calamus	sweet flag	G4?	S1	OSMP
Aristida basiramea	forked threeawn	G5	S2	OSMP
Bromus pubescens (Bromopsis pubescens)	hairy woodland brome	Unranked	Unranked	OSMP
Calypso bulbosa	fairy slipper orchid	Unranked	Unranked	OSMP
Carex capitata ssp. arctogena	capitate sedge	G5	S2	
Carex conoidea	openfield sedge	G5	S1	
Carex crawei	Crawe's sedge	G5	S1	
Carex deweyana	Dewey's sedge	Unranked	Unranked	OSMP
Carex diandra	lesser panicled sedge	G5	S2	USFS, RMNP
Carex disperma	soft-leaf sedge	Unranked	Unranked	OSMP
Carex lasiocarpa	whollyfruit sedge	G5	S2	
Carex limosa	mud sedge	G5	S2/S3	RMNP
Carex livida	livid sedge	G5	S1	USFS
Carex oreocharis	grassyslope sedge	G3	S3	RMNP, OSMP
Carex sartwellii	Sartwell's sedge	G5	S2	
Carex saximontana	Rocky Mountain sedge	G5	S2	OSMP
Carex sprengelii	Sprengel's sedge	G5	S2	OSMP
Carex stenoptila	river bank sedge	G3	S3	RMNP
Carex sychnocephala	manyhead sedge	G5	SH	
Carex torreyi	Torrey sedge	G4G5	S1	OSMP
Corallorhiza striata	striped coralroot	Unranked	Unranked	OSMP
Corallorhiza wisteriana	spring coralroot	Unranked	Unranked	OSMP
Cypripedium fasciculatum	clustered lady's slipper	G4	S3S4	RMNP
Cypripedium parviflorum (C. calceolus ssp. parviflorum)	lesser yellow lady's slipper	G5	S2	USFS
Eriophorum gracile	slender cottongrass	G5	S1S2	USFS
Hesperostipa spartea	porcupinegrass	Unranked	Unranked	OSMP
Juncus brachycephalus	smallhead rush	G5	S1	
Juncus filiformis	thread rush	Unranked	Unranked	BCPOS
Juncus tweedyi (J. brevicaudatus)	Tweedy's rush	G5	S1	RMNP
Juncus vaseyi	Vasey's rush	G5	S1	RMNP
Kobresia simpliciuscula	simple bog sedge	G5	S1	
Lilium philadelphicum	wood lily	G5	S3S4	RMNP, OSMP
Lipocarpha aristulata (Hemicarpha micrantha)	awned halfchaff sedge	Unranked	Unranked	BCPOS
Listera borealis	northern twayblade	G5	S2	RMNP

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Listera convallarioides	broadlipped twayblade	G5	S2	RMNP, OSMP
Listera cordata	heartleaf twayblade	Unranked	Unranked	BCPOS
Luzula subcapitata	Colorado wood rush	G3	S3	RMNP
Malaxis monophyllos (M. brachypoda, M. monophyllos ssp. brachypoda)	white adder mouth orchid	G5T4T5	S1	USFS, OSMP
Phippsia algida	icegrass	G5	S2	
Piperia unalascensis	slender-spire orchid	Unranked	Unranked	OSMP
Potamogeton diversifolius	waterthread pondweed	G5	S1	OSMP
Potamogeton epihydrus	ribbonleaf pondweed	Unranked	Unranked	BCPOS
Ruppia cirrhosa	spiral ditchgrass	Unranked	Unranked	BCPOS
Schizachne purpurascens	false melic, purple oat	Unranked	Unranked	OSMP
Sisyrinchium pallidum	pale blue-eyed grass	G3	S3	BLM, RMNP
Smilax lasioneura	Blue Ridge carrionflower	G5	S3S4	OSMP
Spiranthes diluvialis	Ute ladies'-tresses	G2G3	S2	LT, SWAP Tier 1, OSMP
DICOTS				
Aletes humilis	Colorado aletes	G2G3	S2S3	RMNP
Alsinanthe stricta (Minuartia stricta)	bog stitchwort, rock sandwort	Unranked	Unranked	RMNP
Amorpha nana	dwarf leadplant	G5	S2	OSMP
Anagallis minima (Centunculus minimus)	Chaffweed	G5	S1	OSMP
Antennaria howelii	Howell's pussytoes	Unranked	Unranked	OSMP
Apios americana	American groundnut	G5	S1	OSMP
Aquilegia saximontana	Rocky Mountain blue columbine	G3	S3	RMNP
Aralia nudicaulis	wild sarsaparilla	Unranked	Unranked	OSMP
Artemisia pattersonii	Patterson's wormwood	G3G4	S2S3	RMNP
Artemisia tridentata ssp. vaseyana (Seriphidium vaseyanum)	mountain sagebrush	Unranked	Unranked	BCPOS
Asclepias stenophylla	narrow-leaved milkweed	G4G5	S2	OSMP
Astragalus canadensis	Canadian milkvetch	Unranked	Unranked	OSMP
Astragalus sparsiflorus	Front Range milkvetch	G2	S2	SWAP Tier 2
Betula papyrifera	paper birch	G5	S1	OSMP
Castilleja puberula	shortflower Indian paintbrush, downy indian-paintbrush	G3	S2S3	SWAP Tier 2, RMNP
Chionophila jamesii	Rocky Mountain snowlover	G4?	S3S4	RMNP
Chrysosplenium tetrandrum	northern golden saxifrage	Unranked	Unranked	BCPOS
Claytonia rubra	redstem springbeauty	G5	S1	
Corylus cornuta	beaked hazelnut	Unranked	Unranked	OSMP
Crataegus chrysocarpa	fireberry, yellow hawthorn	G5	S1	
Crocanthemum bicknellii (Helianthemum bicknellii)	hoary frostweed	G5	S2	OSMP
Draba crassa	thickleaf draba	G3G4	S3	RMNP
Draba exunguiculata	clawless draba	G2	S2	SWAP Tier 2, USFS
Draba fladnizensis	Austrian draba, arctic draba	G5	S3	RMNP
Draba grayana	Gray's draba	G3	S3	SWAP Tier 2, USFS, RMNP
Draba streptobrachia	alpine tundra draba	G3	S3	RMNP
Drymaria effusa var. depressa	pinewoods drymary, spreading drymaria	G4T4	S1	RMNP

State Scientific Name	State Common Name	CNHP Global Rank	CHNP State Rank	Other Agency Ranking
Eustoma exaltatum ssp. russellianum (Eustoma grandiflorum)	showy prairie gentian	G5T5?	S3S4	OSMP
Humulus neomexicanus	common hop	Unranked	Unranked	OSMP
Lactuca biennis	tall blue lettuce	Unranked	Unranked	OSMP
Lactuca canadensis	Canada lettuce	Unranked	Unranked	OSMP
Lemna minuta	least duckweed	Unranked	Unranked	BCPOS
Liatris ligulistylis	Rocky Mountain blazing star, gay-feather	G5?	S2	RMNP, OSMP
Machaeranthera coloradoensis	Colorado tansyaster	G3	S3	USFS
Menyanthes trifoliata	buckbean	Unranked	Unranked	BCPOS
Mentzelia sinuata (Mentzelia speciosa; Nuttallia sinuata; Nuttallia multiflora)	leechleaf blazingstar, wavy- leaf stickleaf	G3	S3	RMNP, OSMP
Mimulus gemmiparus	Rocky Mountain monkeyflower, budding monkeyflower	G1	S1	SWAP Tier 2, USFS, RMNP
Oenothera coloradensis (Gaura neomexicana ssp. coloradensis)	Colorado butterfly plant	G3T2	S1	SWAP Tier 1, OSMP
Osmorhiza longistylis	longstyle sweetroot	Unranked	Unranked	OSMP
Oxytropis parryi	Parry's oxytrope	G5	S1	
Packera debilis	weak groundsel	G4	S1	
Papaver radicatum ssp. kluanense (P. kluanense, P. lapponicum ssp. occidentale)	rooted poppy, alpine poppy	G5T4	S3S4	RMNP
Parnassia kotzebuei	Kotzebue's grass of parnassus	G5	S2	USFS, RMNP
Pediocactus simpsonii	mountain ball cactus	G4	Unranked	BCPOS, OSMP
Pediomelum argophyllum	silverleaf Indian breadroot, silver-leaf scurf pea	Unranked	Unranked	BCPOS, OSMP
Pediomelum esculentum	large Indian breadroot	Unranked	Unranked	BCPOS
Penstemon harbourii	Harbour's beardtongue	G3G4	S3S4	RMNP
Penstemon gracilis	lilac penstemon	Unranked	Unranked	OSMP
Pericome caudata	mountain tail-leaf	Unranked	Unranked	OSMP
Phacelia denticulata	Rocky Mountain phacelia	G3	S2	
Physaria bellii	Bell's twinpod	G2G3	S2S3	SWAP Tier 2, OSMP
Physaria bellii x vitulifera	twinpod hybrid	GNA	S1	
Physaria vitulifera	fliddleleaf twinpod	G3	S3	OSMP
Potentilla ambigens	silkyleaf cinquefoil	G3	S2	
Potentilla rupincola (P. effusa var. rupincola)	rock cinquefoil	G5T2	S2	SWAP Tier 2, USFS, RMNP
Pyrola picta	whiteveined wintergreen, pictureleaf wintergreen	G4G5	S3S4	RMNP
Ranunculus abortivus	littleleaf buttercup	Unranked	Unranked	OSMP
Ranunculus gelidus ssp. grayi (R. karelinii)	ice cold buttercup, tundra buttercup	G5	S2	
Rotala ramosior	toothcup	G5	S1	OSMP
Rubus pubescens var. pubescens (Cylactis pubescens)	dwarf red blackberry	Unranked	Unranked	OSMP
Salix candida	sageleaf willow	G5	S2	USFS
Salix serissima	autumn willow	G5	S1	USFS, RMNP
Sanicula marilandica	Maryland sanicula	Unranked	Unranked	OSMP
Stuckenia vaginata	sheathed pondweed	Unranked	Unranked	BCPOS
Telesonix jamesii	James's telesonix	G3G4	S3	SWAP Tier 2, RMNP
Thelypodium sagittatum	arrow thelypody	G4	S1	

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Tonestus lyallii (Haplopappus lyallii)	Lyall's goldenweed	Unranked	Unranked	RMNP
Triodanis leptocarpa	slim-pod Venus's Looking-glass	G5?	S1	OSMP
Utricularia minor	lesser bladderwort	G5	S3	USFS
Utricularia ochroleuca	yellowishwhite bladderwort	G4G5	S1	
Viola pedatifida	prairie violet	G5	S2	OSMP
Viola selkirkii	Selkirk's violet	G5	S2	USFS, RMNP
SIGNIFICANT NATURAL COMMUNITIES				
Abies lasiocarpa - Picea engelmannii / Moss Forest	Subalpine Fir - Engelmann Spruce / Moss Forest	G4	SU	
Achnatherum hymenoides Shale Barren Grassland	Indian Ricegrass Shale Barren Grassland	G2	SU	
Alnus incana - Salix (monticola, lucida, ligulifolia) Wet Shrubland	Gray Alder - (Park Willow, Shining Willow, Strapleaf Willow) Wet Shrubland	G3	S3	
Alnus incana - Salix drummondiana Wet Shrubland	Gray Alder - Drummond's Willow Wet Shrubland	G3	S3	
Alnus incana / Equisetum arvense Wet Shrubland	Gray Alder / Field Horsetail Wet Shrubland	G3	S1	
Alnus incana / Mesic Forbs Wet Shrubland	Thinleaf Alder / Mesic Forb Riparian Shrubland	G3	S3	
Alnus incana / Mesic Graminoids Wet Shrubland	Gray Alder / Mesic Graminoids Wet Shrubland	G3	S2	
Andropogon gerardii - Schizachyrium scoparium Northwestern Plains Grassland	Big Bluestem - Little Bluestem Northwestern Plains Grassland	G2?	S2	
Andropogon gerardii - Sorghastrum nutans West-Central Plains Grassland	Big Bluestem - Indiangrass West-Central Plains Grassland	G2	S2	
Andropogon gerardii - Sporobolus heterolepis Western Foothills Grassland	Big Bluestem - Prairie Dropseed Western Foothills Grassland	G2	S1	
Betula glandulosa / Sphagnum spp. Shrub Fen	Dwarf Birch / Sphagnum Shrubland	G2	S2	
Betula occidentalis / Maianthemum stellatum Wet Shrubland	Water Birch / Starry False Lily-of-the-Valley Wet Shrubland	G4?	S3	
Betula occidentalis / Mesic Graminoids Wet Shrubland	Water Birch / Mesic Graminoids Wet Shrubland	G3	S2	
Bouteloua gracilis - Bouteloua hirsuta Grassland	Blue Grama - Hairy Grama Grassland	G3G4	SU	
Bouteloua gracilis - Bouteloua dactyloides Grassland	Blue Grama - Buffalograss Grassland	G4	S2?	
Calamagrostis stricta Wet Meadow	Slimstem Reedgrass Wet Meadow	GU	S2S3	
Caltha leptosepala Wet Meadow	White Marsh-marigold Wet Meadow	G4	S4	
Carex aquatilis / Sphagnum spp. Fen	Water Sedge - Peatmoss species Fen	G2G3	S2S3	
Carex diandra Wet Meadow Fen	Lesser Panicled Sedge Wet Meadow Fen	GNR	S1	
Carex lasiocarpa Fen	Woolly-fruit Sedge Fen	G4?	S1	
Carex praegracilis Wet Meadow	Clustered Field Sedge Wet Meadow	G3G4	S2	
Carex rupestris - Trifolium dasyphyllum Alpine Turf	Curly Sedge - Alpine Clover Alpine Turf	G3G4	S1	
Carex saxatilis Fen	Rock Sedge Fen	G3	S1	
Celtis laevigata var. reticulata / Pseudoroegneria spicata Wet Scrub	Netleaf Hackberry / Bluebunch Wheatgrass Wet Scrub	G2G3	S1	

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Cercocarpus montanus / Elymus lanceolatus ssp. *lanceolatus* Shrubland	Mountain Mahogany / Griffith's Wheatgrass Shrubland	GU	S2	
Cercocarpus montanus - Rhus trilobata / Andropogon gerardii Shrubland	Mountain Mahogany - Skunkbush / Big Bluestem Shrubland	G2G3	S2	
Cercocarpus montanus / Achnatherum scribneri Shrubland	Alderleaf Mountain-mahogany / Scribner's Needlegrass Shrubland	G3	S3	
Cercocarpus montanus / Hesperostipa comata Shrubland	Alderleaf Mountain-mahogany / Needle-and-Thread Shrubland	G2	S2	
Cercocarpus montanus / Hesperostipa neomexicana Shrubland	Alderleaf Mountain-mahogany / New Mexico Feathergrass Shrubland	G2G3	S2	
Corylus cornuta Wet Shrubland	Beaked Hazelnut Wet Shrubland	G3	S1	
Danthonia parryi Grassland	Parry's Oatgrass Grassland	G3	S3	
Deschampsia cespitosa - Wet Meadow	Tufted Hairgrass - Wet Meadow	G4	S4	
Distichlis spicata Alkaline Wet Meadow	Salt Meadows	G5	S5	
Eleocharis quinqueflora Fen	Few-flower Spikerush Fen	G4	S4	
Eleocharis rostellata Marsh	Beaked Spikerush Marsh	G3	S2	
Festuca thurberi Subalpine Grassland	Thurber's Fescue Subalpine Grassland	G3	S1S2	
Geum rossii - Trifolium ssp. Alpine Turf	Ross' Avens - Clover species Alpine Turf	G3	S2	
Glyceria grandis Wet Meadow	American Mannagrass Wet Meadow	G2?	S1	
Hesperostipa comata - Achnatherum hymenoides Grassland	Needle-and-Thread - Indian Ricegrass Grassland	G2?	S1	
Hesperostipa comata - Bouteloua gracilis Central Grassland	Needle-and-Thread - Blue Grama Central Grassland	GNR	S2	
Hesperostipa comata Colorado Front Range Grassland	Needle-and-Thread Colorado Front Range Grassland	G1G2	S2	
Hesperostipa neomexicana Grassland	New Mexico Feathergrass Grassland	G3	S2	
Juncus parryi / Sibbaldia procumbens Alpine Snowbed	Parry's Rush / Creeping Sibbaldia Alpine Snowbed	G3G4	S1	
Kobresia myosuroides - Carex rupestris var. drummondiana Alpine Turf	Bellardi Bog Sedge - Drummond's Sedge Alpine Turf	G3	S1	
Muhlenbergia montana Grassland	Mountain Muhly Grassland	G3G4	S2	
Muhlenbergia montana - Hesperostipa comata Grassland	Mountain Muhly - Needle-and-Thread Grassland	G1G2	S2	
Pascopyrum smithii - Eleocharis spp. Wet Meadow	Western Wheatgrass - Spikerush species Wet Meadow	G1	S1	
Picea engelmannii / Trifolium dasyphyllum Forest	Engelmann Spruce / Alpine Clover Forest	G2?	S2	
Picea pungens / Alnus incana Riparian Woodland	Blue Spruce / Gray Alder Riparian Woodland	G3	S3	
Picea pungens / Betula occidentalis Riparian Woodland	Blue Spruce / Water Birch Riparian Woodland	G2	S2	
Picea pungens / Linnaea borealis Forest	Blue Spruce / Twinflower Forest	G4	SU	
Pinus flexilis / Arctostaphylos uva-ursi Woodland	Limber Pine / Kinnikinnick Woodland	G4	S1	
Pinus flexilis / Juniperus communis Woodland	Limber Pine / Common Juniper Woodland	G5	S5	

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Pinus ponderosa / Artemisia tridentata ssp. *vaseyana* Woodland	Ponderosa Pine / Mountain Big Sagebrush Woodland	GNR	S1	
Pinus ponderosa / Carex inops ssp. heliophila Woodland	Ponderosa Pine / Sun Sedge Woodland	G3G4	S1	
Pinus ponderosa / Cercocarpus montanus / Andropogon gerardii Open Woodland	Ponderosa Pine / Alderleaf Mountain-mahogany / Big Bluestem Open Woodland	G2	S2	
Pinus ponderosa / Leucopoa kingii Woodland	Ponderosa Pine / Spike Fescue Woodland	G3	S3	
Pinus ponderosa / Muhlenbergia montana Woodland	Ponderosa Pine / Mountain Muhly Woodland	G4G5	S2	
Pinus ponderosa var. scopulorum / Purshia tridentata Southern Rocky Mountain Woodland	Ponderosa Pine / Antelope Bitterbrush Southern Rocky Mountain Woodland	G3G5	S5	
Pinus ponderosa / Schizachyrium scoparium Woodland	Ponderosa Pine / Little Bluestem Woodland	G3G4	S1	
Populus angustifolia / Alnus incana Riparian Woodland	Narrowleaf Cottonwood / Gray Alder Riparian Woodland	G3	S3	
Populus angustifolia / Betula occidentalis Riparian Woodland	Narrowleaf Cottonwood / Water Birch Riparian Woodland	G3	S3	
Populus angustifolia / Salix irrorata Riparian Woodland	Narrowleaf Cottonwood / Dewystem Willow Riparian Woodland	G2	S2	
Populus balsamifera Woodland	Balsam Poplar Woodland	GU	S2	
Populus deltoides - (Salix amygdaloides) / Salix (exigua, interior) Floodplain Woodland	Eastern Cottonwood - (Peachleaf Willow) / (Narrowleaf Willow, Sandbar Willow) Floodplain Woodland	G3G4	S3	
Populus tremuloides / Acer glabrum Forest	Quaking Aspen / Rocky Mountain Maple Forest	G3	S3	
Populus tremuloides / Alnus incana Riparian Forest	Quaking Aspen / Gray Alder Riparian Forest	G3	S4	
Populus tremuloides / Betula occidentalis Riparian Forest	Quaking Aspen / Water Birch Riparian Forest	G3	S2	
Populus tremuloides / Calamagrostis canadensis Riparian Forest	Quaking Aspen / Bluejoint Swamp Forest	G3	SU	
Populus tremuloides / Corylus cornuta Forest	Quaking Aspen / Beaked Hazelnut Forest	G3	S1	
Populus tremuloides / Lonicera involucrata Forest	Quaking Aspen / Twinberry Honeysuckle Forest	G3	S1	
Populus tremuloides / Ribes montigenum Riparian Forest	Quaking Aspen / Gooseberry Currant Riparian Forest	G2	SU	
Populus tremuloides / Vaccinium myrtillus Forest	Quaking Aspen / Whortleberry Forest	G3	S1	
Potamogeton natans Aquatic Vegetation	Floating Pondweed Aquatic Vegetation	G5?	S1	
Pseudotsuga menziesii / Betula occidentalis Riparian Woodland	Douglas-fir / Water Birch Riparian Woodland	G3?	S2	
Pseudotsuga menziesii / Paxistima myrsinites Forest	Douglas-fir / Oregon Boxleaf Forest	G2G3	S2	

State Scientific Name	State Common Name	CNHP Global Rank	CHNP State Rank	Other Agency Ranking
Purshia tridentata / Artemisia frigida / Hesperostipa comata Shrubland	Antelope Bitterbrush / Prairie Sagewort / Needle-and-Thread Shrubland	G1G2	S1S2	
Purshia tridentata / Muhlenbergia montana Shrubland	Antelope Bitterbrush / Mountain Muhly Shrubland	G2	S2	
Rhus trilobata Moist Wet Shrubland	Skunkbush Sumac Moist Wet Shrubland	G3	S3	
Rhus trilobata Rocky Mountain Shrubland	Skunkbush Sumac Rocky Mountain Shrubland	G2	S2	
Salix arctica / Salix nivalus Dwarf Shrubland	Arctic Willow - Net-Veined Willow Shrubland	G2GQ	S2	
Salix bebbiana Wet Shrubland	Bebb's Willow Wet Shrubland	G3?	S2	
Salix boothii / Calamagrostis canadensis Shrubland	Booth Willow / Canadian Reed Grass Shrubland	G3G4Q	S1	
Salix boothii / Carex utriculata Shrubland	Booth's Willow / Beaked Sedge Shrubland	G4	S2	
Salix boothii / Deschampsia caespitosa / Geum rossii Wet Shrubland	Booth's Willow / Tufted Hairgrass - Ross' Avens Wet Shrubland	G4	S4	
Salix boothii Mesic Forbs Wet Shrubland	Booth's Willow / Mesic Forbs Wet Shrubland	G3	S3	
Salix boothii Mesic Graminoids Wet Shrubland	Booth's Willow / Mesic Graminoids Wet Shrubland	G3?	S3	
Salix brachycarpa / Carex aquatilis Wet Shrubland	Short-fruit Willow / Water Sedge Wet Shrubland	G2G3	S2	
Salix drummondiana / Calamagrostis canadensis Wet Shrubland	Drummond's Willow / Bluejoint Wet Shrubland	G3	S3	
Salix geyeriana - Salix monticola / Calamagrostis canadensis Wet Shrubland	Geyer's Willow - Park Willow / Bluejoint Wet Shrubland	G3	S2	
Salix geyeriana / Calamagrostis canadensis Wet Shrubland	Geyer's Willow / Bluejoint Wet Shrubland	G5	S2	
Salix geyeriana / Carex aquatilis Wet Shrubland	Geyer's Willow / Water Sedge Wet Shrubland	G3	S2	
Salix monticola / Calamagrostis canadensis Wet Shrubland	Park Willow / Bluejoint Wet Shrubland	G3	S3	
Salix monticola / Carex aquatilis Wet Shrubland	Park Willow / Water Sedge Wet Shrubland	G3	S2	
Salix monticola / Carex utriculata Wet Shrubland	Park Willow / Northwest Territory Sedge Wet Shrubland	G3	S3	
Salix monticola / Mesic Graminoids Wet Shrubland	Park Willow / Mesic Graminoids Wet Shrubland	G3	S3	
Salix planifolia / Deschampsia caespitosa Wet Shrubland	Diamondleaf Willow / Tufted Hairgrass Wet Shrubland	G2G3	S2	
Salix wolfii / Mesic Forbs Wet Shrubland	Wolf's Willow / Mesic Forbs Wet Shrubland	G3	S3	
Schizachyrium scoparium- Bouteloua curtipendula Western Great Plains Grassland	Little Bluestem - Sideoats Grama Western Great Plains Grassland	G3	S2	
Spartina pectinata Western Wet Meadow	Prairie Cordgrass Western Wet Meadow	G3?	S2	
Suaeda calceoliformis Wet Meadow	Pursh Seepweed Wet Meadow	GNR	SU	
Symphoricarpos occidentalis Shrubland	Western Snowberry Shrubland	G4G5	S4	
SPECIES WITH THE POTENTIAL TO OCCUR IN BOULDER COUNTY				
Andreaea heinemannii		G3G5	S1S3	RMNP

State Scientific Name	State Common Name	CNHP Global Rank	CHNP State Rank	Other Agency Ranking
Botrychium tunux	Moosewort	G3G4	S2	
Carex leptalea	bristle-stalk sedge	G5	S1	RMNP
Cystopteris montana	mountain bladder fern	G5	S1	RMNP
Draba porsildii	Porsild's draba	Unranked	Unranked	RMNP
Erocallis triphylla	Dwarf spring beauty	G4?	S2	RMNP
Heteranthera limosa	blue mudplantain	Unranked	Unranked	BCPOS
Lewisia rediviva	Bitterroot	G5	S3	RMNP
Myosurus apetalus var. montanus	bristly mousetail	Unranked	Unranked	BCPOS
Oligoneuron album (Solidago ptarmicoides, Unamia alba)	prairie goldenrod	G5	S2	
Potamogeton praelongus	whitestem pondweed	G5	S1	
Rhytidium rugosum	golden glade-moss	G5	S1S3	RMNP
Ribes americanum	American black current	G5	S2	
Sagittaria brevirostra	shortbeak arrowhead	Unranked	Unranked	BCPOS

DEFINITIONS

Federal Status

ESA, United States Endangered Species Act

LE, Listed Endangered

LT, Listed Threatened

C, Candidate for listing

Colorado Natural Heritage Program (CNHP)/NatureServe Imperilment Ranks*

G-Rank: Global Rank, S-Rank: Colorado Rank

G/S1, Critically Imperiled

G/S2, Imperiled

G/S3, Vulnerable to extirpation, typically between 21-100 occurrences.

G/S4, Apparently secure

G/S5 Secure

G/S?, Unranked. Some evidence that species may be imperiled, but awaiting formal rarity ranking.

G/SU, Unrankable due to lack of information or substantially conflicting information.

G/SH, Possibly extirpated or extinct.

GQ, Indicates uncertainty about taxonomic status.

G/S#?, Indicates uncertainty about an assigned rank, or the rank has not yet been assessed.

G#T#, Trinomial rank (T) is used for subspecies or varieties. These species or subspecies are ranked on the same criteria as G1- G5.

GNR/SNR, Global not ranked/State not ranked. CNHP has not yet looked at this species.

TNR, Not yet ranked globally due to lack of information.

**Note: Where two numbers appear in a global or state rank, e.g., S2S3, the actual rank of the element falls between the two numbers. CNHP experts tend to round up to the more conservative number, e.g., if S2S3, consider the species a 'S2' until further information is available (Jill Handwerk, personal communication).*

(BLM) Bureau of Land Management Colorado Sensitive Species List

Sensitive plant species or communities

(BCPOS) Boulder County Parks & Open Space Sensitive Status

Sensitive species within Boulder County

(OSMP) City of Boulder Open Space and Mountain Parks Sensitive Status

Sensitive plant species or communities as designated on OSMP lands.

(CPW) Colorado Parks and Wildlife State Wildlife Action Plan (SWAP)

CPW Rare Plant Addendum to the SWAP (2015)

(RMNP) National Park Service, Rocky Mountain National Park Sensitive Status

Sensitive species appearing on NPS' 'State Endangered, Threatened or Rare Species for Rocky Mountain National Park' list (NPS 2006).

(USFS) United States Forest Service Sensitive Status

Indicates a sensitive species designated by the USFS Rocky Mountain Regional Forester to occur on USFS managed lands within Boulder County.

Attachment D

FGDC-STD-005-2008 (Version 2)

NATIONAL VEGETATION CLASSIFICATION STANDARD, VERSION 2

Vegetation Subcommittee
Federal Geographic Data Committee

February 2008

Federal Geographic Data Committee

Established by Office of Management and Budget Circular A-16, the Federal Geographic Data Committee (FGDC) promotes the coordinated development, use, sharing, and dissemination of geographic data.

The FGDC is composed of representatives from the Departments of Agriculture, Commerce, Defense, Education, Energy, Health and Human Services, Homeland Security, Housing and Urban Development, the Interior, Justice, Labor, State, and Transportation, the Treasury, and Veteran Affairs; the Environmental Protection Agency; the Federal Communications Commission; the General Services Administration; the Library of Congress; the National Aeronautics and Space Administration; the National Archives and Records Administration; the National Science Foundation; the Nuclear Regulatory Commission; the Office of Personnel Management; the Small Business Administration; the Smithsonian Institution; the Social Security Administration; the Tennessee Valley Authority; and the U.S. Agency for International Development.

Additional Federal agencies participate on FGDC subcommittees and working groups. The Department of the Interior chairs the committee.

FGDC subcommittees work on issues related to data categories coordinated under the circular. Subcommittees establish and implement standards for data content, quality, and transfer; encourage the exchange of information and the transfer of data; and organize the collection of geographic data to reduce duplication of effort. Working groups are established for issues that transcend data categories.

For more information about the committee, or to be added to the committee's newsletter mailing list, please contact:

Federal Geographic Data Committee Secretariat
c/o U.S. Geological Survey
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Reston, Virginia 22092
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World Wide Web: http://www.fgdc.gov

ACKNOWLEDGEMENT

The Federal Geographic Data Committee Vegetation Subcommittee would like to acknowledge the valuable contributions of the Ecological Society of America's Vegetation Classification Panel. This draft standard is based on the minimum requirements of the Panel's Guidelines for Describing Associations and Alliances of the U.S. National Vegetation Classification, Version 4.0 (Jennings et al. 2006) with modifications to satisfy the needs of Federal agencies

[DSP1]

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1

1. Introduction

The United States Federal Geographic Data Committee (hereafter called the FGDC) is tasked to develop geospatial data standards that will enable sharing of spatial data among producers and users and support the growing National Spatial Data Infrastructure (NSDI), acting under the Office of Management Budget (OMB) Circular A-16 (OMB 1990, 2000) and Executive Order #12906 (Clinton 1994) as amended by Executive Order #13286 (Bush 2003). FGDC subcommittees and working groups, in consultation and cooperation with state, local, tribal, private, academic, and international communities, are to develop standards for the content, quality, and transferability of geospatial data. FGDC standards are to be developed through a structured process, integrated with one another to the extent possible, supportable by the current vendor community (but are independent of specific technologies), and are publicly available.

There is no single agency responsible for classifying, describing, and/or mapping the vegetation of the United States, resulting in the current condition of multiple agencies inventorying, mapping, analyzing, and reporting vegetation data in a variety of ways, sometimes in direct conflict with each other due to differing definitions and protocols. The present situation has prevented development of a national synoptic view of the vegetation resources of the United States. Federal agencies are encouraged by a variety of executive orders and Congressional actions to improve cooperation and to reduce duplication. This standard responds to this direction.

The FGDC Vegetation Subcommittee has responsibility for creating a federal vegetation classification standard, which it did in 1997 (FGDC 1997). This document is a revision of FGDC-STD-005-1997 and replaces that document. The completion of provisional floristic units by NatureServe for the classification (Anderson et al 1998, Drake and Faber-Langendoen 1997, Metzler et al. 1994, Reid et al. 1999, and Weakley et al. 1998), the need to update the standards for these floristic levels based on the Ecological Society of America Vegetation Classification Panel (Jennings et al. 2006), and critiques of the upper physiognomic levels by various teams, including that of the United States Department of Agriculture (USDA) Forest Service team (Brohman and Bryant 2005), led to the request for the revisions (see also Faber-Langendoen et al. 2007). This document presents a process standard to be used to create a dynamic content standard for all vegetation types in the classification. The content standard will constitute a “data classification standard” (FGDC 1996) which will provide hierarchical groups and categories of vegetation to facilitate aggregation of local and regional vegetation inventory data to generate national statistics on vegetation resources. The process standard described in this document constitutes a “classification methodology standard” describing “the procedures to follow to implement a data classification standard” (FGDC 1996). It includes standards for data collection, data analysis, data presentation, and quality control and assurance as described in the FGDC Standards Reference Model (FGDC 1996).

1.1 Dynamic Nature of Vegetation Classification

Implementation of the classification methodology (process) standard will produce a data classification standard, or classification system, consisting of a hierarchical list of vegetation types and their descriptions. This vegetation classification system is expected to change rapidly for several years as the backlog of provisional types, and pilot examples are reviewed and added in, then to continue to change at a slower pace. The standard requires that vegetation types be defined and characterized using appropriate data. New vegetation types will be defined and previously defined types will be refined as data continue to be collected, analyzed, and correlated over time. This process is referred to as successive refinement (or successive approximation), and constitutes a fundamental feature of vegetation classification (Westhoff and van der Maarel 1973, Gauch 1982). Managing the vegetation classification (content standard) dynamically as the classification process is implemented will allow development of the national vegetation classification system (i.e. data classification standard) to proceed efficiently.

It must be noted that a vegetation classification system is not synonymous with a map legend. Vegetation classification consists of grouping stands or plots into vegetation, or plant community, types (Tart et al. 2005a). Each type name represents a taxonomic concept with defined limits, about which meaningful and reliable statements can be made (Jennings et al. 2006). Vegetation mapping is the process of delineating the geographic distribution, extent, and landscape patterns of vegetation types and/or structural characteristics. Consistent mapping of vegetation types requires that a classification be completed first because classification defines the entities to be mapped (Tart et al. 2005a). In turn, mapping and field checking the vegetation types helps improve the classification concepts. This revision should facilitate more effective mapping of vegetation at multiple scales. None-the-less, due to varying scale of vegetation patterns and technological issues, map units may often include more than one vegetation type at any given level of the hierarchy. The hierarchical set of vegetation types can be used to describe the content of vegetation map units at multiple scales.

1.2 Objective

The overall purpose of this National Vegetation Classification Standard (hereafter referred to as the "Standard") is to support the development and use of a consistent national vegetation classification (hereafter referred to as the "NVC") in order to produce uniform statistics about vegetation resources across the nation, based on vegetation data gathered at local, regional, or national levels. This will facilitate cooperation on vegetation management issues that transcend jurisdictional boundaries. It is therefore important that, as agencies map or inventory vegetation, they collect enough data to translate it for national reporting, aggregation, and comparisons. The ability to crosswalk other vegetation classifications and map legends to the NVC will facilitate the compilation of regional and national summaries. The overall purpose of this standard encompasses four broad objectives:

1. To facilitate and support the development of a standardized vegetation classification for the United States and its use for information sharing.

2. To define and adopt standards for vegetation data collection and analysis used in support of the classification.
3. To maintain scientific credibility of the national classification through peer review.
4. To facilitate inter-agency collaboration and inter-agency product consistency.

This national standard requires all federal vegetation classification efforts to meet core data requirements that are the same across all federal agencies to permit aggregation of data from all federal agencies. This will facilitate the ongoing, dynamic development of a vegetation classification content standard (i.e., the NVC). The Standard also requires that vegetation mapping and inventory units crosswalk to the NVC. This means that the composition of any map unit or inventory unit can be described in terms of one or more vegetation types at an appropriate level of the NVC hierarchy.

This Standard shall not preclude alternative classification approaches and systems that address particular needs of Federal agencies. It is intended to facilitate an orderly development of a national vegetation classification as well as collaboration with international vegetation classification activities. The standard should not hamper local Federal efforts from doing whatever they need to meet their specific purposes, such as inventory, monitoring, and mapping.

This standard requires that when Federal efforts are conducted, they are conducted in ways that, whatever else they do, they provide the minimum data needed to integrate plot data and crosswalk vegetation types, and map units to the content standard (the NVC). Individual plots should be assignable to one vegetation type at the lowest possible level of the NVC hierarchy. Local vegetation types and map units may crosswalk to one or more NVC vegetation types at a similar level of the NVC hierarchy.

1.3 Scope

This Standard applies only to existing vegetation, and the NVC includes only existing vegetation types. Existing vegetation is the plant cover, or floristic composition and vegetation structure, documented to occur at a specific location and time (Tart et al. 2005a, Jennings et al. 2006). However, the specific time need not be the present or even recent (i.e., historical data may be included). Existing vegetation types are defined on the basis of inherent attributes and characteristics of the vegetation, such as structure, growth form, floristic composition, and cover (FGDC 1997, Jennings et al. 2006, Tart et al. 2005a, b). Abiotic factors, geographic and successional relationships are used to help interpret the types. This Standard does not directly apply to classification or mapping of potential natural vegetation.

This Standard establishes national procedures for classifying existing vegetation for the United States and its Trust Territories that shall be used by Federal agencies to share vegetation information and facilitate reporting of national statistics across ownerships. The classification system created using these procedures will be referred to as the U.S. National Vegetation Classification (i.e., the NVC) This Standard also establishes

minimum metadata requirements to ensure consistent reporting on the status of our Nation's vegetation resources. Both the NVC and the metadata requirements may be used nationally to link local level vegetation inventory and map efforts.

1.4 Applicability

This Standard is intended to be used for information sharing by federal agencies and as needed by other groups, including those engaged in land use planning or management, such as county and state governments, teaching or research institutions, and the private sector. Widespread use of these standards will facilitate integration of existing vegetation data collected by diverse users to address national and regional information needs.

This standard shall be followed by all Federal agencies for vegetation classification data collected directly or indirectly (through grants, partnerships, or contracts) using federal funds. The standard should be applied at a level of the hierarchy appropriate to the agencies' needs. Agencies are encouraged to participate in the ongoing development of the NVC through implementation of this FGDC Standard. Non-federal organizations might find it useful to use the Standard to increase the compatibility of their efforts with those of nearby federal land managers and/or to make their efforts more compatible with any activities that involve federal agencies.

Each Federal agency is free to develop vegetation classification systems that meet their own information and business needs. The ecological characteristics of such local vegetation types can help guide the design of map legends (sets of map units) to address varying land management issues at multiple spatial scales. The NVC is expected to provide the common link to compare and relate these various map legends to each other and facilitate information sharing between federal agencies and other organizations.

1.5 Related Standards

This standard deals with existing vegetation. It explicitly seeks to avoid land use terms, but may be useful to efforts to describe and map land use.

The NVC overlaps one other federal standard, the FGDC Wetlands and Deep Water Habitats Standard (FGDC-STD-004) (Cowardin et al. 1979), wherever vegetation exists in wetlands or open water. The NVC classifies vegetation primarily according to physiognomic and floristic characteristics, not habitat or related characteristics, whereas the Wetlands standard includes soils and other habitat characteristics in its classification criteria. The two standards have different purposes and so the two classification systems should be viewed as complementary but different systematic approaches in an overall analysis of an area.

The FGDC is working with partners on collaboration of the U.S. NVC in an international context, including coordination of the U.S. NVC with NatureServe and other partners of the International Vegetation Classification (NatureServe 2006, Faber-Langendoen et al. 2007), and with other national classifications such as the Canadian NVC (Alvo and

Ponomarenko 2003, CNVC Technical Committee 2005) and partners in Mexico and other countries in Latin America.

The NVC overlaps to a degree the Land Cover Classification System (LCCS) of the United Nations Food and Agriculture Organization (FAO) (see Di Gregorio and Jansen 1996). The FAO LCCS classifies biological and physical land cover; including non-vegetated land, cultural features, and water bodies; rather than plant communities. It is a standardized *a priori* classification system, designed to meet specific user requirements, and created for broad scale mapping exercises. The FAO LCCS is particularly focused on developing land cover map units. It does not provide details on plant community or vegetation types. In contrast the NVC is an evolving *a posteriori* classification, based on plot data, and is intended to serve a wider variety of purposes. It is intended to facilitate understanding of the ecological distribution of plant species and vegetation types. See Appendix B for a comparison of the NVC and the LCCS.

1.6 Standards Development Procedures

A Subcommittee on vegetation data (FGDC Vegetation Subcommittee, hereafter called the Subcommittee) was established in 1990 by OMB Circular A-16 (OMB 1990) and published a vegetation classification standard (FGDC-STD-005) in 1997. This standard is a modification of that standard. The Subcommittee consists of representatives designated by the Federal agencies that collect, or finance the collection of, vegetation data as part of their mission or have direct application of these data through legislated mandate. Agencies and organizations that participated in the modification of the 1997 standard include:

U.S. Government:
- Department of Agriculture (USDA)
  - Forest Service (FS) - Chair
  - National Agriculture Statistics Service (NASS)
  - Natural Resources Conservation Service (NRCS)
- Department of Defense (DOD)
  - U.S. Army Corps of Engineers (USACERL)
- Department of the Interior (USDI)
  - Bureau of Land Management (BLM)
  - Bureau of Indian Affairs (BIA)
  - Fish and Wildlife Service (FWS)
  - National Park Service (NPS)
  - U.S. Geological Survey (USGS)
- National Aeronautics and Space Administration (NASA)

Non U.S. Government:
- NatureServe
- Ecological Society of America (ESA)

The Subcommittee identified a need to establish a hierarchical classification standard and associated information standards that will contain an organized list of vegetation types

(taxonomic units) with identified relationships among them. Procedures used to develop these standards included user surveys, periodic Subcommittee meetings, a vegetation classification forum held in 1995, preparation of a draft standard for lower floristic units by the Vegetation Classification Panel of ESA (Jennings et al. 2006), preparation of a draft standard for higher physiognomic and floristic units by the FGDC Hierarchy Revisions Working Group (Faber-Langendoen et al. 2007), and a review of the draft standards by the agencies and organizations represented on the Subcommittee. All decisions were made by consensus as prescribed by OMB Circular A-119 (OMB 1998).

1.6.1 Guiding Principles

The following principles were used to modify the NVC Standard:

- Develop a scientific, standardized classification system, with practical use for conservation and resource management.
- Classify existing vegetation. Existing vegetation is the plant cover, or floristic composition and vegetation structure, documented to occur at a specific location and time, preferably at the optimal time during the growing season. This Standard does not directly apply to classification or mapping of potential natural vegetation.
- Classify vegetation on the basis of inherent attributes and characteristics of the vegetation structure, growth form, species and cover, emphasizing both physiognomic and floristic criteria.
- Base criteria for the types on ecologically meaningful relationships; that is, abiotic, geographic and successional relationships help to organize the vegetation into types and levels.
- Organize types by a hierarchy. The NVC is hierarchical (i.e., multi-leveled), with a small number of generalized types at the higher level and an increasingly large number of more detailed types at the lower levels. Having multiple levels allows for applications at a range of scales (UNEP/FAO 1995, Di Gregorio and Jansen 1996).
- The upper levels of the NVC are based primarily on the physiognomy (growth form, cover, structure) of the vegetation (not individual species), lower levels are based primarily on floristics (species composition and abundance), and mid levels are based on a combination of vegetation criteria.
- Describe types based on plot data, using publicly accessible data wherever possible.
- Modify the classification through a structured peer review process. The classification standard shall be dynamic, allowing for refinement as additional information becomes available.
- Facilitate linkages to other classifications and to vegetation mapping (but the classification is not a map legend).

- The classification is applicable over extensive areas.
- The classification shall avoid developing conflicting concepts and methods through cooperative development with the widest possible range of individuals and institutions.
- Application of the classification shall be repeatable and consistent.
- When possible, the classification standard shall use common terminology (i.e., terms should be understandable and jargon should be avoided).

1.7 Maintenance Authority

The United States Department of Agriculture (USDA) Forest Service was assigned responsibility to coordinate vegetation data-related activities under the policy guidance and oversight of the FGDC. This modification of the NVC Standard was developed under the authority of the Office of Management and Budget Circular A-16, revised 2002.

Through the Subcommittee, the USDA Forest Service will oversee the maintenance and updating of the Standard through periodic review, and will oversee maintenance, updating, dissemination, and implementation of the NVC that is based on this Standard in collaboration with member agencies, professional societies, and other organizations. Future revision of this Standard shall follow the standards development process described in the FGDC Standards Reference Model (FGDC 1996). The dynamic content of the NVC shall be updated under the direction of a national review board authorized by the USDA Forest Service through the Subcommittee.

For more information about the Vegetation Subcommittee or the national review board, please contact:

USDA Forest Service
Attn: Research and Development
Yates Federal Building, 1 NW
201 14th Street
Washington, DC 20250

2. Structure of the National Vegetation Classification

The structure of the revised NVC hierarchy is a substantial revision of the 1997 hierarchy. The revised hierarchy addresses the following issues, among others: a) uses vegetation criteria to define all types (de-emphasizing abiotic criteria, such as hydrologic regimes in wetland types), b) provides a clear distinction between natural and cultural vegetation wherever these can be observed from broad growth form patterns (rather than combining natural and cultural vegetation initially and separating them at lower levels), c) for natural vegetation, defines the upper levels based on broad growth form patterns that reflect ecological relationships (rather than detailed structural criteria, which are more appropriate lower down in the hierarchy), d) provides a new set of middle-level natural units that bridge the large conceptual gap between alliance and formation, e) integrates the physiognomic and floristic hierarchy levels based on ecologic vegetation patterns, rather than developing the physiognomic and floristic levels independently and then forcing them into a hierarchy, f) provides detailed standards for plot data collection, type description and classification, data management and peer review of natural vegetation, and g) for cultural vegetation provides an independent set of levels that addresses the particular needs of cultural vegetation. See Jennings et al. (2006) and Faber-Langendoen et al. (2007) for further details on the rationale behind these changes.

Several primary categories are helpful in describing the scope of the NVC and placing it within a broader land cover context. First, it includes all vegetated areas. That is, all areas having typically 1% or more of their surface area with live vegetation cover are classified within the NVC. This includes vegetation found on both strictly upland environments and in wetlands (rooted emergent and floating vegetation). The NVC excludes non-vegetated natural lands (e.g., rock, glaciers, some deserts) and waters (e.g., lakes and rivers) and non-vegetated cultural lands (e.g., roads, buildings, mines) and waters (e.g., reservoirs, canals). These distinctions are outlined in Table 2.1. The relation of the NVC categories to broader land cover classification categories, including the FAO Land Cover Classification System (Di Gregorio and Jansen 1996), the U.S. National Land Cover Database (NLCD) (USGS 2001), and the National Resources Inventory (NRI 2003) is further described in Appendix B.

Separate categories are provided for natural and cultural vegetation, consistent with many other vegetation and land cover classifications (e.g. Küchler 1969, Anderson et al. 1976, Di Gregorio and Jansen 1996). Within this categorical framework, the cultural and natural vegetation classifications are hierarchical, emphasizing primarily floristics at the lower levels, both physiognomic and floristics at mid levels, and primarily physiognomy at upper levels. Separate hierarchies are developed for cultural and natural vegetation types, allowing for the characterization of their distinctive vegetation patterns at multiple spatial and taxonomic scales. The term “vegetation type” is used to name vegetation classification units in general, at any level of the vegetation hierarchy (e.g., a Montane

Tropical Rainforest Formation unit and a Black Cottonwood Forest Alliance unit are both "vegetation types.").

Natural (including semi-natural) vegetation is defined as *vegetation where ecological processes primarily determine species and site characteristics; that is, vegetation comprised of a largely spontaneously growing set of plant species that are shaped by both site and biotic processes* (Küchler 1969, Westhoff and van der Maarel 1973). Natural vegetation forms recognizable physiognomic and floristic groupings that can be related to ecological site features. Human activities influence these interactions to varying degrees (e.g., logging, livestock grazing, fire, introduced pathogens), but do not eliminate or dominate the spontaneous processes (Westhoff and van der Maarel 1973). Wherever doubt exists as to the naturalness of a vegetation type (e.g., old fields, various forest plantations), it is classified as part of the natural / semi-natural vegetation. Semi-natural vegetation typically encompasses vegetation types where the species composition and/or vegetation growth forms have been altered through anthropogenic disturbances such that no clear natural analogue is known, but they are a largely spontaneous set of plants shaped by ecological processes. Natural (or near-natural) and semi-natural vegetation are part of a continuum of change within natural vegetation that reflects varying degrees of anthropogenic and other disturbances.

The distinctive physiognomy, floristics, and dependence on human activity for its persistence set cultural vegetation apart from natural and semi-natural vegetation. **Cultural vegetation** is defined as *vegetation with a distinctive structure, composition, and development determined by regular human activity* (cultural vegetation *sensu stricto* of Küchler 1969). Cultural vegetation has typically been planted or treated, and has relatively distinctive physiognomic, floristic, or site features when compared to natural vegetation. Distinctive physiognomic and structural attributes typically include one or more of the following:

a. Dominant herbaceous vegetation that is regularly-spaced and/or growing in rows, often in areas with substantial cover of bare soil for significant periods of the year, usually determined by tillage or chemical treatment.

b. Dominant vegetation with highly-manipulated growth forms or structure rarely found as a result of natural plant development, usually determined by mechanical pruning, mowing, clipping, etc.

c. Dominant vegetation comprised of species not native to the area that have been intentionally introduced to the site by humans and that would not persist without active management by humans.

Table 2.1. Conceptual Categories and Level One of the NVC hierarchy.
Level 1 units are further explained in section 2.1 and 2.2.

CATEGORY 1	CATEGORY 2	Level 1
VEGETATED AREAS	(SEMI) NATURAL VEGETATION	Forest and Woodland
		Shrubland and Grassland
		Semi-Desert Vegetation
		Polar and High Montane Vegetation
		Aquatic Vegetation
		Nonvascular and Sparse Vascular Vegetation
	CULTURAL VEGETATION	Agricultural Vegetation
		Developed Vegetation
NONVEGETATED AREAS	**Not included in the NVC.**	

2.1 NATURAL VEGETATION

2.1.1 Overview of the Natural Vegetation Hierarchy

The natural vegetation hierarchy consists of eight levels, organized into three upper levels, three middle levels, and two lower levels (Table 2.2). As noted in section 2.0 above, the basis for this hierarchy is a substantial revision of the FGDC 1997 hierarchy, as illustrated in Table 2.2, particularly in that levels and requirements for cultural vegetation are now defined separately from the natural vegetation levels (see Section 2.2 below).

2.1.2 Classification Criteria for Natural Vegetation

Floristic and physiognomic criteria are the primary properties of natural vegetation used to define all units of the classification. The choice of how these criteria are used should be evaluated in light of ecological and biogeographic considerations: The variety of vegetation criteria can be summarized as follows (see also Mueller-Dombois and Ellenberg 1974, p. 154-155):

A. Physiognomic and structural criteria
1. Diagnostic combinations of growth forms
2. Ecological patterns of either dominant growth forms or combinations of growth forms
- Growth forms of similar ecological (habitat) and dynamic significance
- Growth forms of similar geographical distribution
3. Vertical stratification (layering) of growth forms
- Complexity in structure as produced by arrangement of growth forms

B. Floristic criteria
1. Diagnostic combinations of species (characteristic combinations)
- Constant species
- Differential and character species
- Dominant species

Table 2.2. Comparison of Revised Hierarchy for Natural Vegetation with the 1997 Hierarchy. See Appendix C for multilingual (English, French, Spanish) version of the hierarchy. In the 1997 version, natural and cultural vegetation were not separated until Level 4 – formation subgroup.

Revised Hierarchy for Natural Vegetation	1997 FGDC Hierarchy
Upper	
	Division - Vegetation vs. Non-vegetation
	Order – Tree, Shrub, Herb, Nonvascular
Level 1 – Formation Class	Level 1 – Formation Class
	Level 2 - Formation Subclass
Level 2 – Formation Subclass	Level 3 – Formation Group
	Level 4 – Formation Subgroup – Natural/Cultural
Level 3 - Formation	Level 5 – Formation
Mid	
Level 4 – Division	
Level 5 – Macrogroup	
Level 6 - Group	
Lower	
Level 7 – Alliance	Level 6 – Alliance
Level 8 – Association	Level 7 – Association

2. Ecological combinations of species
   - Indicator species of similar ecological (habitat) and/or dynamic significance
   - Species of similar geographical distribution
3. Vertical stratification (layering) of species
   - Species patterns found in the dominant growth forms or strata
   - Species patterns found between strata (overstory/understory)
4. Numerical relation criteria (community coefficients, such as indices of similarity among plots within a type)

Habitat factors (e.g., climate, soil type) or anthropogenic management activities are used to help interpret the vegetation, as these are expressed through the vegetation, but are not an explicit part of the hierarchy.

All type concepts based on these criteria should be derived from analysis of field plot data in which the species, growth forms, and their abundance, along with the plot location, overall vegetation structure, and habitat setting are described. These field data provide the fundamental information for the numerical description of types.

2.1.3 Definitions of Natural Vegetation Hierarchy Levels

The natural vegetation hierarchy consists of eight levels (see Table 2.3).

Upper level (physiognomic-ecological) units:

1. **Formation Class:** A vegetation classification unit of high rank (1st level) defined by broad combinations of dominant general growth forms adapted to basic moisture, temperature, and/or substrate or aquatic conditions.
2. **Formation Subclass:** A vegetation classification unit of high rank (2nd level) defined by combinations of general dominant and diagnostic growth forms that reflect global macroclimatic factors driven primarily by latitude and continental position, or that reflect overriding substrate or aquatic conditions. (Whittaker 1975).
3. **Formation:** A vegetation classification unit of high rank (3rd level) defined by combinations of dominant and diagnostic growth forms that reflect global macroclimatic conditions as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions. (Whittaker 1975, Lincoln et al. 1998)

Mid-level (physiognomic-floristic) units:

4. **Division:** A vegetation classification unit of intermediate rank (4th level) defined by combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant taxa that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes. (Westhoff and van der Maarel 1973, pg. 664-665, Whittaker 1975)

5. **Macrogroup:** A vegetation classification unit of intermediate rank (5th level) defined by combinations of moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes (cf. Pignatti et al. 1995).

6. **Group:** A vegetation classification unit of intermediate rank (6th level) defined by combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect biogeographic differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes (cf. Pignatti et al. 1995, Specht and Specht 2001).

Lower-level (floristic) units:

7. **Alliance:** A vegetation classification unit of low rank (7th level) containing one or more associations, and defined by a characteristic range of species composition, habitat conditions, physiognomy, and diagnostic species, typically at least one of which is found in the uppermost or dominant stratum of the vegetation (Jennings et al. 2006). Alliances reflect regional to subregional climate, substrates, hydrology, moisture/nutrient factors, and disturbance regimes.
8. **Association:** A vegetation classification unit of low rank (8th level) defined on the basis of a characteristic range of species composition, diagnostic species occurrence, habitat conditions and physiognomy (Jennings et al. 2006). Associations reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes.

These eight levels comprise the standard levels of the NVC. Lower level units, such as sub-association or variant, may also be used, if desired. See Westhoff and van der Maarel (1973) for guidance on the definitions and applications of these levels.

Table 2.3. Hierarchy for Natural Vegetation with Example. A fuller set of examples of natural vegetation units for Levels 1 through 7 are provided in Appendix G and H.

Hierarchy for Natural Vegetation	Example
Upper Levels	
1 – Formation Class	**Scientific Name:** Mesomorphic Shrub and Herb Vegetation **Colloquial Name:** Shrubland and Grassland
2 – Formation Subclass	**Scientific Name:** Temperate and Boreal Shrub and Herb Vegetation **Colloquial Name:** Temperate and Boreal Shrubland & Grassland
3 - Formation	**Scientific Name:** Temperate Shrub and Herb Vegetation **Colloquial Name:** Temperate Shrubland & Grassland
Mid Levels	
4 – Division	**Scientific Name:** *Andropogon – Stipa – Bouteloua* Grassland & Shrubland Division **Colloquial Name:** North American Great Plains Grassland & Shrubland
5 – Macrogroup	**Scientific Name:** *Andropogon gerardii – Schizachyrium scoparium – Sorghastrum nutans* Grassland & Shrubland Macrogroup **Colloquial Name:** Great Plains Tall Grassland & Shrubland
6 - Group	**Scientific Name:** *Andropogon gerardii – Sporobolus heterolepis* Grassland Group **Colloquial Name:** Great Plains Mesic Tallgrass Prairie
Lower Levels	
7 – Alliance	**Scientific Name:** *Andropogon gerardii – (Calamagrostis canadensis – Panicum virgatum)* Herbaceous Alliance **Colloquial Name:** Wet-mesic Tallgrass Prairie
8 – Association	**Scientific Name:** *Andropogon gerardii – Panicum virgatum – Helianthus grosseserratus* Herbaceous Vegetation **Colloquial Name:** Central Wet-mesic Tallgrass Prairie

2.1.4 Criteria for Natural Vegetation Hierarchy Levels

The natural vegetation hierarchy is based on diagnostic growth forms and species, and compositional similarity. These are species and growth forms that exhibit patterns of relative fidelity, constancy, or dominance that differentiate one type from another. Emphasis is placed on diagnostic growth forms at upper levels; on compositional similarity reflecting biogeographic differences, character species and dominant growth forms at intermediate levels; and on differential and dominant species and compositional similarity at lower floristic levels, in combination with specific physiognomic and habitat conditions. The overall classification strategy is depicted in figure 2.1. Vegetation encompasses a broad range and scale of types (tundra, aquatic vegetation, woodlands, grasslands, semi-desert, etc.), and attempts to coin universal definitions and criteria at the outset that are valid for each level are bound to fail (Mucina 1997). Still, a fairly uniform application should be possible "within borders of ecologically and structurally similar groups of vegetation types" (Mucina 1997). A summary of the diagnostic criteria are provided in Table 2.4. For each vegetation type, the diagnostic criteria used to define the units should be clearly stated, and the range of variation in composition, habitat, and physiognomy and structure should be clearly described, including similarity with other related types.

For the purposes of this Standard, the various kinds of diagnostic growth forms and diagnostic species are defined as follows:

Dominant Growth Form — a growth form with a high percent cover, usually in the uppermost dominant layer.

Indicator Growth Form — a growth form whose presence, abundance, or vigor is considered to indicate certain climatic and site conditions.

Character species —a species that shows a distinct maximum concentration, quantitatively and by constancy, in one well-defined vegetation type; sometimes recognized at local, regional, and general geographic scales. (Mueller-Dombois and Ellenberg 1974, p. 178, 208; Bruelheide 2000)

Differential Species — A plant species that is distinctly more widespread or successful in one of a pair or group of plant communities than in the other(s), although it may be still more successful in other communities not under discussion (Curtis 1959, Bruelheide 2000). The more limited a species is to one or a few plant community types, the stronger its differential value.

Constant species – species that are present in a high percentage of the plots that define a type, often defined as those species with at least 60% constancy (Mueller-Dombois and Ellenberg 1974, p. 178).

Dominant Species — species with the highest percent of cover, usually in the uppermost dominant layer. In other contexts, dominant species can be defined in terms of biomass, density, height, coverage, etc. (Kimmins 1997).

Indicator Species — a species whose presence, abundance, or vigor is considered to indicate certain site conditions (Gabriel and Talbot 1984).

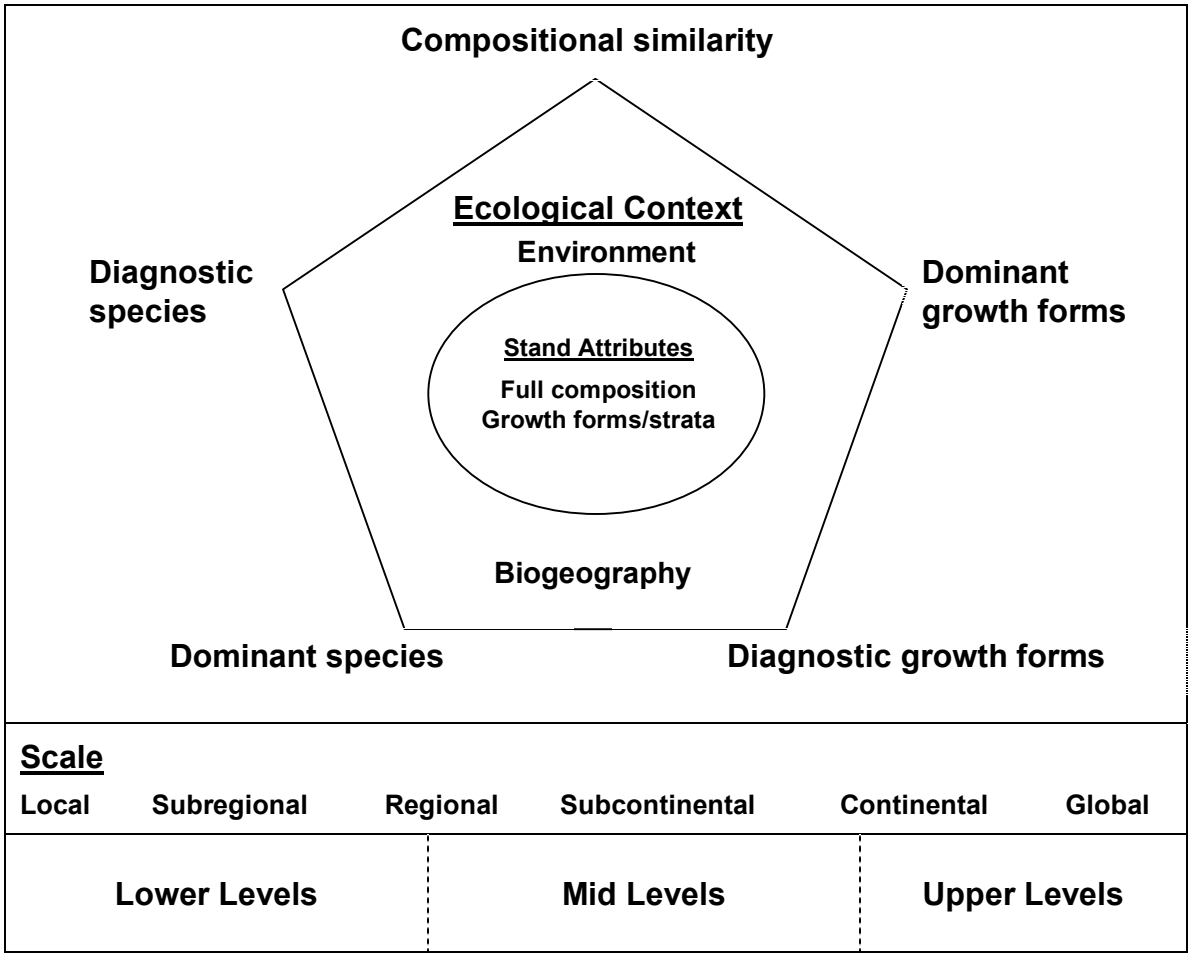


Figure 2.1. Vegetation classification criteria for the US NVC.

The pentagon portrays the five vegetation criteria used to classify vegetation at all levels of the NVC hierarchy. These criteria are arranged from the most fine-scaled on the left to the most broad-scaled on the right. The five criteria are derived from stand attributes or plot data (inside oval) and reflect the ecological context (outside oval) of the stand or plot. The ecological context includes environmental factors and biogeography considered at multiple scales, as well as natural and human disturbance regimes. The upper levels of the NVC hierarchy are based on dominant and diagnostic growth forms that reflect environment at global to continental scales. The mid levels are based on dominant and diagnostic growth forms and compositional similarity reflecting biogeography and continental to regional environmental factors. The lower levels are based on diagnostic and/or dominant species and compositional similarity reflecting local to regional environmental factors.

Table 2.4. Summary of Criteria and Rationale for the Natural Vegetation Hierarchy.

Hierarchy Level	Criteria
Upper: Physiognomy plays a predominant role.	
L1 – Formation Class	Broad combinations of general dominant growth forms that are adapted to basic temperature (energy budget), moisture, and/or substrate or aquatic conditions.
L2 - Formation Subclass	Combinations of general dominant and diagnostic growth forms that reflect global macroclimatic factors driven primarily by latitude and continental position, or that reflect overriding substrate or aquatic conditions.
L3 – Formation	Combinations of dominant and diagnostic growth forms that reflect global macroclimatic factors as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions.
Middle: Both floristics and physiognomy play a significant role.	
L4 – Division	Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant taxa that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.
L5 – Macrogroup	Combinations of moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.
L6 – Group	Combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect biogeographic differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes
Lower: Floristics plays a predominant role**.**	
L7 – Alliance	Diagnostic species, including some from the dominant growth form or layer, and moderately similar composition that reflect regional to subregional climate substrates, hydrology, moisture/nutrient factors, and disturbance regimes.
L8 – Association	Diagnostic species, usually from multiple growth forms or layers, and more narrowly similar composition that reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes.

2.2 CULTURAL VEGETATION

2.2.1 Overview of the Cultural Vegetation Hierarchy

The cultural vegetation hierarchy consists of eight levels, organized into four upper, two mid, and two lower level units (Table 2.5). As noted in section 2.0 above, the basis for this hierarchy is substantially revised from the FGDC 1997 hierarchy, as illustrated in Table 2.1, particularly in that levels and requirements for cultural vegetation are now defined separately from the natural vegetation levels (see 2.1 above). See Faber-Langendoen et al. (2007) for further details on the rationale behind these changes.

2.2.2 Criteria for Classification of Cultural Vegetation

Floristic and physiognomic criteria are the primary properties of cultural vegetation used to define all units of the classification, but assessed in light of human activities that govern these properties. Thus, choice of how these criteria are used should be evaluated in light of human management needs. Excluded from these criteria are properties from outside the current vegetation, such as explicit habitat factors (e.g., climate, soil type) or land use activities (e.g., grazed pasture versus ungrazed pasture), except as these are expressed in the vegetation cover. Some types are difficult to place in terms of natural versus cultural vegetation (e.g., forest plantation, pastures), and the user may need to look in both parts of the hierarchy to determine the type's location. The broad criteria for classifying cultural vegetation may be summarized as follows:

A. Growth form criteria

1. Diagnostic patterns of growth forms
2. Ecologic and managed patterns of growth forms
    - Growth forms of similar management significance (e.g., crop types)
    - Growth forms of similar ecology and habitat
3. Vertical stratification (layering) of growth forms

B. Floristic (crop or managed species) criteria

1. Diagnostic combinations of species/crop or managed types

Table 2.5. Hierarchy for Cultural Vegetation with Examples. A fuller set of examples of vegetation types for each of these levels is provided in Appendix I.

Hierarchy for Culturall Vegetation	Example	Example
Upper		
Level 1 – Cultural Class	Agricultural Vegetation	Agricultural Vegetation
Level 2 – Cultural Subclass	Herbaceous Agricultural Vegetation	Woody Agricultural Vegetation
Level 3 – Cultural Formation	Cultivated Crop	Woody Horticultural Crop
Level 4 – Cultural Subformation	Row Crop	Orchard
Mid		
Level 5 – Cultural Group [optional]	*Temperate and Tropical Row Crop*	*Temperate and Tropical Orchard*
Level 6 – Cultural Subgroup	Corn	Fruit - Orchards
Lower		
Level 7 – Cultural Type	Sweet Corn	Apple
Level 8 – Cultural Subtype [optional]		

2. Ecologic and managed combinations of species/crop or managed types
    - Species of similar management significance (e.g., crop types)
    - Species of similar ecology and habitat
3. Vertical stratification (layering) of species

All type concepts based on these criteria should be derived from field observations, in which the crop or managed species, growth forms, and their abundance, along with the field observation record, overall vegetation structure, and habitat setting are described. These field data provide the fundamental information for the description of types. All types at all levels should be described and characterized. Initially, the new upper and mid levels may have only brief characterizations, but shall be elaborated over time.

2.2.3 Definitions of Cultural Vegetation Hierarchy Levels

The cultural vegetation hierarchy consists of eight levels (see Table 2.5). These levels are different from the natural vegetation hierarchy, by providing an additional physiognomic level (level 4), placing less emphasis on broad-scale, biogeographic and climate patterns, but still providing for multiple scales of floristically and physiognomically defined agricultural and developed vegetation types.

Upper level (physiognomic-ecological) units:

a. **Cultural Class:** A cultural vegetation classification unit of high rank (1st level) defined by a characteristic combination of *dominant growth forms* adapted to *relatively intensive human manipulations, as reflected in relatively rapid changes in structure and/or composition.*

b. Cultural Subclass: A cultural vegetation classification unit of high rank (2nd level) defined by combinations and degree of *herbaceous* versus woody *growth forms.*

c. Cultural Formation: A cultural vegetation classification unit of high rank (3rd level) defined by whether or not *canopy structure* of dominant growth forms is *annually converted* or *heavily manipulated / harvested.*

d. Cultural Subformation: A vegetation classification unit of intermediate rank (4th level) defined by the *spatial structure* of the vegetation, including whether in *swards, rows,* and degree of *manipulation to the canopy*.

Mid-level (physiognomic-floristic) units:

e. Cultural Group: A cultural vegetation classification unit of intermediate rank (5th level) defined by a *common set of growth forms* and *many diagnostic plant taxa* sharing a broadly similar *region* and *climate,* and *disturbance factors.*

f. Cultural SubGroup: A cultural vegetation classification unit of intermediate rank (6th level) defined by a *common set of growth forms* and *diagnostic species* (taxa) preferentially sharing a similar set of *regional edaphic, topographic,* and *disturbance factors.*

Lower-level (floristic) units:

g. Cultural Type: A vegetation classification unit, of moderately low rank (7th level) defined by one or more *dominant or co-dominant species,* as well as *habitat conditions,* and *physiognomy.*

h. Cultural Subtype: A vegetation classification unit, of low rank (8th level) defined on the basis one or more *dominant or co-dominant species,* in conjunction with a *characteristic set of associated species, habitat conditions and physiognomy*.

2.2.4 Criteria for Cultural Vegetation Hierarchy Levels

The cultural vegetation hierarchy is based on a combination of growth forms, dominant species and associated species. These are species and growth forms that exhibit patterns of relative constancy or dominance that differentiate one type from another. Emphasis is placed on dominant growth forms at upper levels, on dominant species and dominant growth forms at intermediate levels, and on a combination of dominant and associated species at lower floristic levels, in combination with specific physiognomic and habitat conditions. Cultural vegetation encompasses a broad range and scale of types (agricultural fields, orchards, lawns) and, as with natural vegetation, attempts to coin universal definitions and criteria at the outset that are valid for each level will be challenging. For each vegetation type, the diagnostic criteria used to define the unit should be clearly stated, and the range of variation in composition, habitat, and physiognomy and structure should be clearly described, including similarity with other related types. Cultural vegetation types already in use by the agricultural community should be preferentially used (see Appendix I). A comparison with some European approaches to some kinds of cultural vegetation (such as pastures and lawns) is provided in Appendix J.

For the purposes of this Standard, the various kinds of diagnostic growth forms and species are defined as follows:

Dominant Growth Form — a growth form with a high percent cover, usually in the uppermost dominant layer

Indicator Growth Form — a growth form whose presence, abundance, or vigor is considered to indicate certain climatic, site and/or cultural conditions.

Dominant Species — species with a high percent of cover, usually in the uppermost dominant layer (in other contexts dominant species can be defined in terms of biomass, density, height, coverage, etc. (Kimmins 1997).

Indicator Species— a species whose presence, abundance, or vigor is considered to indicate certain climate, site and/or cultural conditions (adapted from Gabriel and Talbot 1984).

Diagnostics:

Diagnostic criteria used to define the units should be clearly stated, and the range of variation in composition, habitat, and physiognomy and structure should be clearly described, including similarity with other related types.

Existing vegetation:

All vegetation units are categories of existing, or actual, vegetation (i.e., the plant species present and the vegetation structure found at a given location at the time of observation).

Classification hierarchy:

All units recognized within the cultural vegetation part of the NVC shall be defined so as to uniquely subdivide or nest within other categories of the recognized hierarchy.

3. Description and Classification of Natural Vegetation

This section describes the process standard for updating and revising the dynamic content of the NVC. Standards for field plot data and other data sources are described next, in Section 3.1. Conventions for defining, naming, and describing vegetation types are provided in Section 3.2. The process for peer review of proposals to change the names or concepts of vegetation types is described in Section 3.3. Finally, the component databases and the technical structure of the NVC information system are described in Section 3.4. The content of each of these sections is in outline format for practical application and referencing.

3.1 Data Sources

Vegetation types may be based on two sources of data: field plot data and scientific literature. Plot data are preferred, but literature may be used to expedite the development of the NVC. Eventually, all NVC vegetation types should be based on, and linked to, publicly available plot data. In the meantime, confidence levels are used to evaluate the quality of documentation for each vegetation type (see Section 3.3.1). A fundamental goal of the NVC is to have all vegetation types described from quantitative analysis of field plot data.

3.1.1 Collecting Field Plot Data

The capability to describe vegetation types from quantitative and repeatable measurements depends largely on field data that are collected and archived in a consistent manner and are publicly available. This section describes the types of information that shall be collected in the field. It addresses: selecting vegetation stands for sampling, plot design, recording species composition and site conditions, the geographic information required, and the types of metadata that shall be provided by field workers for each plot record. The focus here is on plot information that is complete enough to serve as *classification plots*; that is, plots which contribute to classification analyses that help define vegetation types. Less information is required from plots that are gathered only for the purpose of documenting the occurrence of a previously defined vegetation type. These plots are referred to as *occurrence plots*. All of the required data fields are listed and defined in Appendix D.

1. *Stand selection and plot design*:
   A stand of vegetation may be selected by a variety of methods and the criteria used to select stands should be thoroughly documented. Each plot should represent one relatively homogeneous stand of vegetation in the field. A plot shall be large enough to represent the stand in terms of total species composition and abundance. A plot may be either a single large comprehensively sampled plot (macroplot), or a set of subsampled areas (microplots) within a larger plot.

2. *Species composition of the plot*:
Species composition is required for defining units in Levels 4 – 8 of the hierarchy. The floristic composition of a plot consists of both the identity and the abundance of the genera, species, and finer taxa. The actual identity of a plant taxon can be somewhat complicated since it consists of (a) a name, and (b) a dated taxonomic reference (for example, the flora or manual used to identify the plant) or an explicit statement that the reference is unknown.

    a. For classification plots, sampling should be designed to detect and record the complete assemblage of vascular plant species in the stand. Recording of nonvascular species is expected in vegetation where nonvascular species are dominant. Only one field visit at an appropriate time of year is required, though additional visits can improve plot quality and are recommended for vegetation types with marked phenological variation.

    b. For classification plots, cover is the required measure of species abundance. Measurement of canopy cover, as opposed to foliar cover, is recommended. If cover values are in discrete categories rather than continuous, the cover scales should be defined quantitatively and able to nest within the Braun-Blanquet cover-abundance scale classes (Table 3.1).

    c. For occurrence plots, the minimum requirements are: names of the dominant taxa (name plus taxonomic reference if available), their cover values (or another suitable measure of abundance), geographic coordinates, date of observation, and name(s) of those who made the observation. Examples of other suitable measures of abundance include, for trees, basal area, density, or some index based on the two; for forbs and graminoids, air dried weight or measures of biomass. If such measures are used to estimate cover, the methods used for this conversion, including appropriate calibration techniques, should be thoroughly documented.

    d. The term species is used here to indicate the fundamental orientation of the plot sampling approach – that of a species-based approach. But it may include species, subspecies, or varieties. If it is not possible to recognize these in the field at the time of sampling, it may include either higher units such as genera or family, or ad hoc units (i.e., "Carex fuzzy red base") that aid in later identification and recording.

    For each species listed in a plot, assign each to a stratum (see Table 3.3) or growth form (see Table 3.2), with a separate cover estimate for its abundance in each of these strata or growth forms. When using strata, epiphytes and lianas are listed in the strata in which they occur. At a minimum, total cover of a species in the plot is required, though this may be calculated based on the stratum cover values.

3. *Vertical structure and physiognomy of the plot*:

To describe the structure and physiognomy of vegetation, record the canopy cover of major growth forms (Table 3.2) and strata or layers (Table 3.3, Figure 3.1). Two approaches are acceptable 1) growth forms may be described first, then subdivided into size classes (or layers), or 2) strata may be described first, then subdivided by growth forms. Either approach provides sufficient information on the dominant and diagnostic growth forms and their structure to place types into the upper levels (levels 1 – 3) of the hierarchy. Where species data are not collected, the information represents the minimum required information for describing the units in these upper levels. See Tables 3.2 and 3.3 for examples of both approaches. It is also possible to approximately convert the data from one approach to the other as shown in Tables 3.4 and Appendix I (see also Jennings et al. 2006).

a. Each plant is assigned to a stratum based on its height, and secondarily by its growth form. Consequently, a tree *species* that has both seedlings and saplings in a plot could be listed in several strata. However, an *individual* plant shall be assigned only to one stratum.

b. Provide the prevailing height of the top and the base of each stratum.

c. The cover of the stratum is the total vertical projection on the ground of the canopy cover of all species collectively, not the sum of the individual covers of all species in the stratum. The total cover of the stratum will, therefore, never exceed 100% (whereas, adding up the individual cover of species within the stratum could well exceed 100% since species may overlap in their cover). Foliar cover is also acceptable.

d. The percent cover of at least the three most abundant growth forms in the dominant or uppermost stratum should also be estimated (see Appendix E for a list of growth forms).

e. Bryophytes (including liverworts) and lichens growing on the same ground substrate as vascular plants are treated as part of the nonvascular strata.

f. When assessing total cover of each stratum, an epiphyte or liana should be included in the stratum where it occurs.

g. The nonvascular stratum (sometimes called ground, bryoid, or moss stratum) is reserved strictly for cryptogams (mosses, lichens, liverworts, algae and bacteria), even where herbs or woody plants may be reduced to very short heights.

Table 3.1. Comparison of Commonly Used Cover-Abundance Scales.

Agencies and authors are abbreviated as: BB=Braun-Blanquet (1928); NC=North Carolina Vegetation Survey (Peet et al. 1998); K=Domin sensu Krajina (1933); DAUB=Daubenmire (1959); FS (Db)=Forest Service, modified Daubenmire (1959) scale; PA=Pfister and Arno (1980); NZ=New Zealand LandCare (Allen 1992, Hall 1992); BDS=Barkman et al. (1964); D=Domin (1928); FS (eco) = Jensen et al. (1994), U.S. Forest Service ECODATA software. Break points shown in the Cover-abundance column reflect the major break points of the Braun-Blanquet scale, which is considered the minimum standard for cover classes. Among the available cover class systems, the NC and K cover class systems can be unambiguously collapsed to the B-B standard, and the D, DAUB, FS, PA and NZ scales are for all practical purposes collapsible into the B-B scale without damage to data integrity. The BDS is discordant with the B-B standard and should be avoided except when required for incorporation of legacy data.

Cover-abundance	BB	NC	K	DAUB	FS(Db)	PA	NZ	BDS	D	FS(eco
Present but not in pl	( )†					+				
Single individual	r	1	+	1	T	T	1	-	+	1
Sporadic or few	+	1	1	1	T	T	1	-	1	1
0 - 1%	1‡	2	2	1	T	T	1	-	2	1
1 - 2%	1	3	3	1	1	1	2	-	3	3
2 - 3%	1	4	3	1	1	1	2	0	3	3
3 - 5%	1	4	3	1	1	1	2	0	4	3
5 - 6.25%	2	5	4	2	2	2	3	1	4	10
6.25 – 10%	2	5	4	2	2	2	3	1	4	10
10 – 12.5%	2	6	5	2	2	2	3	1	5	10
12.5 – 15%	2	6	5	2	2	2	3	1	5	10
15 – 25%	2	6	5	2	2	2	3	2	5	20
25 – 30%	3	7	6	3	3	3	4	3	6	30
30 – 33%	3	7	6	3	3	3	4	3	6	30
33 – 35%	3	7	7	3	3	3	4	3	7	30
35 – 45%	3	7	7	3	3	3	4	4	7	40
45 – 50%	3	7	7	3	3	3	4	5	7	50
50 – 55%	4	8	8	4	4	4	5	5	8	50
55 – 65%	4	8	8	4	4	4	5	6	8	60
65 – 75%	4	8	8	4	4	4	5	7	8	70
75 – 85%	5	9	9	5	5	5	6	8	9	80
85 – 90%	5	9	9	5	5	5	6	9	9	90
90 – 95%	5	9	9	5	5	5	6	9	10	90
95 – 100%	5	10	10	6	6	6	6	10	10	98

† Species present in the stand but not in the plot are usually added in parentheses to the species list.

‡ This is a cover/abundance scale; if numerous individuals of a taxon collectively contribute less than 5% cover, then the taxon can be assigned a value of 1 or, if very sparse, a "+."

Table 3.2. Example of describing growth forms first, then subdividing into size classes USFS Protocol (Tart et al. 2005b). For definitions of optional size classes see Tart et al. (2005b).

General Growth Form	Required Size Classes	Optional Size Classes
Trees: *Woody plants that generally have a single main stem and have more or less definite crowns.* In instances where growth form cannot be determined, woody plants equal to or greater than 5 meters in height at maturity shall be considered trees	**Overstory**: Trees at least 5 meters in height that make up the forest canopy or dwarf trees* that have attained at least half of their (site-specific) potential height growth and make up the forest canopy	Supercanopy Main Canopy Subcanopy
	Regeneration: Trees less than 5 meters in height or dwarf trees* that have attained less than half of their (site-specific) potential height growth and are clearly overtopped by the overstory layer.	Sapling Seedling Established Non-Established
Shrubs: *Woody plants … that generally exhibit several erect, spreading, or prostrate stems which give it a bushy appearance*. In instances where growth form cannot be determined, woody plant less than 5 meters in height at maturity shall be considered shrubs.		Tall Shrubs Medium Shrubs Low Shrubs
Herbs: "V*ascular plants without significant woody tissue above the ground, with perennating buds borne at or below the ground surface.*" Includes graminoids, forbs, ferns, club mosses, horsetails, and quillworts.		Additional recommended growth forms: Graminoid Forb
Nonvascular: *A plant or plant-like organism without specialized water or fluid conductive tissue (xylem and phloem).* Includes mosses, liverworts, hornworts, lichens, and algae). Also called thallophytes or "nonvascular cryptogams," (that is, excluding the fern cryptogams)		Additional recommended growth forms: Moss Lichen
Floating: *Rooted or drifting plants that float on the water surface* (e.g., duckweed, water-lily).		
Submerged: *Rooted or drifting plants that by-and-large remain submerged in the water column or on the aquatic bottom* (e.g., sea grass).		
Epiphyte** *A vascular or nonvascular plant that grows by germinating and rooting on other plants or other perched structures, and does not root in the ground.*		
Liana:** *A woody, climbing plant that begins life as terrestrial seedlings but relies on external structural support for height growth during some part of its life* (Gerwing 2004), *typically exceeding 5 m in height or length at maturity.*		

*Dwarf trees are defined as trees that are typically less than 12 meters tall at maturity due to genetic and/or environmental constraints (e.g., pinyon pines, junipers, and mountain mahogany).
**Epiphyte and liana growth forms are subdivided by the size classes in which they occur (e.g., tree overstory, regeneration, shrub).

Table 3.3. Example of describing strata first, then subdividing by growth forms (ESA Guidelines - Jennings et al. 2006).

Stratum	Definition	Possible General Growth Forms in Stratum
Tree Stratum	*The layer of vegetation where woody plants are typically more than 5 m in height, including mature trees, shrubs over 5 m tall, and lianas.* Epiphytes growing on these woody plants are also included in this stratum.	Tree (overstory), Shrub*, Liana, Epiphyte
Shrub Stratum	*The layer of vegetation where woody plants are typically more than 0.5 m tall but less than 5 m in height, such as shrubs, tree saplings, and lianas. Epiphytes may also be present in this stratum.* Rooted herbs are excluded even if they are over 0.5 m in height, as their stems often die back annually and do not provide a consistent structure.	Tree (sapling), Shrub, Liana, Epiphyte
Field (Herb) Stratum	*The layer of vegetation consisting of herbs, regardless of height, as well as woody plants less than 0.5 m in height.*	Herb, Dwarf-shrub**, Tree (seedling***)
Nonvascular Stratum (Ground)	*The layer of vegetation consisting of non-vascular plants growing on soil or rock surfaces*. This includes mosses, liverworts, hornworts, lichens, and algae. Sometimes called "moss stratum."	Nonvascular
Floating Stratum	*The layer of vegetation consisting of rooted or drifting plants that float on the water surface* (e.g., duckweed, water-lily).	Floating
Submerged Stratum	*The layer of vegetation consisting of rooted or drifting plants that by-and-large remain submerged in the water column or on the aquatic bottom (e.g., sea grass).* Emergent plant growth forms are excluded (e.g., alder shrubs would be placed in the shrub stratum, cattails in the herb stratum).	Submerged

*Very tall shrubs are sometimes included in the tree stratum.
**can also include seedlings of shrubs, i.e. all shrubs less than <0.5 m.
*** tree seedlings are often defined as up to 1.4 m height or as < 2.5 cm dbh by many forest survey methods, in which case they span the shrub and herb strata.

Figure 3.1. An illustration of strata showing growth forms of individual plants as may be found in a plot (the field stratum is not delineated). Height is shown in meters. The field stratum is between 0 and 0.5 m; the shrub stratum is from 0.5 to 3 m; and the tree stratum extends from 3 m (bottom of canopy) to 12 m (top of canopy), with the bulk of the canopy clearly exceeding 5 m . Assignment of individual plants to a stratum is based on height and growth form as follows: A. A plant having an herbaceous growth form. Although projecting vertically into the shrub stratum it is excluded from being recorded as part of the shrub stratum canopy cover since its stems die and regrow each year. B. A plant having a dwarf shrub growth form is recorded as part of the field stratum. If desired, a separate dwarf-shrub substratum may be recognized. C. A moss; recorded as part of the nonvascular stratum. D. A plant having a tree growth form but at a sapling stage of life. This individual is recorded as part of the shrub stratum canopy. E. A plant having a tree growth form but at a seedling stage of life. This plant is recorded as part of the field stratum canopy. F. Mature trees, recorded as part of the tree stratum. G. A sapling, as in D. H. A plant having a shrub growth form; recorded as part of the shrub stratum canopy cover. I. A plant having an herb growth form and projecting into the shrub stratum; excluded from being recorded as part of the shrub stratum canopy (as in A).

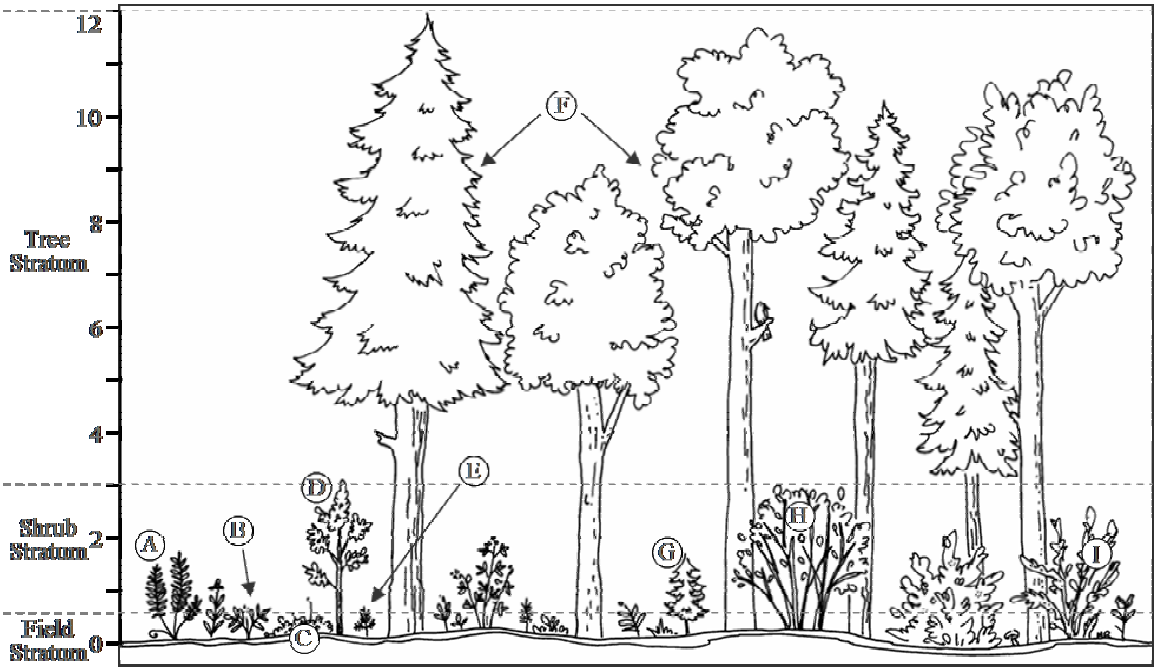


TABLE 3.4. A crosswalk of strata categories (left column) (from Table 3.3) **with common growth form and size class categories** (all other columns) (from Table 3.2). Size classes in italics are optional for overall characterization of vegetation structure and physiognomy.

Stratum	**Growth Form**							
	Tree			Shrub			Herb	Non-vascular
	Size Classes:			Size Classes:				
	Regeneration		Over-story	*Tall Shrub*	*Medium Shrub*	Low Shrub		
	Seedling	*Sapling*						
Tree Stratum			x	(x)				
Shrub Stratum	x	x		x	x			
Field (Herb) Stratum	x					x	x	
Nonvascular Stratum Ground)								x
Floating Stratum							x	
Submerged Stratum							x	x

x – Indicates the most common combination of growth form layer and stratum.
(x) – Indicates an occasional combination of growth form layer and stratum.

4. *Physical data of the plot*:

The physical variables relevant to any interpretation of plot data vary widely across the range of vegetation types. It is, therefore, difficult to require any absolute minimum set of specific environmental criteria. Rather, we provide a set of environmental variables that should be given serious consideration in any vegetation survey, most especially for classification plots. The following site variables should be considered for use describing the environment of the type:

   a. Physical features of the stand, including elevation (in m), slope aspect (in azimuth degrees of 0 to 360), and slope gradient (in degrees or percent), topographic position, landform, and geologic parent material.

   b. Soil and water features, including soil moisture, drainage, hydrology, depth of water, and water salinity (where appropriate).

   c. The soil surface cover of litter, rock, bare ground, coarse woody debris, live vascular stem, nonvascular species on the soil surface, surface water, or other important surface features.

   d. General vegetation conditions, including landscape context, homogeneity of the vegetation, phenological phase at the time of observation, stand maturity, successional status, and evidence of disturbance.

5. *Geographic data for plots:*

Information on the location of a plot is vitally important and should be carefully recorded in a standard format. For historical, or "legacy", data where the geographic information may have been recorded in different formats and measurements, the original information shall be preserved and the methods used to transform this information should be described and reproducible. Additional details can be found in Appendix D. The standard requires the following data when recording geographic information for field plots:

   a. Latitude and longitude in decimal degrees and WGS 84 (NAD83) datum. Record the coordinates that were collected in the field and the datum used. If a nonstandard projection was used, then record the projection name, spatial units (decimal degrees, meters, etc.), size of the spheroid, central meridian, latitude of projection's origin, and any other vital parameters such as false easting and false northing.

   b. Description of the method used to determine the plot location (e.g., estimated from a USGS 7.5 minute quadrangle, GPS, etc.). For example: (a) collected in the field with a geographic positioning system (this shall include the datum used, or specify if a nonstandard projection) or (b) through a narrative that describes how the plot location was determined, and the means of locating the plot centroid (e.g., the plot location was estimated from the USGS Assateague Park 7.5' map quadrangle; the centroid for locating the plot is the geographic center of Assateague Park).

c. An estimate of the accuracy of the plot's location information in the form of the radius in meters, preferably for a 95% certainty.

d. Narrative information useful for plot relocation.

6. *Metadata for plots:*

Careful attention to recording metadata for each plot record is essential to maximizing the long term utility of the record. Because many type descriptions will necessarily be derived from a variety of plot sources, it is the plot metadata that facilitate searching for and identifying useful records. All plots should have a project name and description associated with them, the methods used to select and lay out the plots, the level of effort expended in gathering floristic data, cover scale and strata types used, and the name and contact information of the lead field investigators. See Appendix D for detailed criteria. The requirements are:

a. An author plot code

b. An author observation code (if there are multiple observations of a plot over time).

c. Observation date and date accuracy.

d. Lead field investigator's name

e. Plot selection approach.

f. Plot characteristics including:

i. Plot area in m^2.

ii. Plot type, indicating if vegetation data were recorded in the entire plot or using subplots in a specified configuration.

iii. If subplots are used then specify the species (taxon) observation area in terms of size and total area of subplots (e.g., a plot may be 100 m^2, but if 10 1 m^2 subplots are used then the taxon observation area is 10 m^2).

iv. Subplot distribution (if subplots are used, how they are distributed).

g. Description of cover or other abundance method for species composition, growth form, or strata.

3.1.2 Use of Literature and Other Data Sources

Plot data are not always available, or are available in limited numbers. In some cases, published literature and other documentation may be used as a data source to describe the vegetation type.

1. Literature-based Data Sources.

At times, the source of data for a type description may come from the literature There are several scenarios for using this kind of data:

a. The literature may describe a type that is now either no longer extant or no longer available to be described across its historic range. The literature may be incomplete, but to be useful it should contain sufficient information to form the basis for a type description.

b. The literature may summarize a type in a region where the NVC is weakly developed, and the literature adds information not otherwise available to the NVC. Or, it may be a range-wide description of types that have not previously been analyzed to this extent, and the analysis is strong. Use of this type of information should accompany an estimate of the confidence the user places in it as discussed in Section 3.3.1

2. Table-based Data Sources

At times, the original plot data themselves may not be readily available, but the data have been carefully summarized in a tabular description (synthesis or synoptic table, typically showing the list of species, their constancy and average cover across all plots). As long as the original data meet minimum standards (preferably they are stored in accessible distributed databases), the summarized data may be used as the basis for describing a type. Subsequent classification and description of types may even be based on these data, as the use of synthesis tables can greatly increase the speed of analysis, and allows the original interpretation of the plots and types to be part of the analysis. In addition, this approach has value where the intent of an analysis is to retain direct crosswalk links to a state or provincial set of types, where the synthesis tables are a summary of those types. The use of synthesis tables may also have value when a plot-based description has been developed, and an investigator wants to compare the type to other related types. Synthesis tables should be used cautiously because they may combine plots that are part of two types. Synthesis tables can help with broader comparisons among types, but individual plot data are the best data source for resolving classification issues among types.

3.2 Classification and Description

The most fundamental unit of information for describing and classifying vegetation types is the field plot. The quality and extent of the field plot data affect the overall confidence in the concept of the type. Literature and other data sources, as described in Section 3.1.2, may also be used, but these provide less confidence in the type description). Factors affecting the "classification confidence" of the type include: a) type of analyses used, b) degree of publicly accessible data, c) quality of the plot data, d) geographical scope of analysis, relevance to the type being analyzed, e) effort made to compare the type with closely related types (see also 3.3.1 below). The description of a vegetation type is a synthesis of data from many plots, possibly from many data sets, through what is termed here "classification analysis." This section summarizes the essential steps needed for data preparation, classification analysis, and interpretation of a proposed vegetation type, naming conventions for new types, and criteria for describing types.

Those using the Standard only to crosswalk their plots to an existing set of NVC types, may find it helpful to collect plot data according to the standards in Section 3.1.1, then use any available descriptions and keys of NVC types to assign their plots to a type. Those using the Standard to crosswalk their own type descriptions to NVC types may find it helpful to prepare their descriptions using the standard provided in Section 3.2.3 below, before comparing their descriptions to any available descriptions of NVC types. Neither of these practices is required and they are not intended to replace agency methods designed to meet their specific business needs.

3.2.1 Data preparation

When preparing plot data for classification analysis one should:

a. Ensure that the plots used sufficiently sample the biotic and abiotic range of the study area.

b. Ensure a unique and standardized identity for each plant taxon in the data set.

3.2.2 Classification Analysis and Interpretation

A variety of numerical methods are available for classification analysis, including direct gradient analysis, ordination, and clustering (Gauch 1982, Kent and Coker 1992). No single methodological formula is suitable for all possible analyses. It is therefore incumbent on those proposing new or modified types to apply contemporary methods of vegetation classification for implementing a sound statistical approach, and to explain clearly the rationale for the approach used. The general components of a classification analysis are described below:

a. The plots records used shall be clearly referenced and accessible by others.

b. An outlier analysis of the initial set of plots should be provided and the criteria used for identification and elimination of outlier plot records should be provided.

c. Show that there is sufficient redundancy in plot composition to identify a threshold of significant pattern in compositional variation. That is, that the data set has the statistical power needed to be convincing. One example would be to explore a null hypothesis that a given collection of plots is more self-similar than would be expected of a random collection of plots.

d. An exact description of the analysis procedure should be provided, including careful documentation of assumptions and limitations of the data, methods of dimensional reduction, and value transformations.

e. Results should be presented in tabular and graphical formats as well as narrative.

f. Criteria used to identify diagnostic species, such as constancy and fidelity should be specified for mid and lower levels.

g. Criteria used to identify diagnostic growth forms and other physiognomic features, particularly for upper levels, should be specified.

h. A tabular summary of diagnostic and constant species should be provided, where appropriate.

3.2.3 Description of Vegetation Types

Formal description of a vegetation type requires that each of the following items be addressed. The required topical sections for describing vegetation types are also shown in Table 3.5 and a worked example is provided in Appendix F.

Type Description Sections:

a. Name. Develop a scientific name for the vegetation type using the nomenclatural standards in the nomenclature section. A colloquial name may also be provided.

b. Hierarchy Level. A description shall indicate the hierarchical level of the vegetation type being described.

c. Placement in Hierarchy. Indicate the full name of the vegetation type under which the type shall be placed, based on the most current list of NVC types available.

d. Classification Comments. Describe any classification issues relating to the definition or concept of the type.

e. Classification Rationale. Describe basis for choosing the nominal taxa or physiognomic criteria (the species or growth forms by which the type is named). For mid and lower units, explain the choice of nominal species

and growth forms; for example, whether species are dominant, character, or indicator.

f. Type Concept. Provide a concise paragraph describing the overall concept of the type based on the structure, composition, environmental setting, and geographic range. (See items g through l below.)

g. Floristics (for mid and lower units). Species composition and average cover for species should be provided in the following summary form:

   i. A table of floristic composition showing constancy and mean cover. All species should be listed that have more than 20% constancy, and diagnostic species should be identified. List species in descending order of constancy, then cover.

   ii. Compositional variability of the type across the range of its classification plots. A discussion of possible subunits or variants may be useful, especially for future refinement of type concepts.

h. Taxonomic usage in floristic tables should include reference to a taxonomic standard so as to define the meaning associated with a name. Reference to accepted name in USDA PLANTS or ITIS, coupled with the specific date of observation of the website, is sufficient.

i. Physiognomy. Provide a summary of the physiognomy, structure, and dominant species, including an assessment of the physiognomic variability of the type.

j. Dynamics. To the degree possible, provide a summary of the successional status of the type and the disturbance factors that influence stability and within-plot variation for the type. Describe the extent to which this information is known and the limitations and assumptions of the assessment.

k. Environmental description. Provide a description of important factors such as climate, elevation (in meters), landscape context, slope aspect, slope gradient, geology, soils, hydrology, and any other environmental factors thought to be determinants of the biological composition or structure of the type.

l. Description of the range. To the extent possible, provide a brief textual description (not a list of places) of the total range (present and historic) of the type. List national and subnational (states, provinces, or counties) jurisdictions of occurrence across the entire range of the type. Distinguish between areas where the type: (a) definitely occurs; (b) probably occurs; or (c) does not occur and is believed to have historically occurred.

m. Identify field plots. Identify plots used to define the type and indicate where the plot data are archived and the associated plot identifiers. All plot records used shall conform to the standards for classification plots.

Identify any occurrence plots that may have been used to help describe the geographic range or other characteristics of the type.

Table 3.5. Required topical sections for monographic description of vegetation types.

OVERVIEW
- Proposed names of the type (scientific, common, colloquial).
- Hierarchical level of the vegetation type.
- Placement in hierarchy.
- A brief description of the overall type concept.
- Classification comments.
- Rationale for nominal species or physiognomic features.

VEGETATION
- Physiognomy and structure.
- Floristics.
- Dynamics.

ENVIRONMENT
- Environment description.

DISTRIBUTION
- A description of the range/distribution.
- A list of U.S. states and Canadian provinces where the type occurs or may occur.
- A list of any nations outside the U.S. and Canada where the type occurs or may occur.

PLOT SAMPLING AND ANALYSIS
- Plots used to define the type.
- Location of archived plot data.
- Factors affecting data consistency.
- The number and size of plots.
- Methods used to analyze field data and identify the type.
    a. Details of the methods used to analyze field data.
    b. Criteria for defining the type.

CONFIDENCE LEVEL
- Overall confidence level for the type (see Section 4).

CITATIONS
- Synonymy
- Full citations for any sources
- Author of Description

DISCUSSION
- Possible sub-association or -alliance types or variants, if appropriate, should be discussed here along with other narrative information.

Supporting Documentation Sections:

a. Plot data quality. Describe all factors that affect plot data adequacy and quality, including such factors as incomplete sampling throughout the range or poor quality of floristic information.

b. The number and size of plots. Justify the number of and sizes of plots used in terms of the floristic variability and geographic distribution.

c. Methods used to analyze and interpret field data. Discuss the analytical methods used by the author of the type description to define the types. Include software citations.

d. Overall confidence level for the type. Recommend a level of confidence of high, moderate, or low, based on criteria described in Section 3.3.1. The peer-review process shall ultimately establish the formal confidence level (see Section 3.3.1) for a given type.

e. Citations. Provide complete citations for all references used in the above section.

f. Vegetation type synonymy. List any names already in use in the NVC or other classifications to describe this or closely related types, either in whole or in part. Where possible, include comments or explanations on the relatedness of the type to other types that are adjacent in the classification. For example, is a type listed as being synonymous, broader in concept, more narrow, or equal to the type concept being proposed?

3.2.4 Naming of Mid and Lower Level Vegetation Types

The nomenclature of vegetation types is not to be confused with the nomenclature of plant taxa, even though species names are used in the names of associations and alliances. To be accepted, a name shall address the following criteria:

a. Community nomenclature shall contain both scientific and English common names, e.g., *Pinus taeda* - *Quercus* (*alba, falcata, stellata*) Forest Alliance as well as Loblolly Pine - (White Oak, Southern Red Oak, Post Oak) Forest Alliance. If desirable, common names may also be provided in French and Spanish. A colloquial name, e.g., Ozark Dolomite Glade, may also be provided. The relevant dominant and diagnostic species that are useful in naming a type should be selected from the tabular summaries of the types. Dominant and diagnostic species should include at least one from the dominant stratum (layer) of the type.

b. Nomenclature for vascular plant taxa used in scientific type names should follow the accepted name in USDA PLANTS or ITIS except when this would prevent the recognition of ecologically distinct types, coupled with the specific date of observation of the website. Exceptions should be documented in the rationale for choosing nominal taxa (see item 3e above).

Each plant taxon used in a scientific name shall have only one common name that shall form the basis for the common name of types. (e.g. aspen, not quaking aspen or trembling aspen)

c. For alliance and mid-level unit names, taxa from subordinate layers should be used sparingly.

d. Among the taxa that are chosen to name the type, those occurring in the same stratum or growth form (tree, shrub, herb, nonvascular, floating, submerged) are separated by a hyphen (-), and those occurring in different strata are separated by a slash (/). Diagnostic taxa occurring in the uppermost stratum are listed first, followed successively by those in lower strata. The order of taxon names within stratum or growth form generally reflects decreasing levels of dominance, constancy, or other measures of diagnostic value.

e. Association or alliance names include the name of the level of the hierarchy that the unit is placed in, e.g., (e.g., *Pinus ponderosa* Forest alliance).

f. In cases where diagnostic taxa are unknown or in question, a more general term is currently allowed as a "placeholder" (e.g., *Cephalanthus occidentalis / Carex* spp. Northern shrubland). Associations and alliances with placeholders in the name shall not be considered of high or moderate confidence. Minimize the use of placeholders.

g. The least possible number of taxa is used in a name. Up to five species may be necessary to define associations in some regions that contain very diverse vegetation with relatively even dominance and variable total composition. For alliances and other levels, no more than three species shall be used.

Nomenclatural rules shall be followed exactly to avoid creating the appearance of distinct names that are based on differences in character spacing, punctuation or spelling.

3.2.5 Naming of Upper Level Vegetation Types

Formation types at Levels 1 -3 are named, defined and organized by structure and physiognomy, as these are reflected in broad climatic and site factors. It is a convenient aid to naming the formations to use terms based on the habitats that they occupy (though it should be re-emphasized that habitat factors are not typically used in defining the Formation(s) (Whitmore 1984, pg. 155). The result is a set of easily recognized formations with memorable names that say something about the most distinctive associated ecological characteristics of the formation. These names serve as both common and scientific names.

Level 1 (Formation class)

Class names are based on the very broad growth forms that correspond to global moisture/temperature regimes. The single name helps identify the broad grouping of growth forms that correspond to particular moisture/temperature conditions. A parenthetical set of names is included to guide general users to the main kind of vegetation included in the class. The level is organized by decreasing complexity and cover of the vegetation, reflecting increasingly stressful site factors. Given the wide overlap in use of the terms "Forest" and "Woodland" we use both terms to indicate that the class definition encompasses all mesomorphic (i.e. broad-leaved or needle-leaved) trees of varying height and canopy spacing.

Examples:

Mesomorphic Tree Vegetation (Forest & Woodland)
Mesomorphic Shrub & Herb Vegetation (Shrubland & Grassland)
Xeromorphic Shrub & Herb Vegetation (Semi-Desert)
Hydromorphic Vegetation (Aquatic Vegetation)

Level 2 (Formation subclass)

The subclass name reflects the structure, physiognomy and environmental factors that characterize the subclass. The primary environmental factor is macroclimate. Physiognomic terms are sometimes more specific than the class name (e.g., scrub versus shrubland where the vegetation may include tall xeromorphic tree-like plants such as tall cacti). All such terms, if used, should be defined.

Examples:

Tropical Dry Forest
Mediterranean Scrub and Grassland
Cool Semi-Desert Scrub and Grassland
Saltwater Aquatic Vegetation

Level 3 (Formation)

The formation name reflects the structure, physiognomy and environmental factors that characterize the formation. The primary environmental factors are soil moisture conditions and elevation. Physiognomic terms are sometimes more specific than the class or subclass name. All physiognomic terms should be defined in the vegetation type description.

Examples:

Tropical Evergreen Sclerophyll Forest
Mediterranean Scrub
Cool Semi-Desert Sparse Vegetation
Marine & Estuarine Aquatic Vegetation

3.3 Peer Review of Proposed Vegetation Types

Vegetation types shall be established through an authoritative peer review process (Figure 3.2, 3.3). An authoritative process is necessary to maintain the consistency, credibility, orderly change, and rigor of the classification. Peer review of proposals for new vegetation types, as well as for changes proposed to type concepts that are already recognized, is essential to the long term utility and progressive development of the NVC. The peer process requires those proposing new types to make a convincing case based on a clear explanation of the data, methods, and results. A unified classification of plant communities for the United States can only be viable if peer review of proposed types is an integral part of it. The essential components of a peer review system for the NVC are summarized below.

3.3.1 Classification Confidence and Status

Each accepted vegetation type, particularly for lower and middle level units, shall be assigned one of the confidence levels based on the relative rigor of the data and the analysis used to identify, define, and describe the type. Upper level vegetation types, which are global in scope and typically based on very synthetic data, often from the literature, cannot be as easily assigned confidence levels based on these criteria:

a. High: Type is based on quantitative analysis of classification plots that are published in full or are archived in a publicly accessible database. Classification plots shall meet the minimum requirements shown in Appendix D. Classification plots shall represent the geographic distribution and habitat range of the type as known from classification and occurrence plots. In addition, plots that form the basis for closely related types shall be compared.

   For an alliance, the majority of component associations shall have a high to moderate level of confidence.

b. Moderate: Type is lacking in either geographic scope or degree of quantitative characterization and subsequent comparison with related types, or plots are published only as a comprehensive summary (floristic) table; plot otherwise meets the requirements for a high level of confidence.

   For an alliance, many associations within the type may have a moderate to low level of classification confidence.

c. Low: Type is based on plot data that are incomplete, not accessible to others, or not published; or, based on informal analysis, anecdotal information, or community descriptions that are not accompanied by plot data, or if so, only in an incomplete summary (floristic) table (such as only reporting dominant or characteristic species of a type). Local experts have often identified these types. Although there is a high level of confidence that they represent significant vegetation entities that should be incorporated in the NVC, it is not clear whether they would meet the

standard for floristic types in concept or in the NVC classification approach if data were available.

Alliances are classified as low confidence if defined primarily from:

i. incomplete or unpublished and inaccessible plot data (e.g., plots may only contain information about species in the dominant layer),

ii. non-standard, anecdotal, or local vegetation types, or

iii. imagery, or other information, that relies primarily on the dominant species in the dominant canopy layer.

In addition to the three levels of classification confidence, two categories are established to identify vegetation types that have been described to some extent, but which have not been formally accepted as an NVC unit of vegetation, and therefore are not part of the content standard. These categories are:

d. Proposed: Formally described types that are in some stage of the NVC peer review process, but for which the process is still incomplete. For example, indicating that a type is "proposed" may be used when investigators have a need to refer to these types in publications or reports prior to the completion of the peer review process.

e. Provisional: These types not yet formally described, but are expected to be additions to the existing list of NVC types for an area or project. Provisional types should only be used when a clear effort is being made to apply the NVC, but where some vegetation does not appear to have been covered by the concepts of known units for an area or project. For example, authors of a report or publication may need to submit a list of NVC types and any additional observed types, such as those that have not been recognized by the NVC nor have they been formally submitted for peer review. Such types may be designated as "provisional."

3.3.2 Peer Review Process

a. The objectives of the peer review process are to:

i. ensure compliance with classification, nomenclature and documentation standards,

ii. maintain reliability of the vegetation data and other supporting documentation, and

iii. referee conflicts with established and proposed NVC types.

b. The peer review process shall be administered by the NVC Peer Review Board (authorized and overseen by the Lead Agency (USDA Forest Service)), which provides independent and scientifically credible reviewers.

c. The NVC Peer Review Board may structure a peer review process that is different for the various levels of the hierarchy; e.g., a different process may be needed for upper levels (which are global in definition), mid levels (often national to regional in definition), and lower levels (regional to local in definition), but this shall be left to the discretion of the Board.

d. The Peer Review Board is responsible for ensuring that the criteria specified in this standard are followed. This Board shall adhere to the scientific and technical principles of the NVC and it shall ensure the good order and scientific credibility of the classification.

e. Investigators wishing to contribute to the NVC by proposing changes to the classification shall submit their methods and results to the Peer Review Board.

f. The Peer Review Board shall maintain publicly available Proceedings of all official actions. Full descriptions of types shall constitute the NVC primary literature and shall be published in the Proceedings. The Proceedings shall contain official changes to the list of NVC associations and alliances, and it shall include the required supporting information for all changes made to the list.

g. Peer reviewers shall have sufficient regional expertise to understand how a given proposed change to the NVC would affect related associations and alliances.

h. Investigators proposing revisions to the NVC shall use a defined template for type descriptions that can be readily reviewed.

i. Investigators who describe types shall place their proposed types within the context of existing NVC types so as to determine whether the type under consideration is distinct, or whether their proposal will instead refine or upgrade the definition of a type or types already on the list.

j. The peer review process should occur in a reasonable time frame, and should balance the need for improvement to the quality and to the stability of the NVC.

Figure 3.2. Flow of information through the peer review process for formal recognition of a vegetation type.

Beginning at the top, field plot data, existing summary data, or literature based on field plot data, are collected or compiled, the data are submitted to a publicly available database (such as VegBank), data are analyzed, and a proposal describing a type is submitted for review. If accepted by reviewers, the type description is classified under the NVC, the monograph is published, and the description made available.

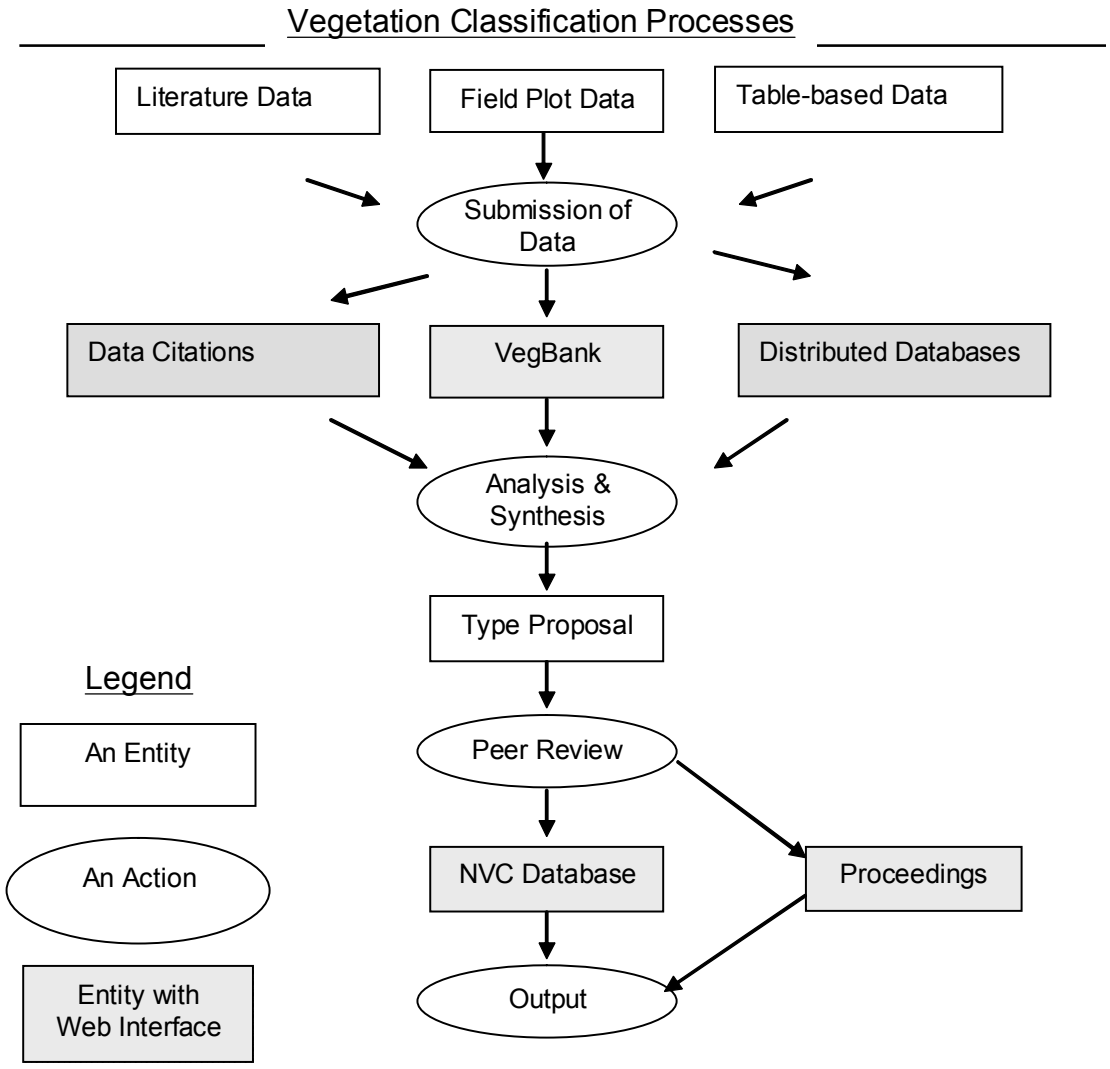
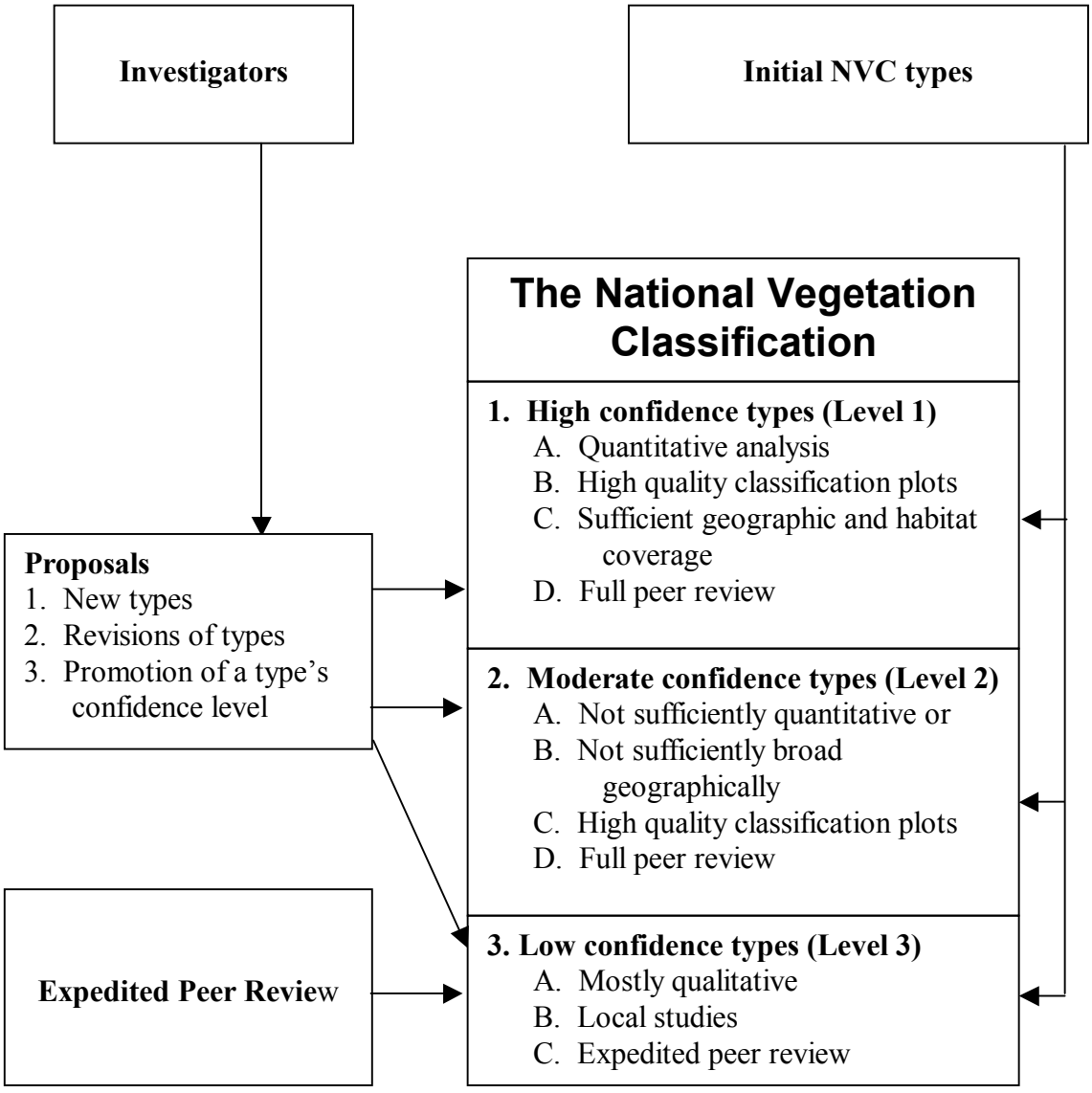


Figure 3.3. Relationship of peer review processes to the NVC.

Initial NVC types are the current set of provisional NVC alliances and associations for natural vegetation (FGDC 1997, NatureServe 2006), upper level types developed by the Hierarchy Revisions Working Group (Faber-Langendoen et al. 2007), and cultural vegetation types developed by NRI (2003).



3.4 Data Management and Dissemination

The vegetation classification described in this standard cannot succeed without careful and explicit rules for data management. The classification process requires three dynamic and interacting datasets of (a) botanical taxonomy and nomenclature, (b) vegetation field plots, and (c) classified alliance and associations. It is the synthesis of these datasets that will provide a consistent working knowledge of the vegetation of the United States and its Trust Terrritories.

3.4.1 Component Datasets

a. The Taxonomic Dataset

   i. Each known taxon shall be reported as a name-and-reference couplet known as a "taxon-concept".

   ii. Unknown or irregular taxa (such as composite morphotypes representing several similar taxa) should be reported with the name of the taxon for the finest taxonomic level with certain identification, and should be associated with a note field in the dataset that provides additional information.

   iii. Taxonomic names and concepts shall be cross-walked in order to classify floristic units.

   iv. Growth form names and concepts used to describe vegetation types should be based on a specified reference that contains clear definitions. A list of preferred growth form names and definitions are provided in Appendix E.

b. The Plots Dataset

   i. Plot data used to support the NVC shall be archived in publicly accessible and searchable datasets.

   ii. Plot data used to support description of a vegetation type shall be linked by a unique number to the description of the type and shall be publicly available.

   iii. All uses of plot data with respect to the NVC shall cite the original author of the plot.

   iv. The Plot dataset shall use concept-based taxonomy by allowing multiple interpretations of each taxon (e.g., a plot record may contain multiple names for a given taxon in the plot, that of the field ecologist who used a name with a reference of a regional taxonomy manual and that of another person who annotated the name to correspond to the PLANTS list. Both names are stored in the database).

v. All datasets used to archive plot data supporting the NVC shall have assured data permanency and should be able to export plot data in a consistent format.

c. The Vegetation Classification Dataset

i. The Vegetation Classification Dataset shall contain all fields needed for a type description (Section 3).

ii. The Vegetation Classification Dataset shall use concept-based taxonomy for vegetation types. At a minimum this requires citing a reference for each type name.

iii. The Vegetation Classification Dataset shall allow for backward compatibility. That is, a user should be able to track the history of vegetation type concepts and names used in the NVC as they change over time.

3.4.2 Web Access

a. Each of these datasets shall be publicly viewable and searchable over the web, and shall be regularly updated.

b. There shall be a primary access point for viewing and retrieving information from these datasets over the web. Although mirrors of this information may be established at other sites, the primary access point shall be the definitive source of information on taxonomy and nomenclature, field plots, and recognized alliances and associations, respectively.

c. The website shall contain an explicit date and version, so that users of the NVC can cite the website and the explicit version observed (or date observed) so as to allow exact reconstruction of the taxonomic and community concepts employed as well as the observation data provided from field plots.

3.4.3 Publication

Successful proposals for recognized associations and alliances shall be published in the Proceedings of the NVC and shall be accessible at the primary access point for the Vegetation Classification Dataset. The Proceedings shall constitute the primary literature underpinning the NVC, and will be permanently and publicly available.

4. Description and Classification of Cultural Vegetation

This section describes the process standard for updating and revising the dynamic content of cultural vegetation in the NVC. Standards for field plot data and other data sources are described in Section 4.1. Conventions for defining, naming, and describing vegetation types are provided in Section 4.2. The process for peer review of proposals to change the names or concepts of vegetation types is described in Section 4.3. Finally, the component databases and the technical structure of the NVC information system are described in Section 4.4. The content of each of these sections is in outline format for practical application and referencing.

4.1 Data Sources

Assigning a cultural vegetation 'stand' to a classification type at each level of the classification hierarchy requires a defined set of information. The cultural vegetation types in the NVC may be developed through the analysis of imagery, thematic spatial data layers, and field survey data. More and more detailed data are required to derive units at consecutively finer levels of the classification hierarchy. Standard sampling methods should be followed and documented to identify the sample points, and uniform data collection protocols should be followed to ensure consistency and comparability of the field data. The standards for vegetation sampling methods for cultural vegetation will be completed as a future stage of work by this Subcommittee. In the meantime, standards for natural vegetation may be followed, if desired (see Section 3.1).

4.2 Classification and Description

A comprehensive list of the nation's cultural vegetation types is currently a goal to be pursued in the long term application of this Standard. The first approximation of a national list of cultural vegetation types is provided in this standard, based on the work of NRI (2003) (see Appendix I). This publication shall serve as the initial basis for assigning vegetation stands to cultural types within the NVC. A process to help users classify cultural vegetation will be developed in the future involving Federal, State, and private agencies and professional organizations. The standards for vegetation classification and description for cultural vegetation will be completed as a future stage of work by this Subcommittee. In the meantime, standards for natural vegetation may be followed, as desired (see Section 3.2).

The nomenclature for planted and cultivated types shall initially follow that of the NRI list shown in Appendix I. Where appropriate, it may include the name of the species present (e.g., Corn). Preferably a Latin name is also provided. If desired, the name may be modified by an appropriate structural (formation) name (e.g. Corn Row Crop).

4.3 Peer Review

Questions regarding the use of this part of the classification may be referred to the FGDC Vegetation Subcommittee, which shall maintain a professional advisory panel authorized by the Subcommittee for review and assistance. The Subcommittee or the authorized professional panel shall ensure that the vegetation is classified within the NVC at the appropriate level and type within the classification hierarchy.

4.4 Data Management and Dissemination

The standards for data management and dissemination of cultural vegetation information will be completed as a future stage of work by this Subcommittee. In the meantime, standards for natural vegetation may be followed (see Section 3.4).

5. References

Abercrombie, M., C.J. Hickman, and M.L. Johnson. 1966. A Dictionary of Biology. Penguin Books, Inc. Baltimore, MD. 284p.

Allen, R.B. 1992. RECCE: an inventory method for describing New Zealand's vegetation cover. For. Res. Inst. Bull. 176. Christchurch, New Zealand.

Alvo, R. and S. Ponomarenko. 2003. Vegetation Classification Standard for Canada Workshop: 31 May-2 June 2000. Canadian Field-Naturalist 117: 125-139.

Anderson, J.R., E.E. Hardy, J.T. Roach and R.E. Witmer. 1976. A Land Use and Land Cover Classification System for Use with Remote Sensor Data. U.S. Geological Survey Professional Paper 964. Washington, D.C: U.S. Government Printing Office.

Anderson, M., P.S. Bourgeron, M.T. Bryer, R. Crawford, L. Engelking, D. Faber-Langendoen, M. Gallyoun, K. Goodin, D.H. Grossman, S. Landaal, K. Metzler, K.D. Patterson, M. Pyne, M. Reid, L. Sneddon, and A.S. Weakley. 1998. International classification of ecological communities; terrestrial vegetation of the United States. Volume II. The national vegetation classification system: list of types. The Nature Conservancy, Arlington, Virginia, USA.

Bailey, R.G. 1988. Ecogeographic Analysis: A Guide to the Ecological Division of Land for Resource Management. Misc. Pub. 1465. USDA Forest Service. Washington DC. 16p.

Bailey, R.G. 1996. Ecosystem Geography. Springer-Verlag, Inc. New York. 204p.

Barkman, J. J., H. Doing, and S. Segal. 1964. Kritische Bemerkungen und Vorschläge zur quantitativen Vegetationsanalyse. Acta Botanica Neerlandica 13: 394-419.

Beard, J.S. 1973. The physiognomic approach. In: R.H. Whittaker, Ed. Ordination and classification of communities. Handbook of Vegetation Science 5:355-386. Junk, The Hague.

Berendsohn, W.G., 1995. The concept of "potential taxa" in databases. Taxon 44:207-212.

Braun-Blanquet, J. 1928. Pflanzensoziologie. Gründzuge der Vegetationskunde. Springer-Verlag, Berlin, Germany.

Bourgeron, P.S., Engelking, L.D., eds. 1992. Preliminary compilation of a series level classification of the vegetation of the western United States using a physiognomic framework. The Nature Conservancy Western Regional Office, Boulder, Colorado. Report submitted to Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow.

Box, E. O. 1981. Macroclimate and plant forms: An introduction to predictive modeling in phytogeography. Dr. W. Junk, the Hague. 258 p.

Brohman, R. and L. Bryant eds. 2005. Existing Vegetation Classification and Mapping Technical Guide. Gen. Tech. Rep. WO-67. Washington, D.C.: U.S. Dept. of Agriculture Forest Service, Ecosystem Management Coordination Staff.

Bruelheide, H. 2000. A new measure of fidelity and its application to defining species groups. Journal of Vegetation Science 11:167-178.

Bush, G.W. 2003. Amendment of Executive Orders, and Other Actions, in Connection With the Transfer of Certain Functions to the Secretary of Homeland Security (Executive Order 13286). Federal Register 68: 10619–10633. http://www.fas.org/irp/offdocs/eo/eo-13286.htm. [Accessed 11/19/2007].

Canadian National Vegetation Classification (CNVC) Technical Committee. 2005. Goals, Principles and Priorities of the Canadian National Vegetation Classification. 17 pp incl. appendices. http://cnvc-cnvc.ca.

Clinton, W.L. 1994. Coordinating geographic data acquisition and access: the national spatial data infrastructure (Executive Order 12906). Federal Register 59: 17671–17674. http://www.fgdc.gov/publications/documents/geninfo/execord.html. [Date accessed unknown].

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. FWS/OBS-79/31. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 131 p.

Cronquist, A., A.H. Holgren, N.H. Holgren, and J.L. Reveal. 1972. Intermountain Flora, Vol. 1. The New York Botanical Gardens. New York. 270p.

Curtis, J.T. 1959. The vegetation of Wisconsin: an ordination of plant communities. 2000 University of Wisconsin Press, Madison, Wisconsin, USA. 657 p.

Daubenmire, R.F. 1959. A canopy-coverage method of vegetation analysis. Northwest Science 33:43-64.

Daubenmire, R.F. 1968. Plant Communities: a textbook of plant synecology. New York: Harper and Row. 300p.

Di Gregorio, Antonio; Jansen, Louisa J.M. 1996. FAO Land Cover Classification: A dichotomous, Modular-Hierarchical Approach. Rome, Italy: Food and Agriculture Organization of the United Nations. 11 p.

Domin, K. 1928. The relations of the Tatra mountain vegetation to the edaphic factors of the habitat: a synecological study. Acta Botanica Bohemica 6/7:133-164.

Drake, J. and D. Faber-Langendoen. 1997. An alliance-level classification of the vegetation of the Midwestern United States. A report prepared by The Nature Conservancy Midwest Conservation Science Department for the University of Idaho Cooperative Fish and Wildlife Research Unit. The Nature Conservancy Midwest Regional Office, Minneapolis, Minnesota, USA.

Driscoll, R.E. et al. 1984. An ecological land classification framework for the United States. USDA Forest Service, Misc. Pub. 1439. Washington, DC: U.S. Department of Agriculture, Forest Service.

Eyre, F.H. 1980. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters.

Faber-Langendoen, D., and J. Drake. 1996. An initial description of Alliances of the Midwest. The Nature Conservancy Midwest Regional Office.

Faber-Langendoen, D., D. Tart, A. Gray, B. Hoagland, Otto Huber, C. Josse, S. Karl, T. Keeler-Wolf, D. Meidinger, S. Ponomarenko, J-P. Saucier, Alejandro Velázquez-Montes, A. Weakley. 2007 (in prep). Guidelines for an integrated physiognomic – floristic approach to vegetation classification. Hierarchy Revisions Working Group, Federal Geographic Data Committee, Vegetation Subcommittee, Washington, DC.

FGDC. 1996. FGDC Standards Reference Model. Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey. Reston, VA. 24p.

FGDC. 1997. Vegetation Classification Standard. FGDC-STD-005. Vegetation Subcommittee, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey. Reston, VA. 58p.

FGDC. 2002. Directive #6: FGDC Standards Documents. Standards Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey. Reston, VA. 11p.

Forman, R.T.T. and M. Godron. 1986. Landscape Ecology. John Wiley and Sons. New York. 619p.

Fosberg, F.R. 1961. A classification of vegetation for general purposes. Tropical Ecology 2:1–28.

Gauch, H. 1982. Multivariate Analysis in Community Ecology. Cambridge University Press, New York. 298p.

Gabriel, H.W. and S.S. Talbot. 1984. Glossary of landscape and vegetation ecology for Alaska. Alaska Technical Report 10. Bureau of Land Management, U.S. Department of the Interior, Washington, D.C.

Gerwing, J.J. 2004. Life history diversity among six species of canopy lianas in an old-growth forest of the eastern Brazilian Amazon. Forest Ecology and Management 190:57-72.

Grossman, D.H., D. Faber-Langendoen, A.W. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K.D. Patterson, M. Pyne, M. Reid and L. Sneddon. 1998. International Classification of Ecological Communities: Terrestrial Vegetation of the United States. Volume I: The National Vegetation Classification Standard. The Nature Conservancy.

Hall, G.M.J. 1992. PC-RECCE: Vegetation inventory data analysis. For. Res. Inst. Bull. 182. Christchurch, New Zealand.

Helms, J. 1998. The Dictionary of Forestry. Bethesda, MD: Society of American Foresters. 210p.

Jennings, M.D. 1996. Mapping units: Their classification and nomenclature for Gap Analysis land cover data. pp 71-78 in: Gap Analysis: A landscape approach to biodiversity planning. American Society for Photogrammetry and Remote Sensing, Scott et al., eds.

Jennings, M.D., D. Faber-Langendoen, R.K. Peet, O.L. Loucks, D.C. Glenn-Lewin, A. Damman, M.G.Barbour, R. Pfister, D.H. Grossman, D. Roberts, D. Tart, M. Walker, S.S. Talbot, J. Walker, G.S Hartshorn, G. Waggoner, M.D. Abrams, , A. Hill, M. Rejmanek. 2006. Description, Documentation, And Evaluation Of Associations And Alliances Within The U.S. National Vegetation Classification, Version 4.5. Ecological Society of America, Vegetation Classification Panel. Washington DC. 119p.

Jensen, M. E., W. Hann, R. E. Keane, J. Caratti, and P. S. Bourgeron. 1994. ECODATA—A multiresource database and analysis system for ecosystem description and evaluation. Pages 192-205 *in* M. E. Jensen, and P. S. Bourgeron, editors. Ecosystem Management: principles and applications. Volume II. U.S. Forest Service General Technical Report PNW-GTR-318. Pacific Northwest Research Station, Portland, Oregon, USA.

Kent, M. and P. Coker. 1992. Vegetation description and analysis: a practical approach. Belhaven Press. London, UK. 363 p.

Kimmins, J.P. 1997. Forest ecology: a foundation for sustainable management. Second edition. Prentice Hall, Upper Saddle River, New Jersey, USA.

Krajina, V.J. 1933. Die Pflanzengesellschaften de Mlynica-Tales in den Vysoke Tatry (Hohe Tatra). Mit besonderer Berücksichtigung der ökologischen Verhältnisse. Botan. Central., Beih. Abt. II, 50:774-957; 51:1-224.

Küchler, A.W. 1969. Natural and cultural vegetation. The Professional Geographer 21: 383-385.

Lincoln, R, G. Boxshall, and P. Clark. 1998. A dictionary of ecology, evolution and systematics. New York: Cambridge University Press. 361p.

McCune, B., J.B. Grace, and D.L. Urban. 2002. Analysis of ecological 2163 communities. MjM Software Design, Gleneden Beach, Oregon, USA.

Michener, William K., James W. Brunt, John J. Helly, Thomas B. Kirchner, Susan G. Stafford, 1997. Nongeospatial metadata for the ecological sciences. Ecological Applications 7:330–342.

Mucina, L. 1997. Conspectus of classes of European vegetation. Folia Geobotanica et Phytotaxonomica 32:117-172.

Mueller-Dombois, D. and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley,New York.

National Resources Inventory (NRI). 2003. Handbook of Instruction for Remote Data Collection, Chapter 13 – Land Cover / Use. Natural Resources Conservation Service. USDA, Washington, DC.

NatureServe. 2006. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A.

OMB. 1990. Circular A-16: Coordination of Geographic Information and Related Spatial Data Activities. Office of Management and Budget. Washington DC.

OMB. 1998. Circular A-119: Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities. Office of Management and Budget. Washington DC. Available at: http://www.whitehouse.gov/omb/ circulars/ a119/a119.html#1

OMB. 2002. Circular A-16: Coordination of Geographic Information and Related Spatial Data Activities. Office of Management and Budget. Washington DC. Available at: http://www.whitehouse.gov/omb/ circulars/a016/a016_rev.html

Peet, R. K., T. R. Wentworth, and P. S. White. 1998. The North Carolina Vegetation Survey protocol: a flexible, multipurpose method for recording vegetation composition and structure. Castanea 63:262-274.

Pfister, R. D. and S. F. Arno. 1980. Classifying forest habitat types based on potential climax vegetation. Forest Science 26:52-70.

Pignatti, S., E. Oberdorfer, J.H.J. Schaminee, and V. Westhoff. 1994. On the concept of vegetation class in phytosociology. Journal of Vegetation Science 6:143-152.

PLANTS Data Base - PLANTS. 1995. USDA Natural Resources Conservation Service, National Plants Data Center, Baton Rouge, LA.

Pyle, R.L. 2004. Taxonomer: a relational data model for managing information relevant to taxonomic research. PhyloInformatics 1:1-54.

Raunkiaer, C. 1934. The life forms of plants and statistical plant geography. Clarendon, Oxford.

Reid, M.S., K.A. Schulz, P.J. Comer, M.H. Schindel, D.R. Culver, D.A. Sarr, and M.C. Damm. 1999. Descriptions of vegetation alliances of the coterminous western United States. The Nature Conservancy, Boulder, Colorado, USA.

Rodwell, J.S., J.H.J. Schamineé, L. Mucian, S. Pignatti, J. Dring and D. Moss. 2002. The diversity of European vegetation. An overview of phytosociological alliances and their relationships to EUNIS habitats. Wageningen, NL. EC-LNV. Report EC-LNV nr. 2002/054.

Rutherford, M.C.; Westfall, R.H. 1994. Biomes of Southern Africa: an objective categorization. Memoirs of the Botanical Survey of South Africa NO. 63. Pretoria, SA: National Botanical Inst.

Society for Range Management (SRM). 1989. A glossary of terms used in range management. Denver, CO: Society for Range management.

Sneddon, L., M. Anderson. 1994. A classification and description of terrestrial community alliances in The Nature Conservancy's eastern region: First approximation. The Nature Conservancy, Eastern Regional Office, Boston, Mass.

Specht, R.L. and A. Specht. 2001. Australia, ecosystems of. Pp. 307 - 324,
In S.A. Levin (ed.). Encyclopedia of Biodiversity, Vol. 1. Academic Press, New York.

Tart, D., C. Williams, C. Brewer, J. DiBenedetto, and B. Schwind. 2005a. Section 1: Existing Vegetation Classification and Mapping Framework. In: Brohman, R. and L. Bryant eds. Existing Vegetation Classification and Mapping Technical Guide. Gen. Tech. Rep. WO-67. Washington, DC: U.S. Department of Agriculture Forest Service, Ecosystem Management Coordination Staff.

Tart, D., C. Williams, J. DiBenedetto, E. Crowe, M. Girard, H. Gordon, K. Sleavin, M. Manning, J. Haglund, B. SHortand D. Wheeler. 2005b. Section 2: Existing Vegetation Classification Protocol. In: Brohman, R. and L. Bryant eds. Existing Vegetation Classification and Mapping Technical Guide. Gen. Tech. Rep. WO-67. Washington, DC: U.S. Department of Agriculture Forest Service, Ecosystem Management Coordination Staff.

The Nature Conservancy Ecology Working Group. 1994. The National Vegetation Classification Standard. A Report for the NBS/NPS Vegetation Mapping Program. Arlington, VA: The Nature Conservancy.

Tüxen, R. 1956. Die heutige natürliche potentielle Vegetation als Gegenstand der vegetationskartierung. Remagen. Berichte zur Deutschen Landekunde 19:200-246.

UNEP/FAO. 1995. Background note on on-going activities relating to land use and land cover classification. Nairobi, Kenya: United Nations Environment Programme.

UNESCO. 1973. International Classification and Mapping of Vegetation, Series 6, Ecology and conservation. Paris, France: United Nations Educational, Scientific and Cultural Organization. 32 p.

U.S. Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS). 1997. National range and pasture handbook. Washington, DC: U.S. Department of Agriculture, Natural Resources Conservation Service.

U.S. Geological Survey (USGS). 2001. *NLCD Land Cover Class Definitions*, USGS EROS Data Center, Sioux Falls, South Dakota, URL: http://landcover.usgs.gov/natllandcover.php, last accessed 30 August 2006.

Weakley, A.S., K. Patterson, S. Landaal, M. Pyne, and M. Gallyoun. 1997. An alliance-level classification of the vegetation of the southeastern United States. A report prepared for the University of Idaho Cooperative Fish and Wildlife Research Unit by The Nature Conservancy Southeastern Regional Office, Chapel Hill, North Carolina, USA.

Weakley, A. S., K. D. Patterson, S. Landaal, M. Pyne, and others (compilers). 1998. International classification of ecological communities: terrestrial vegetation of the southeastern United States. Working draft of March 1998. The Nature Conservancy, Southeast Regional Office, Southern Conservation Science Department, Community Ecology Group, Chapel Hill, North Carolina, USA.

Westhoff, V. and E. van der Maarel. 1973. The Braun-Blanquet approach. *In:* R.H. Whittaker (ed.). Handbook of Vegetation Science. Part V. Ordination and Classification of Communities. Junk, The Hague, The Netherlands. pp 617-726.

Whitmore, T.C. 1984. Tropical rain forests of the Far East (2nd edition). Clarendon Press, Oxford. 352 p.

Whittaker, R.H. 1975. Communities and Ecosystems. 2nd ed. The Macmillan Company, New York, 385 p,

Wilson, M.V., and A. Shmida. 1984. Measuring beta diversity with presence-absence data. Journal of Ecology 72:1055-1064.

Young, A. 1994. Towards International Classification Standards for Land Use and Land Cover. A preliminary proposal for UNEP and FAO. Rome, Italy: FAO. 45 p

APPENDICES

Appendix A (Normative): Glossary

Agricultural Vegetation — a vegetation type that exhibits a) rapid turnover in structure, typically at least on an annual basis, either through comprehensive manipulation of physiognomy and floristics by harvesting and/or planting, or by continual removal of above ground structure (e.g., cutting, haying), or b) showing strong linear (planted) features. The herbaceous layer may be bare at various times of the year.

Abiotic — pertaining to the nonliving parts of an ecosystem, such as soil particles, bedrock, air, and water (Helms 1998).

Abundance — the total number of individuals of a taxon or taxa in an area, volume, population, or community; often measured as cover in plants (Lincoln et al. 1998).

Alliance — a vegetation classification unit containing one or more associations, with a defined by a characteristic range of species composition, habitat conditions, physiognomy, and diagnostic species, typically at least one of which is found in the upper most or dominant stratum of the vegetation (Jennings et al.2006).

Association — a vegetation classification unit defined on the basis of a characteristic range of species composition, diagnostic species occurrence, habitat conditions, and physiognomy (Jennings et al. 2006).

Basal Area — the cross-sectional area of all stems of a species or all stems in a stand measured at breast height (4.5 feet or 1.37 meters above the ground) and expressed per unit of land area (Helms 1998).

Canopy Cover — the percentage of ground covered by the vertical projection of the outermost perimeter of the natural spread of foliage of plants. Small openings in the canopy are included (SRM 1989, USDA NRCS 1997). *cf.* foliar cover.

Character species — a species that shows a distinct maximum concentration (quantitatively and by presence) in a well-definable vegetation types, sometimes recognized at local, regional, and general geographic scales. Character species may also be viewed as very strong differential species (Mueller-Dombois and Ellenberg 1974, p. 178, 208; Bruelheide 2000). *cf.* differential species, fidelity.

Class — see Formation Class.

Classification — the grouping of similar types (in this case – vegetation types) according to criteria (in this case - physiognomic and floristic). The rules for classification shall be clarified prior to delineation of the types within the classification standard. Classification methods should be clear, precise, and based upon objective criteria so that the outcome is theoretically independent of who applies the classification. (UNEP/FAO 1995, FGDC 1997).

Classification Plot Records — plot records that contain the data necessary to inform the development or revision of the floristic units within the NVC. Such plots typically contain

high quality data on floristic composition and structure, and conform to the standard articulated in Section 3.1.1 (Jennings et al.2006). *cf.* Occurrence Plot Records.

Climax Vegetation — the final, relatively stable community at the conclusion of ecological succession that is able to reproduce itself indefinitely under existing environmental conditions (Gabriel and Talbot 1984).

Close grown crops — crops that are generally drill-seeded or broadcast, such as wheat, oats, rice, barley, and flax, resulting in very narrow regularly spaced, structure (adapted from NRI 2003).

Community — a group of organisms living together and linked together by their effects on one another and their responses to the environment they share (Whittaker 1975).

Compositional similarity — the degree of commonality in species composition between two plant communities, based on either species presence (usually at broad scales) or species abundance (usually at fine scales).

Constancy — the percentage of plots in a given data set that a taxon occurs in (Jennings et al. 2006).

Constant species — – species that are present in a high percentage of the plots that define a type, often defined as those species with at least 60% constancy (Mueller-Dombois and Ellenberg 1974, p. 178). Sometimes referred to as "constant companion" species.

Cover — see canopy cover, foliar cover.

Cover Type — a vegetation type defined on the basis of the plant species forming a plurality of composition and abundance (FGDC 1997; also see Eyre 1980).

Cropland — see Agricultural Vegetation.

Cross-walk — to describe and document the relationships between members of one set or series and members of another set or series. These relationships may be one-to-one, one-to-many, or many-to-many.

Cryomorphic — pertaining to plants having structural or functional adaptations to survive cold temperatures and resist frost damage (e.g., alpine creeping dwarf-shrubs,krummholz).

Cultural Vegetation — vegetation with a distinctive structure, composition, and development determined by regular human activity (Küchler 1969).

Developed Vegetation — a vegetation type that typically contains an almost continuous herbaceous (typically grass) layer, with a closely cropped physiognomy, typically through continual removal of above ground structure (e.g. cutting, mowing), and where tree cover is highly variable, or other highly manipulated planted gardens.

Diagnostic Species — any species or group of species whose relative constancy or abundance differentiates one vegetation type from another (Jennings et al. 2006). It can include Character, Differential, Constant, Indicator or Dominant species. Some authors restrict the term to include only Character, Differential and Constant species (Westhoff and van der Maarel 1973).

Diagnostic Growth Form — any growth form or group of growth forms whose relative constancy or abundance differentiates one vegetation type from another. Diagnostic growth forms include Dominant Growth Form and Indicator Growth Form.

Differential Species — A plant species that is distinctly more widespread or successful in one of a pair of plant communities than in the other, although it may be still more successful in other communities not under discussion (Curtis 1959, Bruelheide 2000). *cf.* character species, fidelity.

Division — the fourth level in the NVC natural vegetation hierarchy, in which each vegetation unit is defined by a group of plant communities in a given continental or other broad geographic area exhibiting a common set of dominant growth forms and many diagnostic plant taxa (including character taxa of the dominant growth forms) corresponding to broad climatic and environmental characteristics. (Westhoff and van der Maarel 1973, p 664-665, Whittaker 1975).

Dominance — the extent to which a given taxon or growth form has a strong influence in a community because of its size, abundance, or cover. (Lincoln et al. 1998).

Dominance Type — a class of communities defined by the dominance of one or more species, which are usually the most important ones in the uppermost or dominant layer of the community, but sometimes of a lower layer of higher coverage (Gabriel and Talbot 1984).

Dominant Growth Form — growth form with the highest percent of cover, usually in the uppermost dominant layer (in other contexts dominant growth forms can be defined in terms of biomass, density, height, coverage, etc.

Dominant Species — species with the highest percent of cover, usually in the uppermost dominant layer (in other contexts dominant species can be defined in terms of biomass, density, height, coverage, etc. (Kimmins 1997).

Entitation — the process by which we recognize and define entities, usually by dividing a continuously varying phenomenon into a set of discreet entities. In vegetation ecology entitation refers to the act of segmenting an area of vegetation into homogeneous entities, within which samples (plots) can be placed (Mueller-Dombois and Ellenberg 1974), or the division of community data (usually plot data) into discrete vegetation classes.

Epiphyte — a vascular or nonvascular plant that grows by germinating and rooting on other plants or other perched structures, and does not root in the ground (adapted from FGDC 1997).

Existing Vegetation — vegetation found at a given location at the time of observation (Jennings et al.2006). cf. Potential Natural Vegetation.

Fidelity — the degree to which a species is confined in a given vegetation unit. The fidelity of a species determines whether it can be considered a **differential** or **character** species, or just a companion (a species not particularly restricted to any vegetation type) or **accidental** species (a species not normally occurring in a particular vegetation type or habitat), (Bruelheide 2000, Lincoln et al. 1998).

Field Stratum — the layer of vegetation consisting of herbs, regardless of height, as well as woody plants less than 0.5 m in height (Jennings et al. 2006).

Floating Aquatic Stratum — the layer of vegetation consisting of rooted or drifting plants that float on the water surface; e.g. duckweed, water-lily (Jennings et al. 2006).

Foliar Cover — the percentage of ground covered by the vertical projection of the aerial portion of plants. Small openings in the canopy and intraspecific overlap are excluded (SRM 1989) *cf.* canopy cover.

Forb — a non-aquatic, non-graminoid herb with relatively broad leaves and/or showy flowers. Includes both flowering and spore-bearing, non-graminoid herbs.

Formation — the third level in the NVC natural vegetation hierarchy, in which each vegetation unit is defined by a geographically widespread (global) plant communities of similar physiognomy and dominant growth forms, typically related to major topographic and edaphic conditions occurring within major climatic conditions (Whittaker 1975, Lincoln et al. 1998).

Formation Class — the first (highest) level in the NVC natural vegetation hierarchy, in which each vegetation unit is defined by a characteristic combination of dominant growth forms adapted to a very basic set of moisture / temperature regimes.

Formation Subclass — the second level in the NVC natural vegetation hierarchy, in which each vegetation unit is defined by geographically widespread (global) plant communities of similar physiognomy and dominant growth forms, typically related to major climatic conditions (Whittaker 1975, Lincoln et al. 1998).

Frequency — percentage of occurrence of a species in a series of samples of uniform size contained in a single stand (Daubenmire 1968).

Graminoid — a non-aquatic, flowering herb with relatively long, narrow leaves and inconspicuous flowers with parts reduced to bracts. Includes grasses, sedges, rushes, and arrowgrasses.

Ground Stratum — *cf.* nonvascular stratum.

Group — the sixth level in the NVC natural vegetation hierarchy, in which each vegetation unit is defined by a group of plant communities with a common set of growth forms and diagnostic species or taxa (including several character species of the dominant growth forms), preferentially sharing a similar set of regional edaphic, topographic, and disturbance factors. (cf. Pignatti et al. 1995, Specht and Specht 2001)

Growth form — the shape or appearance of a plant reflecting growing conditions and genetics. Growth form is usually consistent within a species, but may vary under extremes of environment (Mueller-Dombois and Ellenberg1974). Growth forms determine the visible structure or physiognomy of plant communities (Whittaker 1973a).

Habitat — a general term referring to the locality, site and particular type of local environment occupied by an organisim or community (adapted from Lincoln et al. 1998).

Habitat Type — a collective term for all parts of the land surface supporting, or capable of supporting, a particular kind of climax plant association (Daubenmire 1978; Gabriel and Talbot 1984).

Herb — a vascular plant without perennial aboveground woody stems, with perennating buds borne at or below the ground surface (Whittaker 1975, FGDC 1997). Includes forbs (both flowering forbs and spore-bearing ferns), graminoids, and herbaceous vines.

Herb Stratum — see Field Stratum.

Hydromorphic — pertaining to plants having structural or functional adaptations for living in water-dominated or aquatic habitats (adapted from FGDC 1997 and Lincoln et al. 1998).

Indicator Growth Form — a growth form whose presence, abundance, or vigor is considered to indicate certain site conditions.

Indicator Species — a species whose presence, abundance, or vigor is considered to indicate certain site conditions (Gabriel and Talbot 1984).

Informative Appendix — an appendix giving additional information with is not part of the Standard. They are provided only for the purposes of clarification, illustration, and general information in respect to the standard (FGDC 2002).

Land Cover — the observed (bio)physical cover of the earth's surface (Di Gregorio and Jansen 1996).

Land Use — the arrangements, activities, and inputs people undertake in a certain land cover type to produce, change, or maintain it (Di Gregorio and Jansen 1996).

Layer (vegetation) — a structural component of a community consisting of plants of approximately the same height and growth form (e.g., tree overstory, tree regeneration). *cf.* Stratum.

Liana — a woody, climbing plant that begins life as terrestrial seedlings but relies on external structural support for height growth during some part of its life (Gerwing 2004), typically exceeding 5 m in height or length at maturity.

Life form — plant type defined by the characteristic structural features and method of perennation, generally as defined by Raunkiaer (1934; see Beard 1973).

Lithomorphic — pertaining to plants having structural or functional adaptations for living on rock surfaces or in rocky substrates (i.e. particle sizes larger than 2 mm diameter (adapted from Lincoln et al. 1998).

Macroclimate — the climate of a major geographical region primarily reflecting latitude and continental position, excluding the effects of landform and vegetation (adapted from Bailey 1988, 1996; Lincoln et al. 1998; Forman and Godron 1986).

Macrogroup — the fifth level in the NVC natural vegetation hierarchy, in which each vegetation unit is defined by a group of plant communities with a common set of growth forms and many diagnostic plant taxa, including many character taxa of the dominant growth forms, preferentially sharing a broadly similar geographic region and regional climate, and disturbance. (cf Pignatti et al. 1995, and Braun-Blanquet concept of "Class").

Mesoclimate — the climate of a geographic area resulting from modification of the macroclimate by the influences of landforms, altitude, aspect, and slope gradient (Bailey 1988, 1996).

Mesomorphic — pertaining to plants requiring environmental conditions of moderate moisture and temperature or which are only partially protected against desiccation (adapted from Lincoln et al. 1998).

Metadata — information about data. This describes the content, quality, condition, and other characteristics of a given dataset. Its purpose is to provide information about a dataset or

some larger data holdings to data catalogues, clearinghouses, and users. Metadata are intended to provide a capability for organizing and maintaining an institution's investment in data as well as to provide information for the application and interpretation of data received through a transfer from an external source (FGDC 1997).

Microclimate — the climate of the immediate surroundings or habitat resulting from modification of the mesoclimate by the influences of local topography, vegetation, and soil (adapted from Lincoln et al. 1998 and Bailey 1988, 1996).

Moss Stratum — see Ground Stratum.

Natural Vegetation — vegetation where ecological processes primarily determine species and site characteristics; that is, vegetation comprised of a largely spontaneously growing set of plant species that are shaped by both site and biotic processes (Kuchler 1969, Westhoff and Van der Maarel. 1973).

Nonvascular — a plant or plant-like organism without specialized water or fluid conductive tissue (xylem and phloem). Includes mosses, liverworts, hornworts, lichens, and algae (adapted from FGDC 1997).

Nonvascular Stratum — the layer of vegetation consisting of non-vascular plants growing on soil or rock surfaces. This includes mosses, liverworts, hornworts, lichens, and algae (Jennings et al. 2006). Sometimes called the Ground Stratum.

Non-vegetated — A category used to classify lands with limited capacity to support life and typically having less than 1 percent vegetative cover. Vegetation, if present, is widely spaced. Typically, the surface of barren land is sand, rock, exposed subsoil, or salt-affected soils. Subcategories include salt flats; sand dunes; mud flats; beaches; bare exposed rock; quarries, strip mines, gravel pits, and borrow pits; river wash; oil wasteland; mixed barren lands; and other barren land (adapted from NRI 2003). Exceptions include vegetation which exhibits a distinct composition under very sparse conditions (e.g., sea rocket coastal shore vegetation, or amaranth coastal vegetation). These types rarely have greater than 1% cover.

Normative Appendix — an appendix which contains information which is an integral part of the Standard, but for reasons of convenience is placed in an appendix (FGDC 2002).

Occurrence Plot Records — plot records that contain data valuable for ecological and geographical characterization of vegetation, but which do not contain sufficient data to be used in quantitative description of an association or alliance (see Section 3.1.1 (Jennings et al.2006). *cf.* Classification Plot Records.

Physiognomy — the visible structure or outward appearance of a plant community as expressed by the dominant growth forms, such as their leaf appearance or deciduousness (Fosberg 1961, Jennings et al. 2006) *cf.* structure.

Plant Community — a group of plant species living together and linked together by their effects on one another and their responses to the environment they share (modified from Whittaker 1975). Typically the plant species that co-occur in a plant community show a definite association or affinity with each other (Kent and Coker 1992).

Planted/Cultivated — see Cultural Vegetation.

Plot — in the context of vegetation classification, an area of defined size and shape that is intended for characterizing a homogenous occurrence of vegetation. *cf.* relevé.

Potential Natural Vegetation — the vegetation that would become established if successional sequences were completed without interference by man or natural disturbance under the present climatic and edaphic conditions (Tüxen 1956). *cf.* existing vegetation.

Range of Variation — the values of an attribute, such as species composition or environmental parameters, that fall within the upper and lower bounds determined for that attribute. The range of variation in the floristic composition of a vegetation type may, for example, be expressed in terms of its beta diversity (*cf.* Wilson and Shmida 1984, McCune et al. 2002), either along an environmental gradient or as the amount of compositional change among a group of plots.

Relevé — a record of vegetation intended for characterizing a stand of vegetation having uniform habitat and relatively homogeneous plant cover, and which is large enough in area to contain a large proportion of the species typically occurring in the plant community (Mueller-Dombois and Ellenberg 1974) *cf.* plot.

Reserved — a section of the FGDC standard that will be addressed or developed in subsequent versions.

Sampling Strategy — the means and criteria used to select the locations for plots (based on Tart et al. 2005b, Mueller-Dombois and Ellenberg 1974, and Gauch 1982).

Seral — a vegetation type (or component species) that is nonclimax; a species or community demonstrably susceptible to replacement by another species or community (Daubenmire 1978).

Semi-Natural Vegetation — vegetation in which past or present human activities significantly influence composition or structure, but do not eliminate or dominate spontaneous ecological processes (Westhoff and Van der Maarel 1973).

Sere — a continuous sequence of community types that occur in a successional sequence prior to reaching the climax type (Jennings et al. 2006).

Shrub — a woody plant that generally has several erect, spreading, or prostrate stems which give it a bushy appearance. In instances where growth form cannot be determined, woody plants less than 5 m in height at maturity shall be considered shrubs. Includes dwarf-shrubs, krummholz, and low or short woody vines (adapted from FGDC 1997 and Box 1981).

Shrub Stratum — the layer of vegetation consisting of woody plants more than 0.5 m tall but less than 5 m in height, such as shrubs, tree seedling and saplings, and lianas. Epiphytes may also be included in this stratum. Rooted herbs are excluded even if they are over 0.5 m in height (adapted from Jennings et al. 2006).

Stand — a spatially continuous unit of vegetation with uniform composition, structure, and environmental conditions. This term is often used to indicate a particular example of a plant community (Jennings et al. 2006).

Stratum — a structural component of a community consisting of plants of approximately the same height; e.g., tree, shrub, or herb strata (Jennings et al. 2006).

Structure (vegetation) — (1) the spatial pattern of growth forms in a plant community, especially with regard to their height, abundance, or coverage within the individual layers (Gabriel and Talbot 1984). (2) the spatial arrangement of the components of vegetation resulting from plant size and height, vertical stratification into layers, and horizontal spacing of plants (Lincoln et al, 1998, Mueller-Dombois and Ellenberg 1974). *cf.* physiognomy.

Subclass — the level in the NVC classification hierarchy under class (see Figure 1) based on growth form characteristics (Grossman et al. 1998).

Subclimax — the stage plant succession immediately preceding the climax stage (Gabriel and Talbot 1984).

Submerged Aquatic Stratum — the layer of vegetation consisting of rooted or drifting plants that by-and-large remain submerged in the water column or on the aquatic bottom; e.g. sea grass (Jennings et al. 2006).

Taxon-concept —when used with respect to taxonomic nomenclature, the combination of a taxon name along with a reference to a circumscribed taxonomic concept (as in "potential taxon" of Berendsohn (1995) or "assertion" of Pyle (2004)).

Tree — a woody plant that generally has a single main stem and a more or less definite crown. In instances where growth form cannot be determined, woody plants equal to or greater than 5 m in height at maturity shall be considered trees (adapted from FGDC 1997). Includes dwarf trees (Tart et al. 2005b) or "treelets" (Box 1981).

Tree Stratum — the layer of vegetation consisting of woody plants more than 5 m in height, including mature trees, shrubs over 5 m tall, and lianas. Epiphytes growing on these woody plants are also included in this stratum (Jennings et al. 2006).

Type — see Vegetation Type.

Vegetation — the collective plant cover of an area (FGDC 1997)

Vegetation type — a named category of plant community or vegetation defined on the basis of shared floristic and/or physiognomic characteristics that distinguish it from other kinds of plant communities or vegetation (Tart et al. 2005a). This term can refer to units in any level of the NVC hierarchy.

Xeromorphic — pertaining to plants having structural or functional adaptations to prevent water loss by evaporation (Lincoln et al. 1998).

Appendix B (Informative). Relation of USNVC to Land Cover Classifications

Table B.1. Comparison of FAO LCCS Land Cover Types (based on structural domains) and National Land Cover Database (NLCD) types with that of NVC Levels 1&2 (see Di Gregorio and Jansen 1996, USGS 2001).

		CATEGORY			
		LCCS	**LCCS Major Land Cover Type with Structural Domain**	**NLCD (* indicates applies to Alaskan tundra only).**	**NVC Level**
VEGETATED	NATURAL	TERRESTRIAL: A12. Natural and Semi-Natural Terrestrial Vegetation	Forest & Woodland Thicket & Shrubland Grasslands Sparse Vegetation Lichens/Mosses	• **Forest** • **Shrubland** – Dwarf Shrub* – Shrub/Scrub • **Grasslands/Herbaceous** – Grassland/Herbaceous – Sedge Herbaceous* • **Non-Vascular** – Lichens* – Moss*• **Wetlands** Forested Wetland Scrub/Shrub Wetland Emergent Herb Wetland Aquatic Bed	**Forest & Woodland** **Shrubland & Grassland** **Semi-Desert** **Polar & High Montane Vegetation** **Aquatic Vegetation** **Nonvascular & Sparse Vascular Vegetation**
		WETLAND/AQUATIC :A24. Natural and Semi-Natural Aquatic or Regularly Flooded Vegetation	Forest & Woodland Closed Shrubs & Open Shrubs Grasslands Sparse Vegetation Lichens/Mosses		
	CULTURAL	TERRESTRIAL: A11. Cultivated and Managed Terrestrial Areas	• Agriculture Tree Crops Shrub Crops Herbaceous Crops • Developed Managed Lands - parks (woody) - parkland (scattered woody) - lawns (herb)	• **Agriculture** - Cultivated Crops (woody) - Cultivated Crops (herb) - Pasture/Hay • **Developed** – Developed, Open Space	• **Agricultural Vegetation** - Woody Ag. Vegetation Woody Horticultural Crops Other Woody Ag. Vegetation - Herbaceous Ag. Vegetation Cultivated Crop Pasture/Hay Other Herbaceous Ag Vegetation • **Developed Vegetation** - Herbaceous and Woody Developed Vegetation

		WETLAND/AQUATIC : A23. Cultivated Aquatic or Regularly Flooded Areas	- Aquatic Or Regularly Flooded Graminoid Crops - Aquatic Or Regularly Flooded Non-Graminoid Crops	?	
NON-VEGETATED	NATURAL	TERRESTRIAL: B16. Bare Areas	Consolidated Areas Unconsolidated Areas	• **Barren** – Rock/Sand/Clay – Unconsolidated Shore**	FAO (informative)
		AQUATIC: B28. Natural Waterbodies, Snow and Ice	Natural Waterbodies Snow Ice	• **Water** – Open Water – Perennial Ice/Snow	FAO (informative)
	CULTURAL	TERRESTRIAL: B15. Artificial Surfaces and Associated Areas	Built-Up Areas (Developed) Non Built-Up Areas (Waste)	• **Developed** – Low Intensity – Medium Intensity – High Intensity	(FAO informative)
		AQUATIC: B27. Artificial Surfaces and Associated Areas	Artificial Waterbodies Artificial Snow Artificial Ice	• **Water** – Open Water – Perennial Ice/Snow	FAO (informative)

Table B2. Relation of NRCS National Resources Inventory classification (NRI 2003) used on non-federal lands in the lower 48 States, to the broad categories and classification units of the NVC.

Category 1	**Category 2**	**NVC Level 1 (vegetated) or FAO equivalents (non-vegetated**	**NRCS NRI Category**
VEGETATED	NATURAL	Forest & Woodland	Forest Land
		Shrubland & Grassland	Rangeland
		Semi-Desert	
		Polar & High Montane Vegetation	
		Aquatic Vegetation	
		Nonvascular & Sparse Vascular Vegetation	
	CULTURAL	Agricultural Vegetation	Cropland
			Pastureland
		Developed Vegetation	Developed Land
			Other Rural Land (?)
NON-VEGETATED	NATURAL	*NATURAL NON-VEGETATED TERRESTRIAL AREAS*	Other Rural Land (?)
		NATURAL NON-VEGETATED WATERBODIES (Open water)	Water
	CULTURAL	*CULTURAL NON-VEGETATED TERRESTRIAL AREAS*	Other Rural Land (?)
		CULTURAL NON-VEGETATED WATER-BODIES (Open Water)	Water

Appendix C (Informative): Multilingual version of natural hierarchy.

Table C.1. Multilingual version of names for the levels of the natural vegetation hierarchy

Level	*English name*	*English Short name*	*French Name*	*French Short Name*	*Spanish Name*	*Spanish Short Name*
1	Formation Class	Class	Classe de formation	Classe	Clase de formación	Clase
2	Formation Subclass	Subclass	Sous-classe de formation	Sous-classe	Subclase de formación	Subclase
3	Formation	Formation	Formation	Formation	Formación	Formación
4	Division	Division	Division	Division	División	División
5	Macrogroup	Macrogroup	Macrogroupe	Macrogroupe	Macrogrupo	Macrogrupo
6	Group	Group	Groupe	Groupe	Grupo	Grupo
7	Alliance	Alliance	Alliance	Alliance	Alianza	Alianza
8	Association	Association	Association	Association	Asociación	Asociación

Appendix D (Normative): Required attributes for plots

Classification plots provide data needed to develop and define classified vegetation types. ***Occurrence plots*** document a less formal observation of a known vegetation type at a location. Required fields are those minimally needed to serve as either classification or occurrence plots. The required information includes the plot data itself, metadata about the plot, and information about each assignment of a field plot to a vegetation type.

D.1 Information required in field plot data sets.

Field plot data includes the following kinds of information

1. Information required in the field plot record.
2. Information required for the plot vegetation.
3. Information required for the plot location.
4. Information about the plot environment.

Tables D.1.1 through D.1.4 describe field plot data requirements.

Table D.1.1 — Information required in the field plot record.

Attribute Name	Attribute Definition	Classification Plots	Occurrence Plots
Author Plot Code	Author's plot number/code, or the original plot number if taken from literature.	Required	Required
Author Observation Code	Code or name that the author uses to identify this plot observation. Where a plot has only one observation, this code may equal Author Plot Code.	Required	
Observation Start Date	The date of the observation, or the first day if the observation spanned more than one day.	Required	Required
Date Accuracy	Estimated accuracy of the observation date. Accuracy is often low for legacy data.	Required	

Table D.1.2. — Information required for the plot vegetation.

Attribute Name	Attribute Definition	Classification Plots	Occurrence Plots
The following stratum variables are recorded once for each stratum recognized. While not strictly required, measurements of strata are a best practice.			
Stratum Index	Indices used to represent stratum	Required only if strata are recorded	
Stratum Name	Name of stratum	Required only if strata are recorded	
Stratum Description	Description of stratum	Required only if strata are recorded	
Stratum Cover	Total cover of vegetation within the given stratum in percent.	Required only if strata are recorded	
The following growth form variables are recorded once for each growth form recognized. While not strictly required, measurements of growth form are a best practice. If growth forms are measured, the first three and last are required			
Growth Form Index	Indices used to represent growth form	Required only if growth forms are recorded	
Growth Form Name	Name of growth form	Required only if growth forms are recorded	
Growth Form Description	Description of growth form	Required only if growth forms are recorded	
Growth Form Cover	Total cover of vegetation for the growth form in percent.	Required only if growth forms are recorded	
The following apply for recording plant taxa, with at least one record per taxon, and multiple records when taxa are observed in multiple strata.			
Plant Name	Name of the taxon. For occurrence plots, only dominant taxa are required, whereas for classification plots a comprehensive list of taxa is required.	Required if species are recorded	Required if species are recorded
Plant Reference	Authority followed for taxon (could be entered by taxon, or collectively for the whole plot or as a default where not otherwise specified in the metadata).	Required if species are recorded	Required if species are recorded
Taxon Cover	Overall cover of the taxon across all strata. For occurrence plots, only dominant taxa are required, whereas for classification plots a	Required if species are recorded	Required if species are recorded

Attribute Name	Attribute Definition	Classification Plots	Occurrence Plots
	comprehensive list of taxa is required.		
Taxon Inference Area	This is the area in square meters used to estimate the cover of a given taxon. Generally this should be equal to Taxon Observation Area, but at times this area may be larger or smaller for a specific taxon.	Required if species are recorded	

Table D.1.3 — Information required for the plot location.

(some may be determined after a return to office, for example, with coordinate conversions)

Attribute Name	Attribute Definition	Classification Plots	Occurrence Plots
Latitude & Longitude	WGS84 Latitude and Longitude of the plot origin in degrees and decimals following any adjustments, conversions and postprocessing.	Required	Required
Type of Field Coordinates	Coordinates recorded in the field (latitude and longitude with datum, UTM with datum, or alternative geographic projection with units, longitude of center of projection, latitude of center of projection, False easting, False northing, X axis shift, & Y axis shift)	Required	Required
Location Accuracy	Estimated accuracy of the location of the plot. Plot origin has a 95% or greater probability of being within this many meters of the reported location.		Required
Area	Total area of the plot in square meters. If many subplots, this area includes the subplots and the interstitial space.	Required	

Table D.1.4 — Information about the plot environment.

(Reserved)

There are no required plot environment fields, because no one set of factors is relevant for all vegetation types. Provisions shall be made in the database to store a variety of plot environment information.

D.2 Information to be included as field plot metadata.

Field plot metadata includes the following kinds of information

1. Metadata about the plot and the plot observation.
2. Metadata about the methods used to collect the field data.
3. Metadata about the human sources of the field data.
4. Metadata about references for other sources of plot data.

Tables D.2.1 through D.2.4 describe the required metadata attributes.

Table D.2.1 — Metadata about the plot and the plot observation.

Attribute Name	Attribute Definition	Classification Plots	Occurrence Plots
Plot Type	Indicate if information is recorded from the entire plot or from subplots. If from subplots indicate how the subplots were configured: contiguous, regular, random, or haphazard	Required	
Taxon Observation Area	The total surface area (in square meters) used for cover estimates and for which a complete species list is provided. If subplots were used, this would be the total area of the subplots without interstitial space.	Required	
Cover Dispersion	Indication of how cover values for the total taxon list were collected; i.e., from one contiguous area or dispersed subplots (e.g., contiguous, dispersed-regular, dispersed-random)?	Required	

Table D.2.2 — Metadata about the methods used to collect the field data.

Identify the stratum/growth form method used. Vertical strata used for recording taxon cover shall be defined in terms of their upper and lower limits with this information reported in Table 1.2.

Attribute Name	Attribute Definition	Classification Plots	Occurrence Plots
Stratum/Growth Form Method Name	Name of the stratum/growth form method. Any appropriate label (e.g., NVC, Braun-Blanquet, NatureServe, North Carolina Vegetation Survey #1, etc..).	Required	
Stratum/Growth Form Method Description	This field describes the general methods used for strata/growth forms.	Required	
Cover Class Method	Name of the cover class method (e.g., Braun-Blanquet, Barkman, Domin, Daubenmire, North Carolina Vegetation Survey, etc.).	Required	
Cover Source	Direct Field Measure, Indirect (calculated) Measure	Required	
Cover Code	The name or label used in the cover class scale for this specific cover class.	Required	
Cover Code Upper Limit	Upper limit, in percent, associated with the specific cover code.	Required	
Cover Code Lower Limit	This is the lower limit, in percent, associated with a specific Cover Code.	Required	

Table D.2.3 — Metadata about the human sources of the field data.

Attribute Name	Attribute Definition	Classification Plots	Occurrence Plots
Given Name	One's first name.	Required	Required
Surname	Name shared in common to identify the members of a family, as distinguished from each member's given name.	Required	Required
Address Start Date	The first date on which the address/organization information was applied	Required	Required
The following may be repeated an indefinite number of times per person			
Role: Plot submitter	Name of the person submitting the analysis.	Required	Required
Role: Plot Primary Field Observer	Name of the person who made the field observation (e.g., PI, technician, volunteer, etc.).	Required	Required
Role: Plot Author	Name of the author of the plot record.	Required	Required

Table D.2.4 — Metadata about references for other sources of plot data.

These fields are used when plot observations are taken from published literature sources.

Attribute Name	Attribute Definition	Classification Plots	Occurrence Plots
Authors	Name of authors if plot record is taken from published work.	Required	Required
Title	Title of publication, if plot record is taken from published work.	Required	Required
Publication Date	Date of publication, if plot record is taken from published work.	Required	Required
Edition	Edition of publication if applicable, and if plot record is taken from published work.	Required	Required
Series Name	Name of publication series, if applicable, and if plot record is taken from published work.	Required	Required
Page	Page number of publication, if plot record is taken from published work.	Required	Required
Table Cited	Table number or code, if applicable and if plot record is taken from published work.	Required	Required
Plot Cited	Original plot name, if plot record is taken from published work.	Required	Required
Citation Type	Describes the type of reference this generic type is being used to represent. Examples: book, journal article, webpage.	Required	Required
Title	The formal title given to the work by its author or publisher.	Required	Required
Pub Date	Represents the date that the reference was published.	Required	Required
Access Date	The date the reference being referenced was accessed. This is useful if the reference is could be changed after formal publication, such as websites or databases.	Required	Required
Conference Date	The date the conference was held.	Required	Required
Volume	The volume of the journal in which the article appears.	Required	Required
Issue	The issue of the journal in which the article appears.	Required	Required
Page Range	The beginning and ending pages of the journal article that is being documented.	Required	Required
Total Pages	The total number of pages in the book that is being described.	Required	Required
Publisher	The organization that physically put together the report and publishes it.	Required	Required
Publication Place	The location at which the work was published. This is usually the name of the city in which the publishing house produced the work.	Required	Required
ISBN	The ISBN, or International Standard Book Number assigned to this literature reference.	Required	Required

Attribute Name	Attribute Definition	Classification Plots	Occurrence Plots
Edition	The edition of the generic reference type that is being described.	Required	Required
Number Of Volumes	Number of volumes in a collection	Required	Required
Chapter Number	The chapter number of the chapter of a book that is being described.	Required	Required
Report Number	The unique identification number that has been issued by the report institution for the report being described.	Required	Required
Journal	The name of the publication in which the article was published. Example(s): Ecology, New York Times, Harper's, Canadian Journal of Botany/Revue Canadienne de Botanique, The Journal of the American Medical Association	Required	Required
ISSN	The ISSN, or International Standard Serial Number assigned to this literature reference. Example(s): ISSN 1234-5679	Required	Required
The following may be repeated an indefinite number of times for each contributor to the reference (e.g. author, editor).			
Role Type	The role the party played with respect to the reference contribution. Some potential roles include technician, reviewer, principal investigator, and many others.	Required	Required
Order	Numerical order in which this contributor's name should be in the order of contributors, if applicable. Examples: 1 [for the first author], 2, [for the second author], etc.	Required	Required
Type	The type of Party that a given record refers to, usually a person or institution.	Required	Required
Given Name	The given name field is used for all names except the surname of the individual. Examples: Jo, Jo R., Jo R.W., John Robert Peter	Required	Required
Surname	The surname field is used for the last name of the individual.	Required	Required

D.3 Information about each assignment of a field plot to a vegetation type

Information that should be included about each assignment of a field plot to a vegetation type in the NVC or other party-specific classification. Assignment, per se, of a plot to a classification type is not required. Table D.3.1 describes the required information.

Table D.3.1 — Information about each assignment of a plot to a vegetation type.

Attribute Name	Attribute Definition	Classification Plots	Occurrence Plots
Classification Start Date	Start date for the application of a vegetation class to a plot observation by one or more parties.	Required	Required
Classifier	Name of person who classified the plot – this should link to a person included in the human resources metadata table.	Required	Required
Interpretation Date	The date that the interpretation was made.	Required if known	Required
Interpretation Type	Categories for the interpretation (e.g., author, computer-generated, simplified for comparative analysis, correction, finer resolution).	Required if known	Required
Original Interpretation	Does this interpretation correspond to the original interpretation of the plot author, as best as can be determined. There is no requirement that the authority match the authority of the author; only that the concepts are synonymous.	Required if known	Required
Current Interpretation	This interpretation is the most accurate interpretation currently available.	Required if known	Required
The following may be repeated for each community type associated with a plot during a classification event			
Community Name	Name of the community	Required if known	Required
Community Reference	Reference wherein the above name is defined	Required if known	Required

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Appendix E (Normative): Growth Form Names, Codes, and Definitions

Table E.1. Names, definitions and codes for growth forms for use in collecting vegetation plot data (see also Whittaker 1975:359, Tart et al. 2005b, and Table 1.2 of Appendix B). Not to be confused with vegetation strata.

Table E.1a. General Growth Forms

Growth Form Code	Name and Definition
T	**Tree** - *A woody plant that generally has a single main stem and a more or less definite crown.* In instances where growth form cannot be determined, woody plants equal to or greater than 5 m in height at maturity shall be considered trees (adapted from FGDC 1997). Includes small trees or "treelets" (Box 1981)
S	**Shrub** - *A woody plant that generally has several erect, spreading, or prostrate stems which give it a bushy appearance.* In instances where growth form cannot be determined, woody plants less than 5 m in height at maturity shall be considered shrubs (adapted from FGDC 1997). Includes dwarf-shrubs (less than 30 cm), krummholz (wind-stunted woody scrub), low or short woody vines, and arborescents (woody plants that branch at or near ground-level but grow to low tree heights). (Box 1981).
H	**Herb** - *A vascular plant without perennial aboveground woody stems, with perennating buds borne at or below the ground surface.* (Whittaker 1975, FGDC 1997). Includes forbs (both flowering forbs and spore-bearing ferns), graminoids, and herbaceous vines.
N	**Nonvascular** - *A plant or plant-like organism without specialized water or fluid conductive tissue (xylem and phloem).* Includes mosses, liverworts, hornworts, lichens, and algae (adapted from FGDC 1997). Also called thallophytes or "nonvascular cryptogams," (that is, excluding the fern cryptogams) (Box 1981).
E	**Epiphyte** - *A vascular or nonvascular plant that grows by germinating and rooting on other plants or other perched structures, and does not root in the ground* (adapted from FGDC 1997).
L	**Liana** - *A woody, climbing plant that begins life as terrestrial seedlings but relies on external structural support for height growth during some part of its life* (Gerwing 2004), *typically exceeding 5 m in height or length at maturity*.

Table E.1b. Specific Growth Forms

General Growth Form Code	Specific Growth Form Code	Name and Definition
T	TBD	**Broad-leaved deciduous tree** - *A tree with a branching crown, leaves that have well-defined leaf blades that are generally of at least microphyll size (≥225 mm^2, or 0.35 in^2) and which seasonally loses all of its leaves and becomes temporarily bare-stemmed.* (adapted from FGDC 1997, Box 1981)
	TBE	**Broad-leaved evergreen tree** - *A tree with a branching crown, leaves that have well-defined leaf blades that are generally of at least microphyll size (≥225 mm^2 or 0.35 in^2) and which has green leaves all year round.* (FGDC 1997, Box 1981)
	TBES	**Sclerophyllous tree** - *A type of broad-leaved evergreen tree with leaves that are stiff and firm, and retain their stiffness even when wilted. The leaves are relatively small (microphyll to small mesophyll in size),and sometimes rather linear* (FGDC 1997, Whittaker 1975, Box 1981)
	TN	**Needle-leaved tree** - *A tree with slender, elongated leaves or with small overlapping leaves that usually lie flat on the stem.* Includes scale-leaved and needle-leaved trees, deciduous and everrgreen, needleleaf trees. (FGDC 1997, Box 1981)
	TU	**Succulent tree** – *A tree or arborescent plant with fleshy stems or leaves with specialized tissue for the conservation of water.* (FGDC 1997) Includes cacti, Joshua trees, euphorbias, and others over 5 meters in height at maturity. Referred to as "arborescent stem-succulent" by Box (1981)
	TM	**Small-leaved tree** - *A tree with very small leaves (<225 mm^2, or 0.35 in^2), or even leafless, sometimes armed with spines.* Includes both evergreen and deciduous small-leaved trees, such as *Acacia gregii, Mimosa* (adapted from Thorn tree by Whittaker 1975).
	TP	**Palm tree** - *An evergreen, broad-leaved, flowering tree with a simple, unbranched stem and terminal, rosulate crown of large, pinnate or fan-shaped leaves.* A type of rosette tree. Palms are the primary taxa (but see Draceanaceae, some Pandanaceae etc in Box 1981)
	TF	**Tree fern** - *An evergreen, broad-leaved, spore-bearing tree (or arborescent fern) with a simple, unbranched stem and terminal, rosulate crown of large fronds.* A type of rosette tree, including taxa from Cyatheaceae and some Velloziaceae (Box 1981).
	TG	**Bamboo tree**- *A woody-stemmed, arborescent grass that is equal to or greater than 5 m in height at maturity.* Only applies to woody-stemmed bamboo graminoids. Includes the "Arborescent grasses" of Box (1981).
S	SD	**Dwarf-shrub** - *A caespitose, creeping, matted, or cushion-forming shrub that is typically less than 30 cm tall at maturity due to genetic and/or environmental constraints, and generally small-leaved.* Does not include shrubs less than 30 cm tall due to young age. (adapted from Mueller-Dombois and Ellenberg 1974)

General Growth Form Code	Specific Growth Form Code	Name and Definition
	SBD	**Broad-leaved deciduous shrub** - *A shrub that is typically more than 30 cm tall at maturity with leaves that have well-defined leaf blades that are generally of at least microphyll size (≥225 mm^2, or 0.35 in^2 and seasonally loses all of its leaves and becomes temporarily bare-stemmed.* (FGDC 1997)
	SBE	**Broad-leaved evergreen shrub** - *A shrub that is typically more than 30 cm tall at maturity with leaves that are generally of at least microphyll size (≥225 mm^2, or 0.35 in^2 and has green leaves all year round.* (adapted from FGDC 1997, Box 1981)
	SBES	**Sclerophyllous shrub** - *A type of broad-leaved evergreen shrub with relatively small, leaves that are stiff and firm, and retain their stiffness even when wilted.* (FGDC 1997, Whittaker 1975)
	SN	**Needle-leaved shrub** - *A shrub that is typically more than 30 cm tall at maturity with slender, elongated leaves or with small overlapping leaves that usually lie flat on the stem.* (FGDC 1997) Includes scale-leaved as well as needle-leaved shrubs, and deciduous as well as evergreen.
	SU	**Succulent shrub** – *A shrub or shrub-like plant that is typically more than 30 cm tall at maturity with fleshy stems or leaves with specialized tissue for the conservation of water.* (adapted from FGDC 1997 and the Thorn shrub of Whittaker 1975) Includes cacti less than 5 meters in height at maturity. Includes both the "Typical Stem succulents" and "Bush succulents" of Box (1981). Includes Aloe, Agave.
	SM	**Small-leaved shrub** - *A shrub that is typically more than 30 cm tall at maturity with very small leaves (<225 mm^2, or 0.35 in^2), or even leafless, sometimes armed with spines, usually having compound, deciduous leaves that are often reduced in size*. Includes *Larrea tridentata*, *Prosopis glandulosa,Acacia neovernicosa, Senna, Calliandra* (Jennings et al. 2006, Whittaker 1975)
	SP	**Palm shrub** - *An evergreen, broad-leaved, unbranched shrub that is typically more than 30 cm tall at maturity with a simple stem and terminal, rosulate crown of large, pinnate or fan-shaped leaves.* Includes palms, espelettia, etc.

General Growth Form Code	Specific Growth Form Code	Name and Definition
H	**HA**	**Aquatic herb** - *A flowering or non-flowering herb structurally adapted to live floating or submerged in an aquatic environment*. Does not include emergent herbs such as cattails and sedges. (FGDC 1997, Jennings et al. 2006)
	HF	**Forb** - *A non-aquatic, non-graminoid herb with relatively broad leaves and/or showy flowers*. Includes both flowering and spore-bearing, non-graminoid herbs.
	HFF	**Flowering forb** - *A forb with relatively broad leaves and showy flowers*. Does not include graminoids, ferns, or fern-allies.
	HFE	**Fern (Spore-bearing forb)** - *A non-flowering, spore-bearing forb*. Includes non-aquatic, non-woody ferns, clubmosses, horsetails, and quillworts.
	HFS	**Succulent forb** - *A flowering forb with a fleshy stem and often with reduced leaves.* Includes Salicornia and others.
	HG	**Graminoid** - *A non-aquatic, flowering herb with relatively long, narrow leaves and inconspicuous flowers with parts reduced to bracts*. Includes grasses, sedges, rushes, and arrowgrasses.
N	**NB**	**Bryophyte** - *A nonvascular, non-flowering, photosynthetic plant that bears leaf-like appendages or lobes and attaches to substrates by rhizoids*. Includes mosses, liverworts, and hornworts. (Abercrombie et al. 1966)
	NA	**Alga** - *A nonvascular, photosynthetic plant with a simple form ranging from single- or multi-celled to a filamentous or ribbon-like thallus with relatively complex internal organization.* (Abercrombie et al. 1966)
	NL	**Lichen** - *An organism generally recognized as a single plant that consists of a fungus and an alga or cyanobacterium living in symbiotic association.* (FGDC 1997)
E	**E**	**Epiphyte** - *A vascular or nonvascular plant that grows by germinating and rooting on other plants or other perched structures, and does not root in the ground* (adapted from FGDC 1997).
L	**L**	**Liana** - *A woody, climbing plant that begins life as terrestrial seedlings but relies on external structural support for height growth during some part of its life* (Gerwing 2004), *typically exceeding 5 m in height or length at maturity*.

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Appendix F (Informative): Example Association Description

Field names and information are taken, in part, from the NatureServe Biotics database.

OVERVIEW:

Names:

Name: Sporobolus heterolepis - Schizachyrium scoparium - (Carex scirpoidea) / (Juniperus horizontalis) Herbaceous Association.

Name, translated: Prairie Dropseed - Little Bluestem - (Scirpus-like Sedge) / (Creeping Juniper) Herbaceous Vegetation

Common Name: Little Bluestem Alvar Grassland

Identifier: CEGL005234

Unit: ASSOCIATION

Placement in Hierarchy:

FORMATION:Temperate Grassland, Meadow & Shrubland

DIVISION: Eastern North America Grassland, Meadow & Shrubland

MACROGROUP: Northeastern Rocky Grassland, Meadow & Shrubland

GROUP: Great Lakes Alvar Grassland & Shrubland

ALLIANCE: SPOROBOLUS HETEROLEPIS - (DESCHAMPSIA CAESPITOSA, SCHIZACHYRIUM SCOPARIUM) HERBACEOUS ALLIANCE

Summary: The little bluestem alvar grassland type is found primarily in the upper Great Lakes region of the United States and Canada, in northern Michigan and southern Ontario. These grasslands occur on very shallow, patchy soils (usually less than 20 cm deep, averaging about 6 cm deep) on flat alkaline limestone and dolostone outcrops (pavements). This community often has a characteristic soil moisture regime of alternating wet and dry periods. The vegetation is dominated by grasses and sedges, which tyically have at least 45% cover. Characteristic species of the grassland are *Sporobolus heterolepis, Schizachyrium scoparium, Juniperus horizontalis, Carex scirpoidea, Deschampsia caespitosa, Packera paupercula (= Senecio pauperculus)*, and *Carex crawei*. There is usually less than 10% cover of shrubs over 0.5 m tall; however there may be as much as 50% cover of dwarf-shrubs (under 0.5 m tall) especially *Juniperus horizontalis*. Less than 50% of the ground surface is exposed bedrock (including bedrock covered with nonvascular plants: lichens, mosses, algae).

Classification Comments: The most commonly associated alvar communities that occur with this community in a landscape mosaic are *Juniperus horizontalis - Dasiphora*

fruticosa ssp. floribunda / Schizachyrium scoparium - Carex richardsonii Dwarf-shrubland (Creeping Juniper - Shrubby-cinquefoil Alvar Pavement Shrubland; CEGL005236), *Deschampsia caespitosa - (Sporobolus heterolepis, Schizachyrium scoparium) - Carex crawei - Packera paupercula* Herbaceous Vegetation (Tufted Hairgrass Wet Alvar Grassland;CEGL005110), *Tortella tortuosa - Cladonia pocillum - Placynthium* spp. Sparse Vegetation (Alvar Nonvascular Pavement;CEGL005192) and, *Thuja occidentalis - Pinus banksiana / Dasiphora fruticosa ssp. floribunda / Clinopodium arkansanum* Wooded Herbaceous Vegetation (White-cedar - Jack Pine / Shrubby-cinquefoil Alvar Savanna; CEGL005132) (Reschke et al. 1998).

Rational for nominal species: *Sporobolus heterolepis* and *Schizachyrium scoparium* are dominants. *Carex scirpoidea* and *Juniperus horizontalis* are constants (>60% constancy) in the type. *Sporobolus heterolepis*, *Carex scirpoidea* and *Deschampsia cespitosa* are differential species.

VEGETATION:

Physiognomy and structure: The vegetation is dominated by grasses and sedges, which usually have at least 45% cover. There is usually less than 10% cover of shrubs over 0.5 m tall; however there may be as much as 50% cover of dwarf-shrubs (under 0.5 m tall) especially *Juniperus horizontalis*. This dwarf-shrub is shorter than the dominant grasses, and usually is found under the canopy of grasses, so the physiognomic type here is considered a grassland (in spite of relatively high cover of dwarf-shrubs). Less than 50% of the ground surface is exposed bedrock (including bedrock covered with nonvascular plants: lichens, mosses, algae).

Table 1. Physiognomy of the Sporobolus heterolepis - Schizachyrium scoparium - (Carex scirpoidea) / (Juniperus horizontalis) Herbaceous Association; Little Bluestem Alvar Grassland, NVC identifier code CEGL005234.

Physiognomy	Average Cover	Range of Cover
Tree Cover (> 5m)	1.0	0 - 15
Tree Height (m)	0.5	0 - 9
Tall Shrub Cover (2-5 m)	0.5	0 - 3
Tall Shrub Height (m)	0.5	0 - 3
Short Shrub Cover (0.5-2 m)	11.0	0 - 33
Short Shrub Height (m)	1.0	0 - 1.8
Vine Cover	0.0	0 - 0
Vine Height	0.0	0 - 0
Herb Cover	46.0	4 - 99
Herb Height	0.3	0-1
Nonvascular Cover	34.0	0 - 90

Floristics: Characteristic species of the grassland are *Sporobolus heterolepis, Schizachyrium scoparium, Juniperus horizontalis, Carex scirpoidea, Deschampsia caespitosa, Packera paupercula (= Senecio pauperculus)*, and *Carex crawei*. *Juniperus horizontalis* may co-dominate in some stands.

Table 2: Floristic table of the Sporobolus heterolepis - Schizachyrium scoparium - (Carex scirpoidea) / (Juniperus horizontalis) Herbaceous Association; Little Bluestem Alvar Grassland, NVC identifier code CEGL005234. For species in > 10% of stands for a total of 17 field plots. Species nomenclature is according to Gleason and Cronquist (1991).

Species by Layer	Constancy	Avg. Cover	Range of Cover, Where Present *
SHORT SHRUB LAYER (0.5-2 m)			
Juniperus communis	24	0.1	0.3 - 2
Juniperus horizontalis	71	8.0	1 - 33
Prunus pumila	29	0.5	0.3 - 4
Thuja occidentalis	12	0.1	0.3 - 0.3
HERB LAYER			
Achillea millefolium	12	0.1	0.3 - 0.3
Agropyron trachycaulum	24	0.1	0.3 - 0.3
Ambrosia artemisiifolia	18	0.1	0.3 - 0.3
Antennaria spp.	24	0.1	0.3 - 0.3
Aquilegia canadensis	18	0.1	0.3 - 0.3
Arenaria stricta	29	0.1	0.3 - 1
Aster ciliolatus	12	0.1	0.3 - 0.3
Aster laevis	47	0.5	0.3 - 2
Bromus kalmii	18	0.1	0.3 - 2
Calamagrostis canadensis	12	0.1	1 - 2
Calamintha arkansana	59	1.0	0.3 - 5
Campanula rotundifolia	65	0.5	0.3 - 1
Carex aurea	12	0.1	0.3 - 0.3
Carex crawei	24	2.0	0.3 - 18
Carex eburnea	24	0.5	0.3 - 4
Carex granularis	12	0.1	0.3 - 1
Carex richardsonii	12	0.1	1 - 3
Carex scirpoidea	71	4.0	0.3 - 23
Carex viridula	41	0.5	0.3 - 2
Castilleja coccinea	29	0.1	0.3 - 1
Cladium mariscoides	12	0.5	1 - 5
Comandra umbellata	53	0.1	0.3 - 1
Danthonia spicata	53	1.0	0.3 - 5
Deschampsia cespitosa	47	1.0	0.3 - 5
Eleocharis compressa	29	0.5	0.3 - 3
Eleocharis elliptica	12	0.5	0.3 - 5
Fragaria virginiana	29	0.1	0.3 - 1

Table 2: Floristic table of the Sporobolus heterolepis - Schizachyrium scoparium - (Carex scirpoidea) / (Juniperus horizontalis) Herbaceous Association; Little Bluestem Alvar Grassland, NVC identifier code CEGL005234. For species in > 10% of stands for a total of 17 field plots. Species nomenclature is according to Gleason and Cronquist (1991).

Species by Layer	Constancy	Avg. Cover	Range of Cover, Where Present *
Geum triflorum	18	0.1	0.3 - 0.3
Hedyotis longifolia	18	0.5	0.3 - 5
Hypericum kalmianum	41	0.1	0.3 - 0.3
Hypericum perforatum	29	0.1	0.3 - 0.3
Muhlenbergia glomerata	12	0.1	1 - 2
Panicum spp.	35	1.0	0.3 - 5
Poa compressa	47	5.0	0.3 - 55
Polygala senega	12	0.1	0.3 - 1
Potentilla fruticosa	71	2.0	0.3 - 8
Prunella vulgaris	24	0.1	0.3 - 0.3
Rhamnus alnifolia	12	0.1	0.3 - 2
Rhus aromatica	18	0.2	0.3 - 3
Saxifraga virginiensis	12	0.1	0.3 - 0.3
Schizachyrium scoparium	71	8.0	0.3 - 38
Scirpus cespitosus	12	2.0	1 - 25
Senecio pauperculus	88	2.0	0.3 - 23
Sisyrinchium mucronatum	18	0.1	0.3 - 1
Solidago juncea	12	0.1	0.3 - 0.3
Solidago ohioensis	12	1.0	0.3 - 16
Solidago ptarmicoides	76	0.5	0.3 - 3
Solidago spp.	18	0.1	0.3 - 0.3
Sporobolus heterolepis	53	12.0	0.3 - 76
Sporobolus neglectus/vaginiflorus	24	2.0	0.3 - 25
Zigadenus elegans var. glaucus	29	0.1	0.3 - 2
MOSS LAYER			
Gloeocapsa /rock surface algae	47	12.0	5 - 60
Nostoc commune	41	2.0	0.3 - 18
Trentepohlia spp	29	0.1	0.3 - 0.3
Ditrichum flexicaule	24	0.1	0.3 - 3
Pseudocalliergon turgescens	18	1.0	0.3 - 15
Schistidium rivulare	24	0.5	0.3 - 10
Tortella spp.	41	3.0	0.3 - 29
Tortella tortuosa	12	0.5	0.3 - 10
Cladina rangiferina	18	0.1	0.3 - 0.3
Cladina spp.	12	0.1	0.3 - 0.3
Cladonia pyxidata	29	0.1	0.3 - 1
Cladonia spp.	18	0.1	0.3 - 2
Peltigera spp. (P. rufescens?)	12	0.1	0.3 - 0.3

Table 2: Floristic table of the Sporobolus heterolepis - Schizachyrium scoparium - (Carex scirpoidea) / (Juniperus horizontalis) Herbaceous Association; Little Bluestem Alvar Grassland, NVC identifier code CEGL005234. For species in > 10% of stands for a total of 17 field plots. Species nomenclature is according to Gleason and Cronquist (1991).

Species by Layer	Constancy	Avg. Cover	Range of Cover, Where Present *
Placynthium nigrum	24	0.2	0.3 - 2
Xanthoparmelia spp.	12	0.1	0.3 - 0.3

* Each species may not be present in every plot; the range of values is derived only from plots where the species has been found.

Dynamics: Not documented.

Environment: These grasslands occur on very shallow, patchy soils (usually less than 20 cm deep, averaging about 6 cm deep) on flat limestone and dolostone outcrops (pavements). Soils are loams high in organic matter. This community often has a characteristic soil moisture regime of alternating wet and dry periods; they can have wet, saturated soils in spring and fall, combined with summer drought in most years. In large patches over 20 ha (50 acres) this grassland often occurs as a small-scale matrix, with smaller patches of other alvar communities occurring within the larger patch of little bluestem alvar grassland, forming a landscape mosaic (Reschke et al. 1998).

Table 3. Physical environment of the Sporobolus heterolepis - Schizachyrium scoparium - (Carex scirpoidea) / (Juniperus horizontalis) Herbaceous Association; Little Bluestem Alvar Grassland, NVC identifier code CEGL005234.

Continuous Variables	Average	Range
Elevation (m)	186.0	178-209
Slope Gradient (degrees)	0.5	0 - 3
Organic Horizon Depth (cm)	1.0	0 - 8
Average Field pH	7.8	7.3 - 9
Soil Depth (cm)	4.0	1 - 9
Exposed Bedrock (%)	18.0	0 - 75
Large Rock, Surficial (% > 10 cm)	7.0	0 - 35
Small Rock, Surficial (% 0.2 - 2 cm)	10.0	0 - 72
Sand, Surficial (%)	0.0	0 - 0
Bare Soil, Surficial (%)	0.5	0 - 5
Litter (%)	2.0	0 - 12
Down Wood (% > 1 cm dbh)	0.1	0 - 1
Water (%)	0.1	0 - 1
Categorical Variables	Category	Number of

Table 3. Physical environment of the Sporobolus heterolepis - Schizachyrium scoparium - (Carex scirpoidea) / (Juniperus horizontalis) Herbaceous Association; Little Bluestem Alvar Grassland, NVC identifier code CEGL005234.

Continuous Variables	Average	Range
		Plots (%)
Slope Aspect	Flat	7 (41)
Slope Aspect	South	6 (35)
Slope Aspect	Northeast	2 (12)
Slope Aspect	West	1 (6)
Slope Aspect	North	1 (6)
Topographic Position	High, level	5 (28)
Topographic Position	Low, level	4 (24)
Topographic Position	Midslope	2(12)
Topographic Position	Other	4 (24)
Topographic Position	No Value	2 (12)
Soil Moisture	Periodically Inundated	7 (41)
Soil Moisture	Moist	4 (24)
Soil Moisture	Somewhat Moist	3 (17)
Soil Moisture	Dry	1 (6)
Soil Moisture	Extremely Dry	1 (6)
Soil Moisture	No Value	1 (6)

DISTRIBUTION:

Range: The little bluestem alvar grassland type is found primarily in the upper Great Lakes region of the United States and Canada, in northern Michigan, and in Ontario on Manitoulin Island and vicinity, on the Bruce Peninsula, and at a few sites further east in the Carden Plain and Burnt Lands.

Nations: CA US

States/Provinces: Michigan, Ontario

USFS Ecoregions: 212H:CC, 212Pc:CCC

PLOT SAMPLING AND ANALYSIS:

Location of archived plot data: Spreadsheet files with compiled vegetation data from plots and structural types are available from The Nature Conservancy's Great Lakes Program Office or from the state or provincial Heritage Programs. Original field forms are filed at state/provincial Heritage Programs. Plot data access forthcoming (2004) at www.vegbank.org.

Factors affecting data consistency: See "Methods," below.

The number and size of plots: Vegetation data were collected using 10 x 10 m relevé plots placed haphazardly within subjectively defined stands.

Methods used to analyze field data and identify type:

From Reschke et al. (1998): Field data collected by collaborators in Michigan, Ontario, and New York were compiled by the Heritage program staff in each jurisdiction, and provided to Carol Reschke (inventory and research coordinator for the Alvar Initiative). With assistance from a contractor (Karen Dietz), field data on vegetation, environment, and evidence of ecological processes from alvar sites were entered into spreadsheets. Spreadsheets were edited to combine a few ambiguous taxa (e.g. *Sporobolus neglectus* and *S. vaginiflorus* look similar and can only be positively distinguished when they are flowering in early fall), incorporate consistent nomenclature (Kartesz 1994), delete duplicates, and delete species that occurred in only one or a few samples. Corresponding data on the environment and evidence of ecological processes were compiled in two additional spreadsheets. The plot data set consisted of data from 85 sample plots; there were 240 taxa of vascular and nonvascular taxa included in the initial data set.

The plot data set included a great deal of structural detail. If a tree species was present in different vegetation strata, then it was recorded as a separate taxon for each layer in which it occurred; for example, *Thuja occidentalis* might be recorded as a tree (over 5 m tall), a tall shrub (2 to 5 m tall), and a short shrub (05 to 2 m tall). The full data set of 85 samples by 240 taxa was analyzed using PC-ORD v 3.0 (McCune and Mefford 1995). Vegetation data on percent cover were relativized for each sample and then transformed with an arcsine - square root transformation. This standardization is recommended for percentage data (McCune and Mefford 1995).

Two kinds of classification and two kinds of ordination procedures were applied to the full data set. Classification procedures used were: 1) cluster analysis with group average (or UPGMA) group linkage method and Sørenson's distance measure, and 2) TWINSPAN with the default settings. The two ordination procedures used were 1) Bray-Curtis ordination with Sørenson's distance and variance-regression endpoint selection, and 2) non-metric multidimensional scaling (NMS) using Sørenson's distance and the coordinates from the Bray-Curtis ordination as a starting configuration.

Environmental data recorded for each plot and data on evidence of ecological processes were used as overlays in ordination graphs to interpret ordination patterns and relationships among samples.

The classification dendrograms and ordination graphs were presented to a core group of ecologists to discuss the results. Participants in the data analysis discussions were: Wasyl Bakowsky, Don Faber-Langendoen, Judith Jones, Pat Comer, Don Cuddy, Bruce Gilman, Dennis Albert, and Carol Reschke. The two classifications were compared to see how they grouped plots, and ordinations were consulted to check and confirm groupings of plots suggested by the classification program. At the end of the first meeting to discuss the data analysis, collaborating ecologists agreed on eight alvar community types, and suggested

another four or five that had been observed in field surveys but were not represented in the plot data set. The group also recommended some refinements to the data analysis.

Following the recommendations of the ecology group, the plot data were modified in two ways. For nonvascular plants, the first data set included data on individual species or genera, as well as taxa representing simple growth forms. Since only a few collaborators could identify nonvascular plants in the field, we had agreed to describe the nonvascular plants in plots by their growth form and collect a specimen if the species had at least 5% cover in the plot. If nonvascular species were identified by the surveyor, or from the collected specimen, the species were included in the data set. This may have biased the results, because the plots sampled by investigators who knew the nonvascular plants had a greater potential diversity than plots in which only a few growth forms were identified. Therefore, all data on nonvascular taxa were lumped into nine growth form categories: foliose algae (e.g. *Nostoc*), rock surface algae, microbial crusts, turf or cushion mosses, weft mosses, thalloid bryophytes, crustose lichens, foliose lichens, and fruticose lichens. The second modification involved lumping the different structural growth forms of woody taxa into a single taxon; for example, trees, tall shrubs and short shrubs forms of *Thuja occidentalis* were lumped into a single taxon.

These modifications reduced the data set to 85 plots and 199 taxa, and even fewer taxa with the woody growth forms lumped. The analyses were run again using the procedures described above with the modified data sets. Lumping the nonvascular plants improved the classification and ordination results (yielding more clearly defined groups), but lumping the growth forms of tree species was actually detrimental to the results. The final classification that we used was produced from an analysis of the data set with nonvascular plants lumped into nine growth forms, and multiple growth forms of tree species kept separate.

CONFIDENCE LEVEL:

Confidence Rank: High.

CITATIONS:

Synonymy:

Dry – Fresh Little Bluestem Open Alvar Meadow Type = (Lee et al. 1998).

References:

Gleason, H.A. and A. Cronquist. 1991. Manual of vascular of plants of northeastern United States and adjacent Canada, 2nd edition. The New York Botanical Garden, Bronx, NY, USA. 910 p.

Kartesz, J. T. 1994. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. Second edition. Volume 1--Checklist. Timber Press, Portland, OR. 622 p.

Lee, H., W. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig, and S. McMurray. 1998. Ecological land classification for southern Ontario: First approximation and its application. Ontario Ministry of Natural Resources, Southcentral Science Section, Science Development and Transfer Branch. SCSS Field Guide FG-02.

McCune, B., and M.J. Mefford. 1995. Multivariate analysis of ecological data, PC-ORD version 3.0. MjM Software, Gleneden Beach, Oregon, USA.

Reschke, C., R. Reid, J. Jones, T. Feeney, and H. Potter, on behalf of the Alvar Working Group. 1998. Conserving Great Lakes Alvars. Final Technical Report of the International Alvar Conservation Initiative. December 1998. The Nature Conservancy, Great Lakes Program, Chicago, IL. 119 pp. plus 4 appendices.

Author of Description: C. Reschke and Don Faber-Langendoen

APPENDIX G. (Informative). Pilot examples of units for Natural Vegetation: Levels 1 – 4

Levels 1 – 3 are comprehensive for the globe; Level 4 is incompletely developed for the Western Hemisphere.

LEVEL 1– FORMATION CLASS	LEVEL 2 – FORMATION SUBCLASS	LEVEL 3 – FORMATION Wetland formations marked with *	LEVEL 4 – DIVISION (examples only)
1. Mesomorphic Tree Vegetation (Forest & Woodland)	1.A. Tropical Moist Forest	1.A.1. Tropical Lowland Evergreen Rainforest	Polynesian Lowland Evergreen Rainforest, Central American-Caribbean Lowland Evergreen Rainforest
		1.A.2. Tropical Montane & Cloud Forest	Polynesian Montane & Cloud Forest
		1.A.3. Tropical Flooded & Swamp Forest *	Neotropical Flooded & Swamp Forest
		1.A.4. Mangrove*	Atlantic-Caribbean-East Pacific Mangrove
	1.B. Tropical Dry Forest	1.B.1. Tropical (Semi-) Deciduous Forest	Central American-Caribbean Tropical Dry Forest
	1.C. Temperate Forest	1.C.1. Warm Temperate Forest	Southeastern North America Warm Temperate Forest, Madrean Warm Temperate Forest
		1.C.2. Cool Temperate Forest	Eastern North America Temperate Forest, Western North America Cool Temperate Forest
		1.C.3. Temperate Flooded & Swamp Forest *	Eastern North America Flooded & Swamp Forest
	1. D. Boreal Forest	1.D.1. Lowland & Montane Boreal Forest	North American Boreal Forest
		1.D.2. Boreal Flooded & Swamp Forest *	North American Boreal Flooded & Swamp Forest
2. Mesomorphic Shrub & Herb Vegetation (Shrubland & Grassland)	2.A. Tropical Shrubland, Grassland, & Savanna	2.A.1. Tropical Lowland Shrubland, Grassland, & Savanna	Central American-Caribbean Shrubland, Grassland & Savanna
		2.A.2. Tropical Montane Shrubland, Grassland, & Savanna	Central American-Caribbean Montane Shrubland, Grassland, & Savanna Andean Montane Shrubland, Grassland, & Savanna
		2.A.3. Tropical Scrub & Herb Coastal Vegetation	Neotropical Scrub & Herb Coastal Vegetation
		2.A.4. Tropical Bog & Fen *	Polynesian Bog & Fen
		2.A.5. Tropical Freshwater Marsh *	Neotropical Freshwater Marsh, Tropical Pacific Islands Freshwater Marsh
		2.A.6. Tropical Salt Marsh*	Tropical Pacific Islands Salt Marsh
	2.B. Mediterranean Scrub & Grassland	2.B.1. Mediterranean Scrub	Californian Scrub
		2.B.2. Mediterranean Grassland & Forb Meadow	Californian Grassland & Forb Meadow
	2.C. Temperate & Boreal Shrubland & Grassland	2.C.1. Temperate Grassland, Meadow & Shrubland	North American Great Plains Grassland and Shrubland
		2.C.2. Boreal Grassland, Meadow & Shrubland	North American Boreal Grassland, Meadow &

			Shrubland
		2.C.3. Temperate & Boreal Scrub & Herb Coastal Vegetation	**North American Atlantic Scrub & Herb Coastal Vegetation**
		2.C.4. Temperate & Boreal Bog & Fen*	**North American Bog & Fen**
		2.C.5. Temperate & Boreal Freshwater Marsh*	**North American Freshwater Marsh**
		2.C.6. Temperate & Boreal Salt Marsh *	**Temperate & Boreal Atlantic Rim Salt Marsh, Temperate & Boreal Pacific Rim Salt Marsh**
3. Xeromorphic Scrub & Herb Vegetation (Semi-Desert)	**3.A. Warm Semi-Desert Scrub & Grassland**	**3.A.1. Warm Semi-Desert Scrub & Grassland**	**Sonoran & Chihuahuan Semi-Desert Scrub & Grassland**
	3.B. Cool Semi-Desert Scrub & Grassland	**3.B.1. Cool Semi-Desert Scrub & Grassland**	**Great Basin Cool Semi-Desert Scrub & Grassland**
4. Cryomorphic Shrub & Herb Vegetation (Polar & High Montane Vegetation)	**4.A. Tropical High Montane Vegetation**	**4.A.1. Tropical High Montane Scrub & Grassland**	**Central American-Caribbean High Montane Scrub & Grassland, Andean High Montane Scrub & Grassland**
	4.B. Temperate & Boreal Alpine Vegetation	**4.B.1. Alpine Scrub, Forb Meadow & Grassland**	**Western North America Alpine Scrub, Forb Meadow & Grassland; Eastern North America Alpine Scrub, Forb Meadow & Grassland;**
	4.C. Polar Tundra	**4.C.1. Dwarf-shrub, Herb and Non-vascular Tundra**	**Arctic Dwarf-shrub, Herb and Non-vascular Tundra**
		4.C.2. Tundra Wet Meadow *	**Arctic Tundra Wet Meadow**
5. Hydromorphic Vegetation (Aquatic Vegetation)	**5.A. Saltwater Aquatic Vegetation**	**5.A.1. Marine and Estuarine Saltwater Aquatic Vegetation * (and inland saltwater?)**	**Temperate Atlantic Saltwater Aquatic Vegetation, Temperate Pacific Saltwater Aquatic Vegetation**
	5.B. Freshwater Aquatic Vegetation	**5.B.1. Freshwater Aquatic Vegetation ***	**North American Freshwater Aquatic Vegetation**
6. Lithomorphic Vegetation (Nonvascular & Sparse Vascular Rock Vegetation)	**6.A. Tropical Nonvascular and Sparse Vegetation**	**6.A.1. Tropical Cliff, Scree, & Rock Vegetation**	**Neotropical Cliff, Scree, & Rock Vegetation**
	6.B. Mediterranean, Temperate, & Boreal Nonvascular & Sparse Vegetation	**6.B.1. Mediterranean Cliff, Scree, & Rock Vegetation**	**Californian Cliff, Scree, & Rock Vegetation**
		6.B.2. Temperate & Boreal Cliff, Scree, & Rock Vegetation	**Eastern North America Cliff, Scree, & Rock Vgetation**
	6.C. Semi-Desert Nonvascular & Sparse Vascular Vegetation	**6.C.1. Warm Semi-Desert Cliff, Scree, & Rock Vegetation**	**Sonoran &Chihuahuan Warm Semi-Desert Cliff, Scree, & Rock Vegetation**
		6.C.2. Cool Semi-Desert Cliff, Scree, & Rock Vegetation	**Great Basin Cool Semi-Desert Cliff, Scree, & Rock Vegetation**
	6.D. Polar & High Montane Nonvascular & Sparse Vegetation	**6.D.1. Tropical High Montane Cliff, Scree, & Rock Vegetation**	**Andean High Montane Cliff, Scree, & Rock Vegetation**
		6.D.2. Polar & Alpine Cliff, Scree, & Rock Vegetation	**Arctic Cliff, Scree, & Rock Vegetation; North American Alpine Cliff, Scree, & Rock Vegetation**
6 classes	***18 subclasses***	***39 formations***	***incomplete***
7. Agromorphic Vegetation (Agricultural Vegetation)	See Appendix I		
8. Hortomorphic Vegetation (Developed Vegetation)	See Appendix I		
8 classes			

APPENDIX H. (Informative). Pilot examples of units for Natural Vegetation: Levels 1 – 7 for Eastern U.S. forests.

Pilot example of NVC units for Eastern U.S. forests. Scientific names are used for Levels 1-4 and 7, and Colloquial Names for 5 – 6, but are not yet fully standardized. All units are in Formation Class L1 - Mesomorphic Tree Vegetation (Forest and Woodland).

L2. Formation Subclass	L3. Formation	L4. Division	L5. MacroGroup	L6. Group	L7. Alliance
1A. Tropical Moist Forest	1A1.Tropical Lowland Evergreen Rainforest	1A1a.Caribbean-Central American Lowland Evergreen Rainforest	Caribbean - Central American Seasonal Evergreen Forest MG	Caribbean Hardwood Hammock Forest Group	BURSERA SIMARUBA - COCCOLOBA DIVERSIFOLIA - NECTANDRA CORIACEA - EUGENIA AXILLARIS FOREST ALLIANCE (A.33)
					CASASIA CLUSIIFOLIA - GUAPIRA DISCOLOR FOREST ALLIANCE (A.34)
					METOPIUM TOXIFERUM - EUGENIA FOETIDA FOREST ALLIANCE (A.38)
					SABAL PALMETTO - COCCOLOBA UVIFERA FOREST ALLIANCE (A.43)
					METOPIUM TOXIFERUM WOODLAND ALLIANCE (A.465)
					CONOCARPUS ERECTUS - METOPIUM TOXIFERUM SATURATED FOREST ALLIANCE (A.77)
	1A3.Tropical Flooded & Swamp Forest	1A3a.Neotropical Swamp Forest	Caribbean - Central American Broadleaf Evergreen Swamp Forest MG	Caribbean Hardwood Swamp Group	MAGNOLIA VIRGINIANA - PERSEA PALUSTRIS - CHRYSOBALANUS ICACO SEASONALLY FLOODED WOODLAND ALLIANCE (A.474)
					ANNONA GLABRA SEMIPERMANENTLY FLOODED FOREST ALLIANCE (A.76)
	1A4.Mangrove	1A4a.Atlantic-Caribbean East Pacific Mangrove Forest	Western Atlantic - Caribbean Mangrove MG	Caribbean Mangrove Basin Swamp Group	CONOCARPUS ERECTUS SEASONALLY FLOODED WOODLAND ALLIANCE (A.473)
					RHIZOPHORA MANGLE - CONOCARPUS ERECTUS SEASONALLY FLOODED FOREST ALLIANCE (A.75)
					LAGUNCULARIA RACEMOSA SEASONALLY FLOODED FOREST ALLIANCE (A.81)
				Caribbean Mangrove Tidal Swamp Group	CONOCARPUS ERECTUS TIDAL FOREST ALLIANCE (A.1923)
					AVICENNIA GERMINANS TIDAL FOREST ALLIANCE (A.80)
					RHIZOPHORA MANGLE TIDAL FOREST ALLIANCE (A.83)
1B. Tropical Dry Forest	1B3.Tropical (Semi)-Deciduous and Conifer Forest	1B3a.Caribbean-Central American Dry Forest	Caribbean - Central American Pine - Oak MG	Caribbean Pine Forest Group	PINUS ELLIOTTII TROPICAL WOODLAND ALLIANCE (A.491)

L2. Formation Subclass	L3. Formation	L4. Division	L5. MacroGroup	L6. Group	L7. Alliance
1C. Temperate Forest	1C1. Warm Temperate Forest	1C1a.Southeastern North America Warm Temperate Forest	Southern Broadleaf Evergreen Hardwood MG	Southern Live Oak - Coastal Hardwood Forest Group	CARYA GLABRA - TILIA AMERICANA VAR. CAROLINIANA - CELTIS LAEVIGATA FOREST ALLIANCE (A.223)
					CELTIS LAEVIGATA FOREST ALLIANCE (A.226)
					ILEX OPACA FOREST ALLIANCE (A.3002)
					QUERCUS VIRGINIANA - CELTIS LAEVIGATA FOREST ALLIANCE (A.374)
					QUERCUS VIRGINIANA - QUERCUS PAGODA FOREST ALLIANCE (A.375)
					PINUS TAEDA - QUERCUS NIGRA FOREST ALLIANCE (A.406)
					QUERCUS VIRGINIANA - JUNIPERUS VIRGINIANA - (SABAL PALMETTO) WOODLAND ALLIANCE (A.479)
					SABAL PALMETTO TEMPERATE WOODLAND ALLIANCE (A.481)
					QUERCUS GEMINATA FOREST ALLIANCE (A.52)
					QUERCUS VIRGINIANA - (SABAL PALMETTO) FOREST ALLIANCE (A.55)
					QUERCUS VIRGINIANA - (CELTIS LAEVIGATA) / PRUNUS CAROLINIANA WOODLAND ALLIANCE (A.666)
				Beech - Magnolia - Oak Forest Group	FAGUS GRANDIFOLIA - LIQUIDAMBAR STYRACIFLUA - PINUS TAEDA - (MAGNOLIA GRANDIFLORA) TEMPORARILY FLOODED FOREST ALLIANCE (A.1989)
					FAGUS GRANDIFOLIA - QUERCUS ALBA FOREST ALLIANCE (A.228)
					FAGUS GRANDIFOLIA - MAGNOLIA GRANDIFLORA FOREST ALLIANCE (A.369)
			Coastal Plain Pine MG	Sand Pine Scrub Forest Group	PINUS CLAUSA FOREST ALLIANCE (A.117)
					PINUS CLAUSA WOODLAND ALLIANCE (A.511)
				Dry & Mesic Longleaf Pine Woodland Group	PINUS PALUSTRIS / QUERCUS SPP. WOODLAND ALLIANCE (A.499)
					PINUS ELLIOTTII WOODLAND ALLIANCE (A.517)
					PINUS PALUSTRIS WOODLAND ALLIANCE (A.520)
					QUERCUS LAEVIS WOODLAND ALLIANCE (A.617)
				Wet Longleaf Pine Woodland Group	PINUS ELLIOTTII SATURATED TROPICAL WOODLAND ALLIANCE (A.493)
					PINUS ELLIOTTII SATURATED TEMPERATE WOODLAND ALLIANCE (A.574)
					PINUS PALUSTRIS - PINUS (ELLIOTTII, SEROTINA) SATURATED WOODLAND ALLIANCE (A.578)
					PINUS ELLIOTTII - TAXODIUM ASCENDENS SATURATED WOODLAND ALLIANCE (A.692)

L2. Formation Subclass	L3. Formation	L4. Division	L5. MacroGroup	L6. Group	L7. Alliance
	1C2. Cool Temperate Forest	1C2a. Eastern North America Cool Temperate Forest	Southern Hardwood & Pine MG	Southeastern Oak - Hickory Forest Group	QUERCUS ALBA - (QUERCUS NIGRA) FOREST ALLIANCE (A.238)
					QUERCUS ALBA - QUERCUS (FALCATA, STELLATA) FOREST ALLIANCE (A.241)
					QUERCUS FALCATA FOREST ALLIANCE (A.243)
					QUERCUS SHUMARDII - QUERCUS PAGODA FOREST ALLIANCE (A.252)
					QUERCUS HEMISPHAERICA - CARYA GLABRA FOREST ALLIANCE (A.372)
					QUERCUS HEMISPHAERICA FOREST ALLIANCE (A.53)
					QUERCUS ALBA - QUERCUS STELLATA - QUERCUS VELUTINA - (QUERCUS FALCATA) WOODLAND ALLIANCE (A.613)
				Shortleaf Pine - Oak Forest Group	PINUS ECHINATA FOREST ALLIANCE (A.119)
					PINUS ECHINATA - QUERCUS (ALBA, FALCATA, STELLATA, VELUTINA) FOREST ALLIANCE (A.394)
					PINUS ECHINATA - QUERCUS (COCCINEA, PRINUS) FOREST ALLIANCE (A.395)
					PINUS ECHINATA WOODLAND ALLIANCE (A.515)
					PINUS ECHINATA - QUERCUS (ALBA, FALCATA, STELLATA, VELUTINA) WOODLAND ALLIANCE (A.679)
					PINUS ECHINATA - QUERCUS STELLATA - QUERCUS MARILANDICA WOODLAND ALLIANCE (A.680)
				Loblolly Pine - Oak Forest Group	PINUS TAEDA - PINUS ECHINATA FOREST ALLIANCE (A.129)
					PINUS (ECHINATA, TAEDA) - QUERCUS (STELLATA, MARILANDICA, FALCATA) WOODLAND ALLIANCE (A.2011)
					PINUS (ECHINATA, TAEDA) - QUERCUS (INCANA, MARGARETTIAE, ARKANSANA) FOREST ALLIANCE (A.386)
					PINUS TAEDA - QUERCUS (ALBA, FALCATA, STELLATA) FOREST ALLIANCE (A.404)
					PINUS TAEDA WOODLAND ALLIANCE (A.526)
					QUERCUS INCANA - (QUERCUS ARKANSANA) WOODLAND ALLIANCE (A.615)
			Central Oak - Hardwood & Pine MG	Bur Oak - Northern Pin Oak Woodland Group	QUERCUS MACROCARPA FOREST ALLIANCE (A.245)
					QUERCUS ELLIPSOIDALIS FOREST ALLIANCE (A.255)
					QUERCUS MACROCARPA - QUERCUS BICOLOR - (CARYA LACINIOSA) TEMPORARILY FLOODED FOREST ALLIANCE (A.293)

L2. Formation Subclass	L3. Formation	L4. Division	L5. MacroGroup	L6. Group	L7. Alliance
					QUERCUS MACROCARPA - QUERCUS (ALBA, ELLIPSOIDALIS, VELUTINA) WOODLAND ALLIANCE (A.619)
					QUERCUS MACROCARPA WOODLAND ALLIANCE (A.620)
				Chestnut Oak - American Chestnut Forest Group	CASTANEA DENTATA - QUERCUS PRINUS FOREST ALLIANCE (A.224)
					QUERCUS PRINUS - (QUERCUS COCCINEA, QUERCUS VELUTINA) FOREST ALLIANCE (A.248)
					QUERCUS PRINUS - QUERCUS (ALBA, FALCATA, RUBRA, VELUTINA) FOREST ALLIANCE (A.249)
					QUERCUS PRINUS - QUERCUS RUBRA FOREST ALLIANCE (A.250)
					CASTANEA DENTATA - QUERCUS RUBRA FOREST ALLIANCE (A.268)
					QUERCUS PRINUS - QUERCUS COCCINEA WOODLAND ALLIANCE (A.622)
					QUERCUS PRINUS - QUERCUS MARILANDICA WOODLAND ALLIANCE (A.623)
					QUERCUS RUBRA - QUERCUS PRINUS WOODLAND ALLIANCE (A.624)
				Chinquapin Oak - Ash - Red Cedar Alkaline Forest Group	QUERCUS MUEHLENBERGII - (ACER SACCHARUM) FOREST ALLIANCE (A.1912)
					FRAXINUS QUADRANGULATA - (JUNIPERUS VIRGINIANA) WOODLAND ALLIANCE (A.1913)
					ACER BARBATUM - FRAXINUS AMERICANA - (JUGLANS NIGRA) FOREST ALLIANCE (A.214)
					JUGLANS NIGRA - AESCULUS GLABRA - CELTIS (LAEVIGATA, OCCIDENTALIS) FOREST ALLIANCE (A.232)
					JUNIPERUS VIRGINIANA - QUERCUS (MUEHLENBERGII, STELLATA) FOREST ALLIANCE (A.382)
					JUNIPERUS VIRGINIANA WOODLAND ALLIANCE (A.545)
					FRAXINUS AMERICANA - CARYA GLABRA - (JUNIPERUS VIRGINIANA) WOODLAND ALLIANCE (A.604)
					FRAXINUS QUADRANGULATA - QUERCUS MACROCARPA - QUERCUS MUEHLENBERGII WOODLAND ALLIANCE (A.605)
					QUERCUS MUEHLENBERGII WOODLAND ALLIANCE (A.621)
				Post Oak - Blackjack Oak Woodland Group	QUERCUS STELLATA - QUERCUS MARILANDICA FOREST ALLIANCE (A.253)
					QUERCUS STELLATA FLATWOODS FOREST ALLIANCE (A.261)
					JUNIPERUS VIRGINIANA - QUERCUS (STELLATA, VELUTINA, MARILANDICA) FOREST ALLIANCE (A.383)
					QUERCUS STELLATA - QUERCUS MARILANDICA WOODLAND ALLIANCE (A.625)

L2. Formation Subclass	L3. Formation	L4. Division	L5. MacroGroup	L6. Group	L7. Alliance
				White Oak - Red Oak - Black Oak Forest & Woodland Group	QUERCUS VELUTINA - QUERCUS ALBA - (QUERCUS COCCINEA) FOREST ALLIANCE (A.1911)
					QUERCUS ALBA - (QUERCUS RUBRA, CARYA SPP.) FOREST ALLIANCE (A.239)
					QUERCUS RUBRA - (ACER SACCHARUM) FOREST ALLIANCE (A.251)
					CARYA (GLABRA, OVATA) - FRAXINUS AMERICANA - QUERCUS (ALBA, RUBRA) FOREST ALLIANCE (A.258)
					QUERCUS ALBA MONTANE FOREST ALLIANCE (A.271)
					QUERCUS ALBA - (QUERCUS VELUTINA) WOODLAND ALLIANCE (A.612)
				Pitch Pine - Virginia Pine - Oak Forest & Woodland Group	PINUS VIRGINIANA FOREST ALLIANCE (A.131)
					TSUGA CAROLINIANA FOREST ALLIANCE (A.144)
					PINUS VIRGINIANA - QUERCUS (ALBA, STELLATA, FALCATA, VELUTINA) FOREST ALLIANCE (A.407)
					PINUS VIRGINIANA - QUERCUS (COCCINEA, PRINUS) FOREST ALLIANCE (A.408)
					PINUS (RIGIDA, ECHINATA) - QUERCUS COCCINEA FOREST ALLIANCE (A.415)
					PINUS RIGIDA - QUERCUS (VELUTINA, PRINUS) FOREST ALLIANCE (A.416)
					PINUS PUNGENS - (PINUS RIGIDA) WOODLAND ALLIANCE (A.521)
					PINUS RIGIDA WOODLAND ALLIANCE (A.524)
					PINUS (RIGIDA, PUNGENS, VIRGINIANA) - QUERCUS PRINUS WOODLAND ALLIANCE (A.677)
					PINUS RIGIDA - QUERCUS (ALBA, STELLATA) WOODLAND ALLIANCE (A.681)
					PINUS RIGIDA - QUERCUS (COCCINEA, VELUTINA) WOODLAND ALLIANCE (A.687)
			Northern & Central Mesophytic Hardwood & Conifer MG	Appalachian Mesophytic Montane Forest Group	ACER RUBRUM - NYSSA SYLVATICA - MAGNOLIA FRASERI FOREST ALLIANCE (A.2009)
					LIRIODENDRON TULIPIFERA - TILIA AMERICANA VAR. HETEROPHYLLA - AESCULUS FLAVA - ACER SACCHARUM FOREST ALLIANCE (A.235)
					TSUGA CANADENSIS - LIRIODENDRON TULIPIFERA FOREST ALLIANCE (A.413)
				Maple - Beech - Oak Central Mesophytic Forest Group	FAGUS GRANDIFOLIA - QUERCUS RUBRA - QUERCUS ALBA FOREST ALLIANCE (A.229)
					ACER SACCHARUM - CARYA CORDIFORMIS TEMPORARILY FLOODED FOREST ALLIANCE (A.302)

L2. Formation Subclass	L3. Formation	L4. Division	L5. MacroGroup	L6. Group	L7. Alliance
				Beech - Maple - Birch - Basswood Forest Group	ACER SACCHARUM - BETULA ALLEGHANIENSIS - (FAGUS GRANDIFOLIA) FOREST ALLIANCE (A.216)
					ACER SACCHARUM - FRAXINUS AMERICANA - TILIA AMERICANA FOREST ALLIANCE (A.217)
					ACER SACCHARUM - TILIA AMERICANA - (QUERCUS RUBRA) FOREST ALLIANCE (A.220)
					FAGUS GRANDIFOLIA - ACER SACCHARUM - (LIRIODENDRON TULIPIFERA) FOREST ALLIANCE (A.227)
					FAGUS GRANDIFOLIA - QUERCUS SPP. - ACER SPP. FOREST ALLIANCE (A.230)
					BETULA ALLEGHANIENSIS - FAGUS GRANDIFOLIA - AESCULUS FLAVA FOREST ALLIANCE (A.266)
					QUERCUS RUBRA MONTANE FOREST ALLIANCE (A.272)
					FAGUS GRANDIFOLIA TEMPORARILY FLOODED FOREST ALLIANCE (A.284)
					PINUS STROBUS - ACER SACCHARUM FOREST ALLIANCE (A.3012)
					POPULUS TREMULOIDES WOODLAND ALLIANCE (A.610)
					TILIA AMERICANA - FRAXINUS AMERICANA - (ACER SACCHARUM) WOODLAND ALLIANCE (A.628)
				Eastern Pine - Hemlock - Hardwood Forest Group	PINUS STROBUS - TSUGA CANADENSIS FOREST ALLIANCE (A.127)
					THUJA OCCIDENTALIS FOREST ALLIANCE (A.142)
					TSUGA CANADENSIS FOREST ALLIANCE (A.143)
					TSUGA CANADENSIS - (PINUS STROBUS) TEMPORARILY FLOODED FOREST ALLIANCE (A.171)
					TSUGA CANADENSIS - BETULA ALLEGHANIENSIS FOREST ALLIANCE (A.412)
					THUJA OCCIDENTALIS - BETULA ALLEGHANIENSIS FOREST ALLIANCE (A.417)
					THUJA OCCIDENTALIS WOODLAND ALLIANCE (A.544)
				Red Spruce - Fir Forest Group	ABIES FRASERI - PICEA RUBENS FOREST ALLIANCE (A.136)
					PICEA RUBENS FOREST ALLIANCE (A.138)
					PICEA RUBENS - ABIES BALSAMEA FOREST ALLIANCE (A.150)
					PICEA RUBENS - BETULA ALLEGHANIENSIS FOREST ALLIANCE (A.384)
					PICEA RUBENS WOODLAND ALLIANCE (A.546)
				White Pine - Red Pine - Oak Forest & Woodland Group	PINUS RESINOSA FOREST ALLIANCE (A.126)
					PINUS STROBUS FOREST ALLIANCE (A.128)
					PINUS BANKSIANA - QUERCUS (ELLIPSOIDALIS, VELUTINA) FOREST ALLIANCE (A.391)

L2. Formation Subclass	L3. Formation	L4. Division	L5. MacroGroup	L6. Group	L7. Alliance
					PINUS STROBUS - (PINUS RESINOSA) - POPULUS TREMULOIDES FOREST ALLIANCE (A.400)
					PINUS STROBUS - QUERCUS (ALBA, RUBRA, VELUTINA) FOREST ALLIANCE (A.401)
					PINUS STROBUS - QUERCUS (COCCINEA, PRINUS) FOREST ALLIANCE (A.402)
					PINUS (BANKSIANA, RESINOSA) WOODLAND ALLIANCE (A.507)
					PINUS RESINOSA - QUERCUS RUBRA WOODLAND ALLIANCE (A.670)
					PINUS STROBUS - BETULA POPULIFOLIA WOODLAND ALLIANCE (A.682)
			Southern Great Plains Oak - Hardwood MG	Pinchot Juniper Scrub Group [under review]	JUNIPERUS PINCHOTII WOODLAND ALLIANCE (A.505)
				Texas Live Oak Woodland Group	QUERCUS FUSIFORMIS FOREST ALLIANCE (A.1926)
					QUERCUS BUCKLEYI FOREST ALLIANCE (A.242)
					QUERCUS FUSIFORMIS WOODLAND ALLIANCE (A.477)
					JUNIPERUS ASHEI WOODLAND ALLIANCE (A.501)
					QUERCUS FUSIFORMIS - CELTIS LAEVIGATA WOODLAND ALLIANCE (A.663)
				Texas Mesic Hardwoods Forest Group	ACER GRANDIDENTATUM - QUERCUS BUCKLEYI - QUERCUS MUEHLENBERGII FOREST ALLIANCE (A.215)
			Eastern North America Ruderal Forest & Plantation MG	Southeast Conifer & Hardwood Plantation	PINUS PALUSTRIS PLANTED FOREST ALLIANCE (A.96)
					PINUS TAEDA PLANTED FOREST ALLIANCE (A.99)
				Northern & Central Hardwood & Conifer Ruderal Forest	JUNIPERUS VIRGINIANA FOREST ALLIANCE (A.137)
					JUGLANS NIGRA FOREST ALLIANCE (A.1932)
					AILANTHUS ALTISSIMA FOREST ALLIANCE (A.221)
					LIRIODENDRON TULIPIFERA FOREST ALLIANCE (A.236)
					ROBINIA PSEUDOACACIA FOREST ALLIANCE (A.256)
					PINUS THUNBERGIANA FOREST ALLIANCE (A.3016)
					GLEDITSIA TRIACANTHOS WOODLAND ALLIANCE (A.606)
					PAULOWNIA TOMENTOSA WOODLAND ALLIANCE (A.609)
				Southeast Hardwood & Conifer Ruderal Forest	PINUS TAEDA FOREST ALLIANCE (A.130)
					LIQUIDAMBAR STYRACIFLUA FOREST ALLIANCE (A.234)

L2. Formation Subclass	L3. Formation	L4. Division	L5. MacroGroup	L6. Group	L7. Alliance
					QUERCUS NIGRA FOREST ALLIANCE (A.247)
				Northern & Central Conifer & Hardwood Plantation	PICEA ABIES PLANTED FOREST ALLIANCE (A.ZZ)
	1C3.Temperate Flooded & Swamp Forest	1C3a.Eastern North America Flooded & Swamp Forest	Southern Bottomland Flooded/Swamp MG	Bald-cypress - Tupelo Swamp Group	PINUS TAEDA - NYSSA BIFLORA - TAXODIUM DISTICHUM TIDAL FOREST ALLIANCE (A.1886)
					TAXODIUM DISTICHUM - (PLATANUS OCCIDENTALIS) TEMPORARILY FLOODED FOREST ALLIANCE (A.298)
					NYSSA (AQUATICA, BIFLORA, OGECHE) FLOODPLAIN SEASONALLY FLOODED FOREST ALLIANCE (A.323)
					PLANERA AQUATICA SEASONALLY FLOODED FOREST ALLIANCE (A.326)
					TAXODIUM DISTICHUM - NYSSA (AQUATICA, BIFLORA, OGECHE) SEASONALLY FLOODED FOREST ALLIANCE (A.337)
					NYSSA AQUATICA - (TAXODIUM DISTICHUM) SEMIPERMANENTLY FLOODED FOREST ALLIANCE (A.345)
					TAXODIUM DISTICHUM SEMIPERMANENTLY FLOODED FOREST ALLIANCE (A.346)
					TAXODIUM DISTICHUM - NYSSA BIFLORA - (NYSSA AQUATICA) SATURATED FOREST ALLIANCE (A.355)
					NYSSA BIFLORA - (NYSSA AQUATICA, TAXODIUM DISTICHUM) TIDAL FOREST ALLIANCE (A.357)
					NYSSA BIFLORA - TAXODIUM ASCENDENS SEMIPERMANENTLY FLOODED WOODLAND ALLIANCE (A.655)
					TAXODIUM DISTICHUM TIDAL WOODLAND ALLIANCE (A.659)
				Oak - Sweetgum Bottomland Flooded/Swamp Group	LIQUIDAMBAR STYRACIFLUA - (LIRIODENDRON TULIPIFERA, ACER RUBRUM) TEMPORARILY FLOODED FOREST ALLIANCE (A.287)
					QUERCUS (MICHAUXII, PAGODA, SHUMARDII) - LIQUIDAMBAR STYRACIFLUA TEMPORARILY FLOODED FOREST ALLIANCE (A.291)
					QUERCUS (PHELLOS, NIGRA, LAURIFOLIA) TEMPORARILY FLOODED FOREST ALLIANCE (A.292)
					LIQUIDAMBAR STYRACIFLUA - (ACER RUBRUM) SEASONALLY FLOODED FOREST ALLIANCE (A.321)
					LIQUIDAMBAR STYRACIFLUA - TAXODIUM DISTICHUM SEASONALLY FLOODED FOREST ALLIANCE (A.322)
					QUERCUS (LAURIFOLIA, PHELLOS) SEASONALLY FLOODED FOREST ALLIANCE (A.327)
					QUERCUS PHELLOS SEASONALLY FLOODED FOREST ALLIANCE (A.330)

L2. Formation Subclass	L3. Formation	L4. Division	L5. MacroGroup	L6. Group	L7. Alliance
					QUERCUS TEXANA - (QUERCUS LYRATA) SEASONALLY FLOODED FOREST ALLIANCE (A.331)
					LIQUIDAMBAR STYRACIFLUA SATURATED FOREST ALLIANCE (A.350)
					QUERCUS MICHAUXII - QUERCUS PAGODA SATURATED FOREST ALLIANCE (A.353)
					QUERCUS VIRGINIANA - CELTIS LAEVIGATA - QUERCUS PAGODA TEMPORARILY FLOODED FOREST ALLIANCE (A.376)
					PINUS GLABRA - QUERCUS (LAURIFOLIA, MICHAUXII, NIGRA) TEMPORARILY FLOODED FOREST ALLIANCE (A.431)
					PINUS TAEDA - LIQUIDAMBAR STYRACIFLUA - NYSSA BIFLORA TEMPORARILY FLOODED FOREST ALLIANCE (A.433)
					PINUS TAEDA - QUERCUS (PHELLOS, NIGRA, LAURIFOLIA) TEMPORARILY FLOODED FOREST ALLIANCE (A.437)
					PINUS GLABRA - QUERCUS LAURIFOLIA SATURATED FOREST ALLIANCE (A.442)
					PINUS TAEDA - LIQUIDAMBAR STYRACIFLUA - ACER RUBRUM SATURATED FOREST ALLIANCE (A.445)
					QUERCUS VIRGINIANA TEMPORARILY FLOODED FOREST ALLIANCE (A.57)
				Oak - Tupelo Depression Swamp Group	QUERCUS ALBA - (NYSSA SYLVATICA) SEASONALLY FLOODED FOREST ALLIANCE (A.1996)
					QUERCUS STELLATA - PINUS TAEDA DEPRESSION SEASONALLY FLOODED FOREST ALLIANCE (A.2014)
					CORNUS FOEMINA SEASONALLY FLOODED FOREST ALLIANCE (A.319)
					CRATAEGUS (AESTIVALIS, OPACA, RUFULA) SEASONALLY FLOODED FOREST ALLIANCE (A.320)
					NYSSA (AQUATICA, BIFLORA, OGECHE) POND SEASONALLY FLOODED FOREST ALLIANCE (A.324)
					QUERCUS LYRATA - (CARYA AQUATICA) SEASONALLY FLOODED FOREST ALLIANCE (A.328)
					NYSSA BIFLORA - ACER RUBRUM - (LIRIODENDRON TULIPIFERA) SATURATED FOREST ALLIANCE (A.351)
					QUERCUS LAURIFOLIA - NYSSA BIFLORA SATURATED FOREST ALLIANCE (A.352)
					NYSSA BIFLORA SEASONALLY FLOODED WOODLAND ALLIANCE (A.648)
				Pond-cypress Swamp Group	TAXODIUM ASCENDENS SEASONALLY FLOODED FOREST ALLIANCE (A.336)
					TAXODIUM ASCENDENS SEASONALLY FLOODED WOODLAND ALLIANCE (A.651)
					TAXODIUM DISTICHUM - (TAXODIUM ASCENDENS) SEASONALLY FLOODED LAKESHORE WOODLAND ALLIANCE (A.652)

L2. Formation Subclass	L3. Formation	L4. Division	L5. MacroGroup	L6. Group	L7. Alliance
			Southern Coastal Plain Broadleaf Evergreen & Conifer Swamp MG	Coastal Plain Mixed Evergreen Swamp Group	MAGNOLIA VIRGINIANA - NYSSA BIFLORA - (TAXODIUM DISTICHUM, NYSSA AQUATICA, PERSEA PALUSTRIS) TIDAL FOREST ALLIANCE (A.1885)
					SALIX CAROLINIANA SEASONALLY FLOODED WOODLAND ALLIANCE (A.1914)
					FRAXINUS CAROLINIANA SEASONALLY FLOODED FOREST ALLIANCE (A.344)
					TAXODIUM DISTICHUM - PERSEA PALUSTRIS - CHRYSOBALANUS ICACO SEASONALLY FLOODED FOREST ALLIANCE (A.366)
					MAGNOLIA VIRGINIANA - NYSSA (BIFLORA, OGECHE) SEASONALLY FLOODED FOREST ALLIANCE (A.377)
					MAGNOLIA VIRGINIANA - NYSSA BIFLORA - (QUERCUS LAURIFOLIA) SATURATED FOREST ALLIANCE (A.378)
					QUERCUS VIRGINIANA - QUERCUS NIGRA SATURATED FOREST ALLIANCE (A.379)
					SABAL PALMETTO - QUERCUS LAURIFOLIA - QUERCUS VIRGINIANA - MAGNOLIA VIRGINIANA - ULMUS AMERICANA SATURATED FOREST ALLIANCE (A.380)
					PINUS ELLIOTTII - MAGNOLIA VIRGINIANA - NYSSA BIFLORA - (TAXODIUM ASCENDENS) SATURATED FOREST ALLIANCE (A.441)
					SABAL PALMETTO SATURATED WOODLAND ALLIANCE (A.488)
					CLIFTONIA MONOPHYLLA SATURATED FOREST ALLIANCE (A.58)
					PINUS SEROTINA SATURATED WOODLAND ALLIANCE (A.581)
					GORDONIA LASIANTHUS SATURATED FOREST ALLIANCE (A.59)
					MAGNOLIA VIRGINIANA - PERSEA PALUSTRIS SATURATED FOREST ALLIANCE (A.60)
					SABAL PALMETTO - QUERCUS VIRGINIANA SATURATED FOREST ALLIANCE (A.61)
				Atlantic Maritime Conifer & Hardwood Swamp Group [under review]	JUNIPERUS VIRGINIANA VAR. SILICICOLA TIDAL WOODLAND ALLIANCE (A.1887)
					FRAXINUS PENNSYLVANICA - ACER RUBRUM - ULMUS AMERICANA TIDAL FOREST ALLIANCE (A.356)
					ACER RUBRUM - FRAXINUS PENNSYLVANICA TIDAL WOODLAND ALLIANCE (A.658)
				Atlantic White-cedar Swamp Group	CHAMAECYPARIS THYOIDES SATURATED FOREST ALLIANCE (A.196)
					PINUS RIGIDA - ACER RUBRUM SATURATED FOREST ALLIANCE (A.3005)
					PINUS TAEDA SATURATED FOREST ALLIANCE (A.3009)

L2. Formation Subclass	L3. Formation	L4. Division	L5. MacroGroup	L6. Group	L7. Alliance
					PINUS TAEDA - CHAMAECYPARIS THYOIDES - ACER RUBRUM - NYSSA BIFLORA SATURATED FOREST ALLIANCE (A.444)
					CHAMAECYPARIS THYOIDES - ACER RUBRUM SATURATED FOREST ALLIANCE (A.448)
					CHAMAECYPARIS THYOIDES SEASONALLY FLOODED WOODLAND ALLIANCE (A.571)
					CHAMAECYPARIS THYOIDES SATURATED WOODLAND ALLIANCE (A.575)
					PINUS RIGIDA SATURATED WOODLAND ALLIANCE (A.580)
			Northern & Central Hardwood Flooded/Swamp MG	Hackberry - Green Ash - Silver Maple Floodplain Group	ACER NEGUNDO TEMPORARILY FLOODED FOREST ALLIANCE (A.278)
					ACER SACCHARINUM TEMPORARILY FLOODED FOREST ALLIANCE (A.279)
					BETULA NIGRA - (PLATANUS OCCIDENTALIS) TEMPORARILY FLOODED FOREST ALLIANCE (A.280)
					CARYA ILLINOINENSIS - (CELTIS LAEVIGATA) TEMPORARILY FLOODED FOREST ALLIANCE (A.282)
					FRAXINUS PENNSYLVANICA - ULMUS AMERICANA - CELTIS (OCCIDENTALIS, LAEVIGATA) TEMPORARILY FLOODED FOREST ALLIANCE (A.286)
					PLATANUS OCCIDENTALIS - (FRAXINUS PENNSYLVANICA, CELTIS LAEVIGATA, ACER SACCHARINUM) TEMPORARILY FLOODED FOREST ALLIANCE (A.288)
					PLATANUS OCCIDENTALIS - (LIQUIDAMBAR STYRACIFLUA, LIRIODENDRON TULIPIFERA) TEMPORARILY FLOODED FOREST ALLIANCE (A.289)
					ACER (RUBRUM, SACCHARINUM) - ULMUS AMERICANA TEMPORARILY FLOODED FOREST ALLIANCE (A.299)
					PLATANUS OCCIDENTALIS - (BETULA NIGRA, SALIX SPP.) TEMPORARILY FLOODED WOODLAND ALLIANCE (A.633)
				Red Maple - Ash - Oak Flooded/Swamp Group	QUERCUS BICOLOR - ACER RUBRUM TEMPORARILY FLOODED FOREST ALLIANCE (A.3004)
					QUERCUS PALUSTRIS - ACER RUBRUM TEMPORARILY FLOODED FOREST ALLIANCE (A.301)
					ACER RUBRUM - FRAXINUS PENNSYLVANICA SEASONALLY FLOODED FOREST ALLIANCE (A.316)
					QUERCUS PALUSTRIS - (QUERCUS BICOLOR) SEASONALLY FLOODED FOREST ALLIANCE (A.329)
					ACER RUBRUM - NYSSA SYLVATICA SATURATED FOREST ALLIANCE (A.348)
					ACER RUBRUM SEASONALLY FLOODED WOODLAND ALLIANCE (A.653)
					ACER RUBRUM SATURATED WOODLAND ALLIANCE (A.657)

L2. Formation Subclass	L3. Formation	L4. Division	L5. MacroGroup	L6. Group	L7. Alliance
				Eastern Cottonwood - Black Willow Flooded/Swamp Group	POPULUS DELTOIDES TEMPORARILY FLOODED FOREST ALLIANCE (A.290)
					SALIX CAROLINIANA TEMPORARILY FLOODED FOREST ALLIANCE (A.296)
					SALIX NIGRA TEMPORARILY FLOODED FOREST ALLIANCE (A.297)
					SALIX CAROLINIANA SEASONALLY FLOODED FOREST ALLIANCE (A.332)
					SALIX NIGRA SEASONALLY FLOODED FOREST ALLIANCE (A.334)
				Southeastern Plains Flooded/Riparian Group	ULMUS AMERICANA - CELTIS LAEVIGATA WOODLAND ALLIANCE (A.1916)
					MACLURA POMIFERA WOODLAND ALLIANCE (A.1917)
					CELTIS LAEVIGATA - ULMUS CRASSIFOLIA TEMPORARILY FLOODED FOREST ALLIANCE (A.283)
				Eastern Cottonwood - Willow - Ash Plains Flooded/Riparian Group	FRAXINUS PENNSYLVANICA - (ULMUS AMERICANA) FOREST ALLIANCE (A.259)
					CELTIS LAEVIGATA - ULMUS CRASSIFOLIA TEMPORARILY FLOODED FOREST ALLIANCE (A.283)
					FRAXINUS PENNSYLVANICA - (ULMUS AMERICANA) TEMPORARILY FLOODED FOREST ALLIANCE (A.308)
					FRAXINUS PENNSYLVANICA - (ULMUS AMERICANA) WOODLAND ALLIANCE (A.629)
					POPULUS DELTOIDES TEMPORARILY FLOODED WOODLAND ALLIANCE (A.636)
					SALIX GOODDINGII TEMPORARILY FLOODED WOODLAND ALLIANCE (A.640)
					SALIX EXIGUA SEASONALLY FLOODED WOODLAND ALLIANCE (A.649)
			Northern Hardwood & Conifer Swamp MG	Northern Hardwood Swamp Group	FRAXINUS NIGRA - ACER RUBRUM SATURATED FOREST ALLIANCE (A.347)
				Northern White-cedar - Hemlock - Red Spruce Conifer Swamp Group	PICEA RUBENS SATURATED FOREST ALLIANCE (A.198)
					THUJA OCCIDENTALIS SATURATED FOREST ALLIANCE (A.200)
					TSUGA CANADENSIS SATURATED FOREST ALLIANCE (A.201)
					PICEA RUBENS - ABIES BALSAMEA SATURATED FOREST ALLIANCE (A.202)
					PINUS STROBUS - (ACER RUBRUM) SATURATED FOREST ALLIANCE (A.443)
					THUJA OCCIDENTALIS - ACER RUBRUM SATURATED FOREST ALLIANCE (A.446)

L2. Formation Subclass	L3. Formation	L4. Division	L5. MacroGroup	L6. Group	L7. Alliance
					TSUGA CANADENSIS - ACER RUBRUM SATURATED FOREST ALLIANCE (A.447)
					PICEA RUBENS - ACER RUBRUM SATURATED FOREST ALLIANCE (A.450)
					PINUS STROBUS - ACER RUBRUM SATURATED WOODLAND ALLIANCE (A.582)
					THUJA OCCIDENTALIS SATURATED WOODLAND ALLIANCE (A.583)
1D. Boreal Forest & Woodland	1D1.Lowland and Montane Boreal Forest	1D1a.North American Boreal Forest	Eastern Boreal Conifer & Hardwood MG	Jack Pine - (Black Spruce) Forest Group	PINUS BANKSIANA FOREST ALLIANCE (A.116)
					PICEA MARIANA WOODLAND ALLIANCE (A.3504)
					PINUS BANKSIANA - POPULUS TREMULOIDES FOREST ALLIANCE (A.390)
				White Spruce - Balsam Fir Forest Group	PICEA GLAUCA - ABIES BALSAMEA FOREST ALLIANCE (A.148)
					PICEA MARIANA FOREST ALLIANCE (A.149)
					PICEA MARIANA - POPULUS TREMULOIDES FOREST ALLIANCE (A.414)
					PICEA GLAUCA - ABIES BALSAMEA - POPULUS SPP. FOREST ALLIANCE (A.418)
					PICEA GLAUCA WOODLAND ALLIANCE (A.551)
				Aspen - Birch Forest Group	BETULA PAPYRIFERA FOREST ALLIANCE (A.267)
					POPULUS TREMULOIDES - BETULA PAPYRIFERA FOREST ALLIANCE (A.269)
					BETULA PAPYRIFERA WOODLAND ALLIANCE (A.603)
	1D2.Boreal Peat & Swamp Forest	1D2a.North American Boreal Peat & Swamp Forest	Boreal Conifer Peatland MG	Black Spruce - Tamarack Acid Peatland Group	PICEA MARIANA SATURATED FOREST ALLIANCE (A.197)
					PICEA MARIANA SATURATED WOODLAND ALLIANCE (A.585)
			Boreal Conifer & Hardwood Swamp MG	Tamarack - Conifer Alkaline Swamp Group	LARIX LARICINA SATURATED FOREST ALLIANCE (A.349)
				Boreal Hardwood Swamp	POPULUS BALSAMIFERA EASTERN BOREAL ALLIANCE [new] (A.ZZ)

APPENDIX I. (Informative). Pilot example for Cultural Vegetation: Levels 1 – 8.

For Levels 1 – 4, units for cultural vegetation pilot are adapted from typical land cover categories (e.g., USGS 2001), and are intended to be comprehensive for the globe. For Levels 6 and 7, units are taken directly from the National Resources Inventory (NRI 2003), where those are cultural vegetation units (i.e. not natural or non-vegetated), but the NRI units are re-organized to fit into the upper level structure. Levels 6 and 7 are comprehensive for the United States. Level 5 is only partially developed and Level 8 is not developed at this time (both levels are optional). NLCD = National Land Cover Database (USGS 2001); NRI = National Resources Inventory, Natural Resources Conservation Service (NRI 2003).

LEVEL 1– CULTURAL CLASS	**LEVEL 1– CULTURAL SUB CLASS** *LEVEL 2*	**LEVEL 3 – FORMATION**	**LEVEL 4 – SUBFORMATION**	***LEVEL 5 – GROUP [optional]***	**LEVEL 6 – SUBGROUP**	**LEVEL 7 – TYPE**	***L 8 – SUB-TYPE [optional]***

LEVEL 1– CULTURAL CLASS	**LEVEL 1– CULTURAL SUB CLASS** *LEVEL 2*	**LEVEL 3 – FORMATION**	**LEVEL 4 – SUBFORMATION**	***LEVEL 5 – GROUP [optional]***	**LEVEL 6 – SUBGROUP**	**LEVEL 7 – TYPE**	***L 8 – SUB-TYPE [optional]***
7. **AGRICULTURAL VEGETATION** [NRI = Cropland] [NLCD = Agriculture]	Woody Agricultural Vegetation	**Woody Horticultural Crop** [NRI = Cropland - Horticultural Crops]	**Orchard** (tree) [NRI = Fruit - Orchards, Nut – Trees, bush fruits, vineyards and others.	Temperate and Tropical Orchard	**Fruit – Orchards (001)**	Apple Apricots Avocados Bananas (all types) Breadfruit cacao Cherimoya Cherries Citron Coconut Coffee Cumquat (kumquat) Dates Elderberry Figs Grapefruit Jujube K-Early Citrus Lemon Lime Limon Loquat Mango Nectarine Olives Orange Papayas PawPaw (papaw) Peach Pear Persimmons Plantains Plums Pomegranates Pummelo (Pomelo) Quenepa Quince Sapote Soursop Sweetsop Tangelos Temples	

LEVEL 1– CULTURAL CLASS	**LEVEL 1– CULTURAL SUB CLASS** *LEVEL 2*	**LEVEL 3 – FORMATION**	**LEVEL 4 – SUBFORMATION**	***LEVEL 5 – GROUP [optional]***	**LEVEL 6 – SUBGROUP**	**LEVEL 7 – TYPE**	***L 8 – SUB-TYPE [optional]***
					Nuts – Trees (002)	Almonds Betelnut Cashews Chestnuts Hazelnuts (Filberts) Macadamias Pecans Walnuts	
			Vineyard (vine)	Temperate and Tropical Vineyard	**Vineyard (003)**	Grape Kiwi-fruit Muscadine Passion Fruit Starfruit Hops	
			Bush fruit and berries (shrub)	Temperate and Tropical Bush Fruit	**Bush-fruit (004)**	Blueberry Currant Evergreen-berry Gooseberry Guava Pepino Bramble shrub Blackberry Boysenberry Dewberry Loganberry Marionberry Olallieberry Raspberry-black Raspberry-red	
					Berries (005)	Cranberries (grown in bogs) Strawberries	

LEVEL 1– CULTURAL CLASS	**LEVEL 1– CULTURAL SUB CLASS** *LEVEL 2*	**LEVEL 3 – FORMATION**	**LEVEL 4 – SUBFORMATION**	***LEVEL 5 – GROUP [optional]***	**LEVEL 6 – SUBGROUP**	**LEVEL 7 – TYPE**	***L 8 – SUB-TYPE [optional]***
		Other Woody Agricultural / Rural Vegetation [NRI =Other Farmland, in part]	**Other Woody Farmland /Rural Vegetation**)[excludes semi-natural forestry tree plantations – see Forest and Woodland	Temperate and Tropical Other Woody Farmland/Rural Vegetation	**Farmsteads and ranch headquarters (400)** (woody) [= Developed Vegetation?]	No NRI Types.	
					Other land in farms (not associated with farmsteads) (401) (woody) [= land use, not land cover for some types?]	Agroforestry and tree plantations (planted/ managed trees grown for specialty uses, such as Christmas trees, oils, fiber, flower, specialty woods, biofuel; e.g., eucalyptus, bamboo, paulownia, [overlap with semi-natural forestry plantations] Airplane landing strips Commercial feedlots Duck farms Field windbreaks Greenhouses Hog facilities Mink farms Mushroom farms Nurseries Poultry facilities	

LEVEL 1– CULTURAL CLASS	**LEVEL 1– CULTURAL SUB CLASS** *LEVEL 2*	**LEVEL 3 – FORMATION**	**LEVEL 4 – SUBFORMATION**	***LEVEL 5 – GROUP [optional]***	**LEVEL 6 – SUBGROUP**	**LEVEL 7 – TYPE**	***L 8 – SUB-TYPE [optional]***
	Herbaceous Agricultural Vegetation	**Cultivated Crop** [= NLCD, NRI = Cropland – Row and Close Grown Crops, also includes Cultivated Pastureland, Hayland]	**Row Crop** [=NRI Row and Close Grown Crops]	Temperate and Tropical Row Crop	**Corn (011)**	Corn for silage Decorative corn Field corn Grain corn Popcorn Seed corn Sweet corn	
					Sorghum (012)	No NRI Types	
					Soybeans (013)	No NRI Types	
					Cotton (014)	No NRI Types	
					Peanuts (015)	No NRI Types	
					Tobacco (016)	No NRI Types	
					Sugar beets (017)	No NRI Types	
					Potatoes (018)	No NRI Types	

LEVEL 1– CULTURAL CLASS	**LEVEL 1– CULTURAL SUB CLASS** *LEVEL 2*	**LEVEL 3 – FORMATION**	**LEVEL 4 – SUBFORMATION**	***LEVEL 5 – GROUP [optional]***	**LEVEL 6 – SUBGROUP**	**LEVEL 7 – TYPE**	***L 8 – SUB-TYPE [optional]***
					Other vegetables and truck crops including melons (019)	Artichokes Arrugula Asparagus Beans (all types except soybeans) Beets (excluding sugar beets) Broccoli Brussel sprouts Cabbage Cantaloupe Cardoon Carrots Casabamelon (manioa, manihot, tapioca plant) Cauliflower Celeriac Celery Chard, Swiss Chickory Chinese vegetables (truck type) Corn-sweet, decorative, popcorn, (only if a few rows are grown as part of a larger mixed truck crop or farm market operation) Cucumbers Daikon Dasheen Eggplant Endive Escarole Garlic Gourd Honeydew melon Horse-radish Kale	

LEVEL 1– CULTURAL CLASS	**LEVEL 1– CULTURAL SUB CLASS** *LEVEL 2*	**LEVEL 3 – FORMATION**	**LEVEL 4 – SUBFORMATION**	***LEVEL 5 – GROUP [optional]***	**LEVEL 6 – SUBGROUP**	**LEVEL 7 – TYPE**	***L 8 – SUB-TYPE [optional]***
						Kohirabi Leeks Lettuce (all types) Muskmelon Mustard greens (mustard seed, see other close grown crops) Okra Onions Parsnip Peas (all types) Peppers (all types) Pumpkins Radish Rhubarb Romaine Rutabaga Salsify Scallions Spinach Squash (all types) Sweet Potato Taniers (tania, tanya) Taro (upland dry types) Tomatoes Turnips Watermelon Yam	

LEVEL 1– CULTURAL CLASS	**LEVEL 1– CULTURAL SUB CLASS** *LEVEL 2*	**LEVEL 3 – FORMATION**	**LEVEL 4 – SUBFORMATION**	***LEVEL 5 – GROUP [optional]***	**LEVEL 6 – SUBGROUP**	**LEVEL 7 – TYPE**	***L 8 – SUB-TYPE [optional]***
					All other row crops (020)	Castorbean Ginger root Ginseng Guar Guayule Jojoba Kenaf Pineapple Safflower Sugar cane Taro (wetland)	
					Sunflowers (021)	No NRI Types	
			Close Grown Crop [=NRI Cropland – Close Grown]	Temperate and Tropical Close Crown Crop	**Wheat (111)**	No NRI Types	
					Oats (112)	No NRI Types	
					Rice (113)	No NRI Types	
					Barley (114)	No NRI Types	

LEVEL 1– CULTURAL CLASS	**LEVEL 1– CULTURAL SUB CLASS** *LEVEL 2*	**LEVEL 3 – FORMATION**	**LEVEL 4 – SUBFORMATION**	***LEVEL 5 – GROUP [optional]***	**LEVEL 6 – SUBGROUP**	**LEVEL 7 – TYPE**	***L 8 – SUB-TYPE [optional]***
					All other close grown crops (116)	Alfalfa (for seed) Buckwheat Canola Dill (oil and herb) Dry field peas Emmer Flax (Linseed) Grasses grown for seed Herbs-seasoning Lentils Millet Mint (all types) Mustard-seed Rape Rye Rye grass Salt hay Sod Spelt Tritcale Watercress	
			Cultivated Pasture and Hayland [=NRI Cropland – Hayland]	Temperate and Tropical Cultivated Hayland and Pasture	**Grass (141)**	No NRI Types e.g., Pearl millet, Annual rye, Wheat	
					Legume (142)	No NRI Types e.g., alfalfa	
					Legume-grass (143)	No NRI Types e.g., Perennial rye-grass-White Dutch clover	

LEVEL 1– CULTURAL CLASS	**LEVEL 1– CULTURAL SUB CLASS** *LEVEL 2*	**LEVEL 3 – FORMATION**	**LEVEL 4 – SUBFORMATION**	***LEVEL 5 – GROUP [optional]***	**LEVEL 6 – SUBGROUP**	**LEVEL 7 – TYPE**	***L 8 – SUB-TYPE [optional]***
		Pasture / Hay [NLCD = Pasture / Hay] [NRI = Non-Cultivated Pastureland and Hayland]	**Permanent Pasture & Hayland** [=NRI Pastureland and Native Pasture]	Temperate and Tropical Permanent Pasture & Hayland	**Grass (211)**	No NRI Types e.g., Typical dominant or co-dominant species are orchardgrass, tall fescue, perennial ryegrass, kentucky bluegrass, crested wheatgrass,	
					Legume (212)	No NRI Types e.g.., Alfalfa	
					Grass-forbs-legumes mixed (213)	No NRI Types e.g.: Tall fescue, crabgrass, dandelion, narrow-leaf plantain, and white clover pasture.	
		Other Herbaceous Agricultural and Rural Vegetation [NRI= Other Farmland, in part; Cropland - Horticultural Crops, Other; Other Rural land in part]	**Herbaceous Horticultural Crops** [NRI= Cropland - Other Horticultural Crops, Other; Other Cropland, in part]	Temperate and Tropical Other Horticultural Crops	**Other Horticultural Crops (006)**	Flowers – large commercial operations for bulbs and seed production and sales. Flowers – large commercial operations for cutting	

LEVEL 1– CULTURAL CLASS	**LEVEL 1– CULTURAL SUB CLASS** *LEVEL 2*	**LEVEL 3 – FORMATION**	**LEVEL 4 – SUBFORMATION**	***LEVEL 5 – GROUP [optional]***	**LEVEL 6 – SUBGROUP**	**LEVEL 7 – TYPE**	***L 8 – SUB-TYPE [optional]***
			Other Rural, Crop or Farmland (Weed Vegetation) [cf. semi-natural old fields?] [NRI = Cropland - Other cropland; Other Rural Land, in part, Other Farmland, in part]	Temperate and Tropical Rural Vegetation	**Summer fallow (170)**	No NRI Types e.g., annual weed fields	
					Aquaculture in a crop rotation (171)	No NRI Types e.g. rice crops	
					Other cropland not planted (180) [overlap with old-field semi-natural vegetation?]	No NRI Types e.g., old fallow fields.	
					Conservation Reserve Program (CRP) land (410) [may overlap with Semi-natural Grasslands]	No NRI Types e.g., switchgrass	
					All other land (650) (requires a note of explanation)	No NRI Types	

LEVEL 1– CULTURAL CLASS	**LEVEL 1– CULTURAL SUB CLASS** *LEVEL 2*	**LEVEL 3 – FORMATION**	**LEVEL 4 – SUBFORMATION**	***LEVEL 5 – GROUP [optional]***	**LEVEL 6 – SUBGROUP**	**LEVEL 7 – TYPE**	***L 8 – SUB-TYPE [optional]***
8. DEVELOPED VEGETATION [NRI = Urban and Built up, vegetated part] [NLCD = Developed, vegetated part]	**Herbaceous & Woody Developed Vegetation** [closely cropped ground layer] (tree modifier may be used at all levels)	**Developed (Close-Cropped) Vegetation** [=NLCD, NRI = Urban and Built Up]	**Lawn** with or without trees (urban and recreational)	e.g. Temperate and Tropical Lawns	e.g. Cool-season Lawn, Warm Season Lawn, Dry Season Lawn	e.g.,*cool season:* kentucky bluegrass, fescue, sportfield grasses e.g., *warm season*: bermuda grass, zoysia, St. Augustine, *arid season*:	
		Other Developed Urban / Built Up Vegetation	**Other Urban / Build Up Vegetation**		e.g., **Vacant Lot Vegetation** [overlap with old-field semi-natural vegetation?]		
					e.g. **Flower /Herb Gardens**		

APPENDIX J (Informative). Comparison of U.S. NVC and Braun-Blanquet approaches to classifying pastures.

Table J.1. A brief comparison of NVC pasture types to the European Braun-Blanquet classification (Rodwell et al. 2002, Mucina 1997).

Level	NVC (from Appendix I)	Rodwell et al. (2002)
LEVEL 1–CULTURAL CLASS	Agricultural Vegetation	Not Applicable
LEVEL 2–CULTURAL SUBCLASS	Herbaceous Agricultural Vegetation	Not Applicable
LEVEL 3 – FORMATION	Pasture / Hay	Temperate Grasslands, Heaths and Fringe Vegetation
LEVEL 4 – SUBFORM-ATION	Permanent Pasture & Hayland	-
LEVEL 5 - GROUP	Temperate & Tropical Permanent Pasture & Hayland	Molinio-Arrhenatheretea* (Class) Anthropogenic Pastures And Meadows On Deeper, More Or Less Fertile Mineral And Peaty Soils In Lowland Regions
LEVEL 6 – SUBGROUP	Grass	Arrhenatheretalia (Order) Pastures And Meadows On Well-Drained Relatively Fertile Mineral Soils.
LEVEL 7 - TYPE	Perennial Ryegrass Pasture	Cynosurion crystati (Alliance) Pastures Of Relatively Well Drained, Fertile Mineral Soils At Lower Altitudes.
LEVEL 8 - SUBTYPE	-	Lolium perenne – Cynosurus cristatus Association

*Diagnostic species for this class include (from Mucina 1997): Achillea millefolium ( ), Agrostis gigantea / stolonifera (red top), Alopecuris pratensis ( ), Anthoxanthum odoratum (sweet vernal grass), Arrhenatherum elatius (tall oatgrass), Cerastium fontanum ( ), Dactylis glomerata (orchard grass), Festuca arundinacea ( ), Festuca pratensis ( ), Festuca rubra (red fescue), Holcus lanatus ( ), Juncus [effuses, others] ( ), Molinia caerulea (purple moorgrass), Poa pratensis (Kentucky bluegrass), Poa trivialis ( ), Plantago lanceolatus (plantain), Ranunculus acris (buttercup) and Trifolium [repens, others] (clover), among others.

APPENDIX K (Informative): A Process for Estimating Stratum Cover from Species Cover Values

Table I.1 presents one method for estimating stratum cover from the cover values of individual species occurring in that stratum. This method assumes a constant relationship between species cover sum and percent overlap, which is probably not true under all conditions. It also does not account for positive or negative relationships between species such as nurse crops and allelopathic plants. If this method does not apply to your dataset, you should modify it and carefully document your method.

Table K.1. A process for estimating canopy cover of a single stratum from the cover values of individual species occurring in that stratum. See also Table 3.4.

It is possible to approximate the percent cover of a single stratum, based on the individual cover of the species in that stratum (Jennings et al. 2006), based on the following equation:

$$C_i = \left(1 - \prod_{j=1}^{n}\left(1 - \frac{\%\,\mathrm{cov}\ j}{100}\right)\right) * 100$$

where C_i is the percent cover of stratum i for species or growth form j in stratum i.

It may also be used to approximate the percent cover of a single species across multiple strata, where a total percent cover of that species is desired. In the example, the minimum cover possible would be 40%, the cover of the most abundant species (presuming **complete overlap** with the other two species) and the maximum possible cover would be 85%,the cover of each species added together (presuming **no overlap** among the species). The equation assumes there is at least some overlap, and uses a standard formula to estimate the percent of overlap. In this example the canopy cover of the shrub stratum is estimated to be 64%.

Species (*j*) occurring in the shrub stratum (*i*)	Actual cover in %	Step 1: $\left(1 - \frac{\%\,\mathrm{cov}\ j}{100}\right)$	Step 2 $1 - \prod_{j=1}^{n}(Step1)$	Step 3 $Step2 * 100$
Acer glabrum	15	0.85[a]	1 - 0.357 = 0.643	0.643 * 100 = 64.3
Spiraea douglasii	40	0.6[b]		
Vaccinium scoparium	30	0.7[c]		
Π (the product of a * b * c)		0.357		

APPENDIX L (Informative): FGDC Vegetation Subcommittee Contributors to the Development of this Standard

Name	Affiliation
Don Faber-Langendoen	NatureServe, Co-Lead Author/Editor
David Tart	U.S. Forest Service, Co-Lead Author/Editor
Ralph Crawford	U.S. Forest Service, Subcommittee Chair
Doug Powell	U.S. Forest Service, Subcommittee Vice Chair
John Dennis	National Park Service
Chris Lea	National Park Service
Mike Mulligan	U.S. Geological Survey
Robert K. Peet	University of North Carolina / ESA Vegetation Classification Panel
Alison Hill	U.S. Forest Service, Past Subcommittee Chair
Dennis Grossman	NatureServe (Resigned)
Betsy Middleton	National Aeronautics and Space Administration
Mike “Sherm” Karl	Bureau of Land Management
Gary Waggoner	U.S. Geological Survey (Retired)
Ron Brohman	U.S. Forest Service (Retired)
Dennis Thompson	Natural Resources Conservation Service
Karl Brown	National Park Service / U.S. Geological Survey
Lori Hidinger	Ecological Society of America (Resigned)
Dave Roberts	Montana State University / ESA Vegetation Classification Panel
Cliff Duke	Ecological Society of America
Michael Barbour	ESA Vegetation Classification Panel
Alexa McKerrow	North Carolina State University / GAP Program
Wayne Padgett	U.S. Forest Service
Mindy Destro	Ecological Society of America (Resigned)
Bette Stallman	Ecological Society of America (Resigned)

Attachment E

2019 Prairie Dog Vegetation Monitoring

Hall Property

Prepared for:

Boulder County Parks & Open Space

P.O. Box 471

Boulder, CO 80306

Prepared by:

February 4, 2020

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INTRODUCTION

[redacted] was contracted to complete the 2019 prairie dog vegetation monitoring transects for Boulder County Parks and Open Space (BCPOS). Quantitative vegetation sample transects were established by BCPOS to assist in long term vegetation data acquisition and management decisions.

Two sample locations (BPHA1, BPHA2) were visited and displayed in Figure 1.

METHODS

COVER

Vegetation cover was collected using standard point-intercept surveys consisting of 100 points recorded at 0.5-meter intervals on both sides along an outstretched 50-meter measuring tape. Point intercepts were recorded with a military grade laser pointer attached to a tripod with a SLICK head that offsets the vegetation disturbing effects of the observer from the "point."

Data were recorded as plant species, litter, standing dead plant material, soil, or rock. Plant material produced during the 2019 growing season and still standing was tallied by species. Litter was any organic material that had fallen to the soil surface. Standing dead was any dead plant material that was produced in previous years but was still standing at 45 degrees or above. Inorganic materials greater than 1 cm in diameter were considered rock, while soil was any inorganic material less than 1 cm in diameter. Basal vegetation hits were recorded at the first interception with an attached plant part, located no more than 3 cm above the ground and produced during the current year's growing season.

SPECIES DENSITY

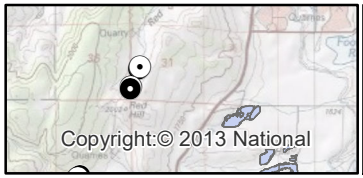
All species present within 1 m. of either side of each 50 m. transect were recorded. A species density value was then calculated and expressed as the number of species per 100 sq.m.

PHOTOGRAPHIC DOCUMENTATION

Two photographs, one oriented along the transect at the origin and at the end of the transect were taken at each site. These photographs are attached in Appendix A.

Map Location: C:\Users\russe\Dropbox (Dragonfly)\Dragonfly\DEC Clients\300 Boulder County Parks and Open Space\Vegetation Monitoring\2018\GIS\Map 1. Wolf Run Property_181106.mxd

Map 1. Hall Property
2019 Prairie Dog
Vegetation Monitoring
Boulder County Parks & Open Space
Boulder County, CO



Transect Location

- Start
- End
- 50 Meter Transect
- Trails
- County Open Space

Prepared For: Boulder County

Prepared By: [redacted]

Feet
0 100 200

1 in = 300 ft

RESULTS

The following results are comparisons from 2016 and 2019 data collection. Table 1 summarizes and compares total vegetation cover, ground cover, and species density. Figure 2 shows total vegetation cover results in a bar graph. Figure 3 compares relative cover by lifeform. Figure 4 compares species density by lifeform.

Table 1. Hall Property Comparison
2016-2019

	2016		2019		2016		2019	
	BPHA1*	Basal Hits	BPHA1*	Basal Hits	BPHA2*	Basal Hits	BPHA2*	Basal Hits
Litter	10	38	22	---	13	99	7	---
Standing Dead	---	---	---	---	---	---	1	---
Bare Soil	32	61	37	---	---	---	3	---
Rock	P	---	1	---	---	---	1	---
TOTAL VEGETATION COVER	58(5)	1	40	0	87(21)	1	89	0
GROUND COVER (Litter+Rock+Veg+St.Dead)	68(5)	39	63	0	100(21)	100	97	0
SPECIES DENSITY (# of species/100 sq.m.)	14	1	10	0	39	1	27	0

*Data in parenthesis are second hits.

^ Basal hits were collected for litter, bare soil and rock in 2016 but not in 2019 per BCPOS.

Figure 2. Boulder County Monitoring - Total Vegetation Cover - Hall Property - 2016 & 2019

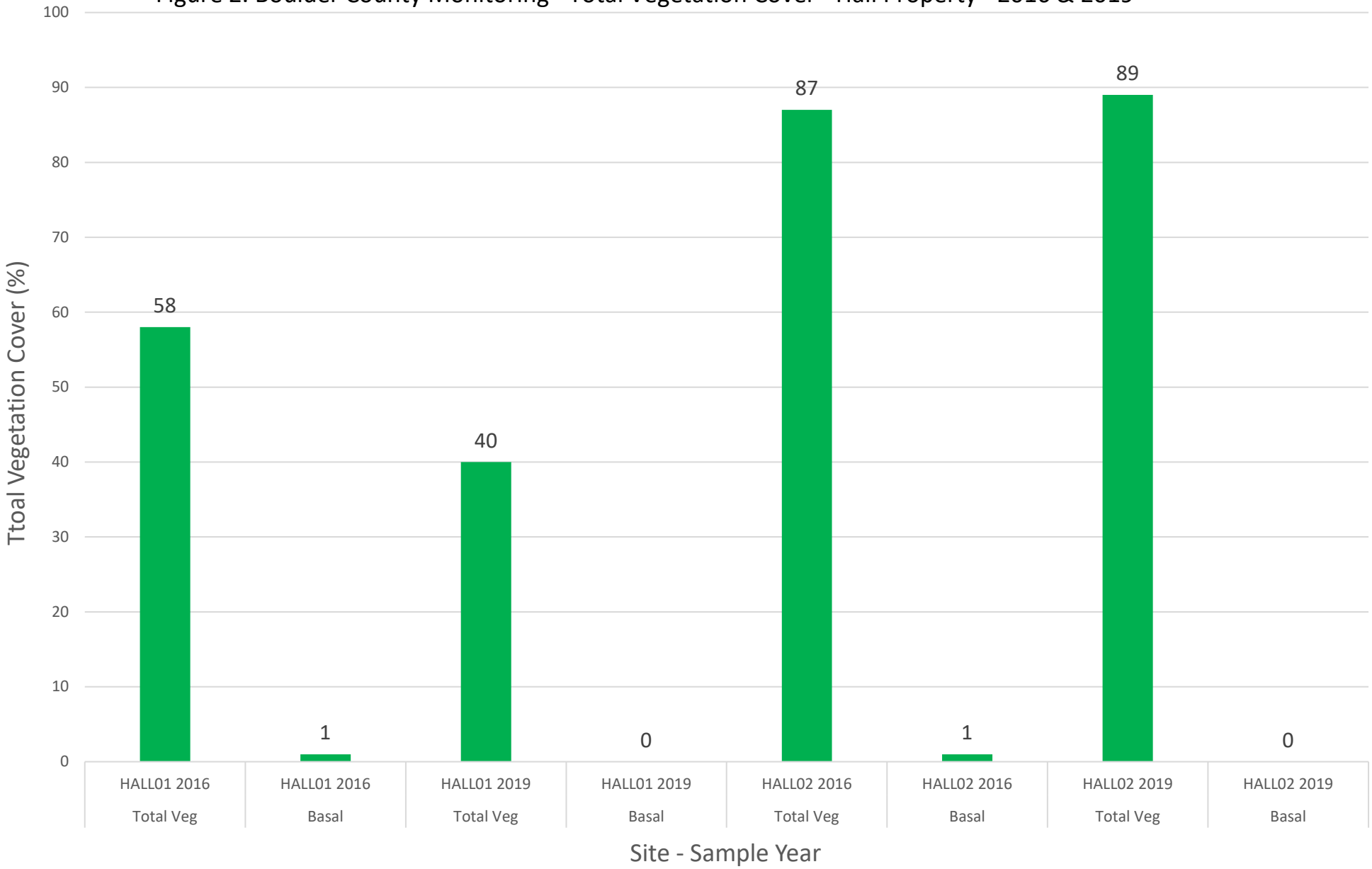
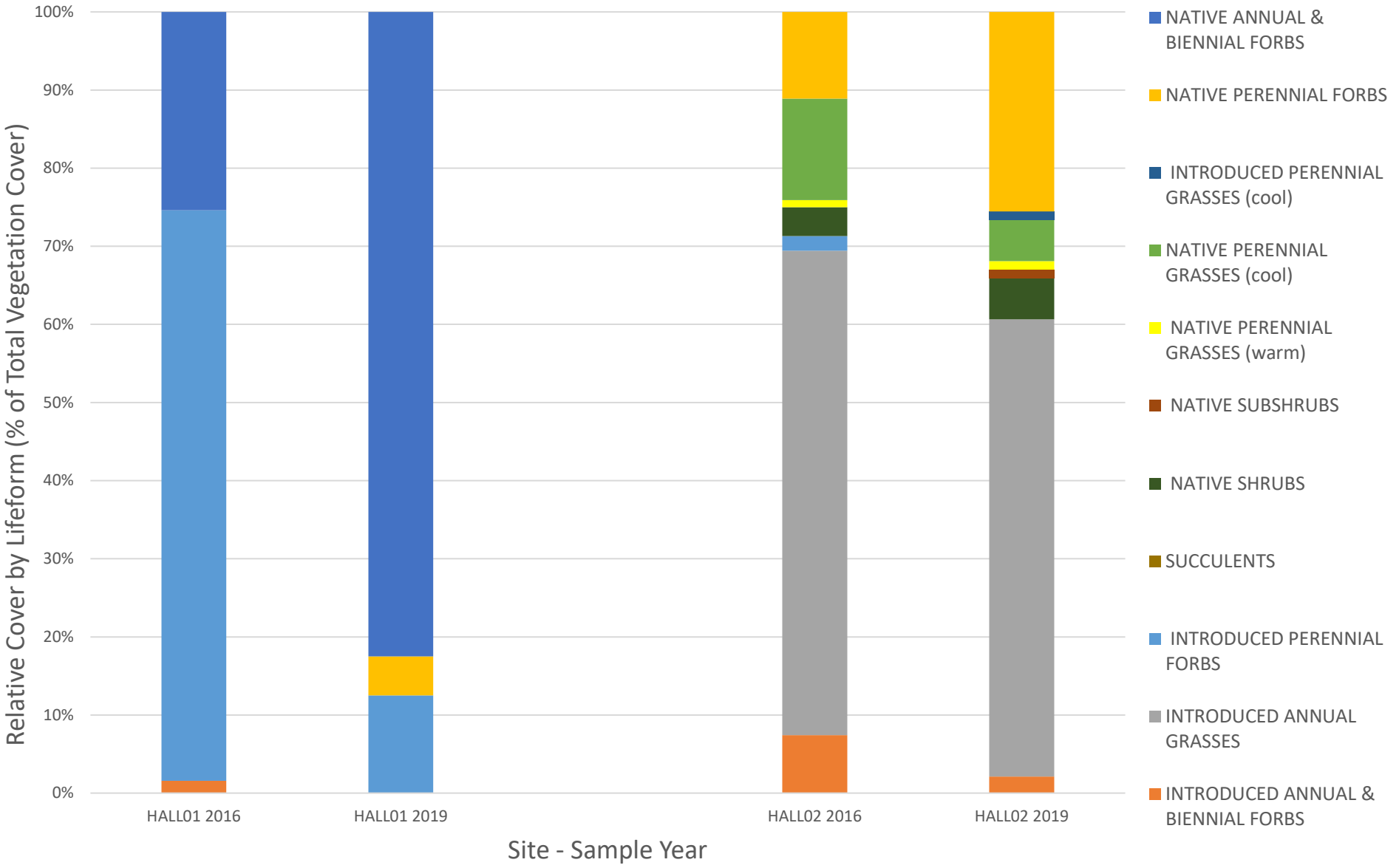


Figure 3. Boulder County Monitoring - Relative Cover by Lifeform - Hall Property - 2016 & 2019



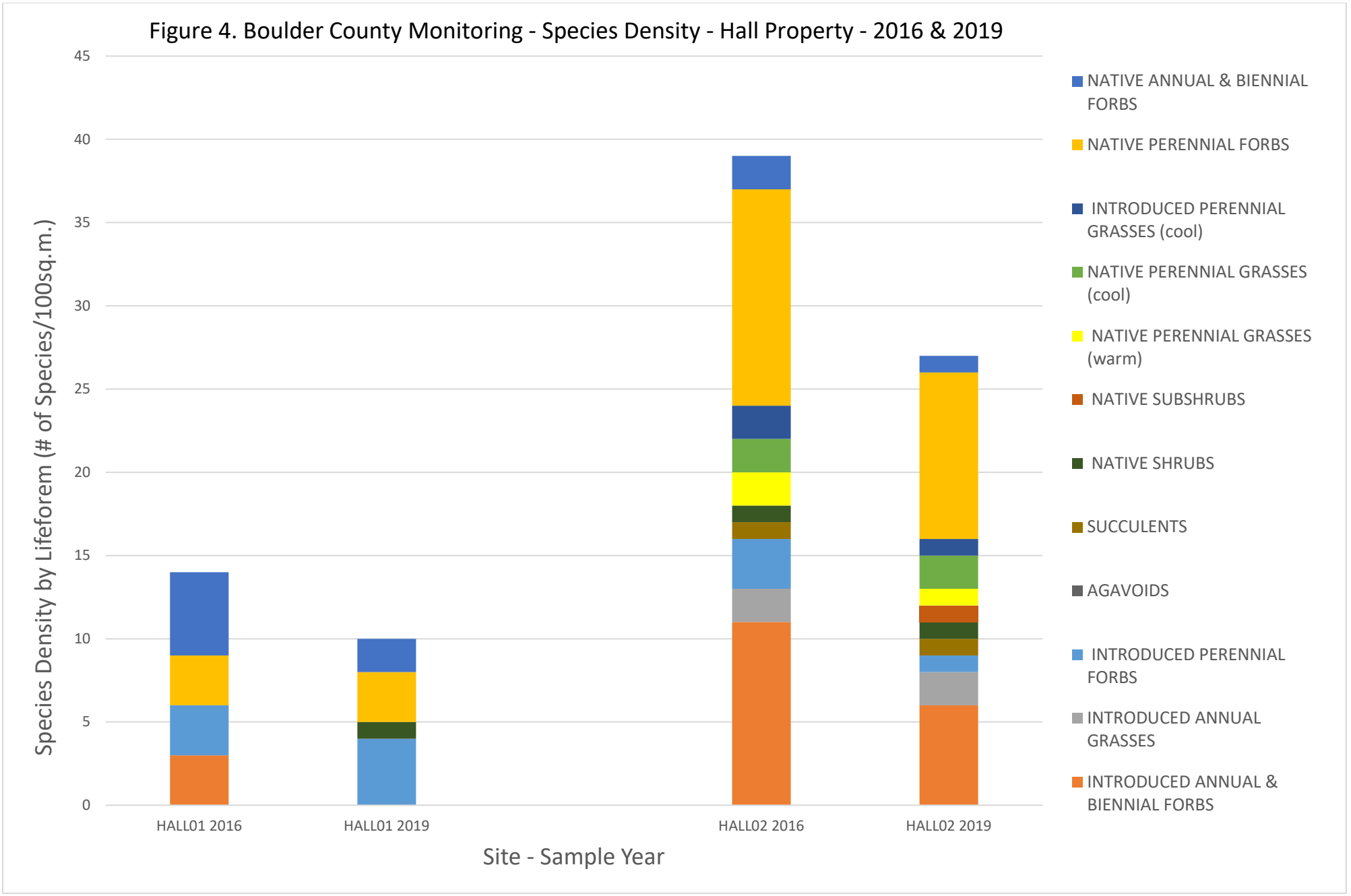


Figure 4. Boulder County Monitoring - Species Density - Hall Property - 2016 & 2019
Species Density by Lifeforem (# of Species/100sq.m.)
45
40
35
30
25
20
15
10
5
0
HALL01 2016
HALL01 2019
HALL02 2016
HALL02 2019
Site - Sample Year
NATIVE ANNUAL & BIENNIAL FORBS
NATIVE PERENNIAL FORBS
INTRODUCED PERENNIAL GRASSES (cool)
NATIVE PERENNIAL GRASSES (cool)
NATIVE PERENNIAL GRASSES (warm)
NATIVE SUBSHRUBS
NATIVE SHRUBS
SUCCULENTS
AGAVOIDS
INTRODUCED PERENNIAL FORBS
INTRODUCED ANNUAL GRASSES
INTRODUCED ANNUAL & BIENNIAL FORBS

DISCUSSION

BPHA1- Affected

Current Prairie dog (Cynomys ludovicianus) activity and open burrows were observed. Total vegetation cover decreased from 58 to 40 percent along with ground cover from 68 to 63 percent between 2016 and 2019. Species Density decreased from 14 to 10 species per 100 square meters in 2019. This included a decrease in Native species from 8 to 6 and Non-Native species decreased from 6 to 4 between 2016 and 2019, respectively.

BPHA2- Unaffected

Prairie dog activity was not observed within or near the transect location and appears to still be unaffected. Total vegetation cover increased from 87 to 89 percent although ground cover decreased from 100 to 97 percent between 2016 and 2019. Species Density decreased from 39 to 27 species per 100 square meters in 2019. This included a decrease of Native species from 21 to 16 and Non-Native species from 16 to 9 between 2016 and 2019, respectively.

Comparison of Paired Samples in 2019.

BPHA1 was previously occupied by prairie dogs and is currently heavily impacted by prairie dogs; BPHA2 was previously unoccupied and remains unoccupied but still shows signs of past disturbance.

The two sites are considerably different in appearance and vegetation characteristics. The prairie dog occupied site BPHA1 is substantially lower in total vegetation cover with 40% vs. 87% in the unoccupied site BPHA2. The percentage of bare soil which is 37% at the occupied site with 3% bare ground at the unoccupied site is an increase in erosion potential, however the site is flat and no rill or gully formation observed. BPHA2 has natural drainage channels but is well vegetated and there are currently no erosional issues observed.

APPENDIX A Photographs

HALL PROPERTY – September 14, 2019

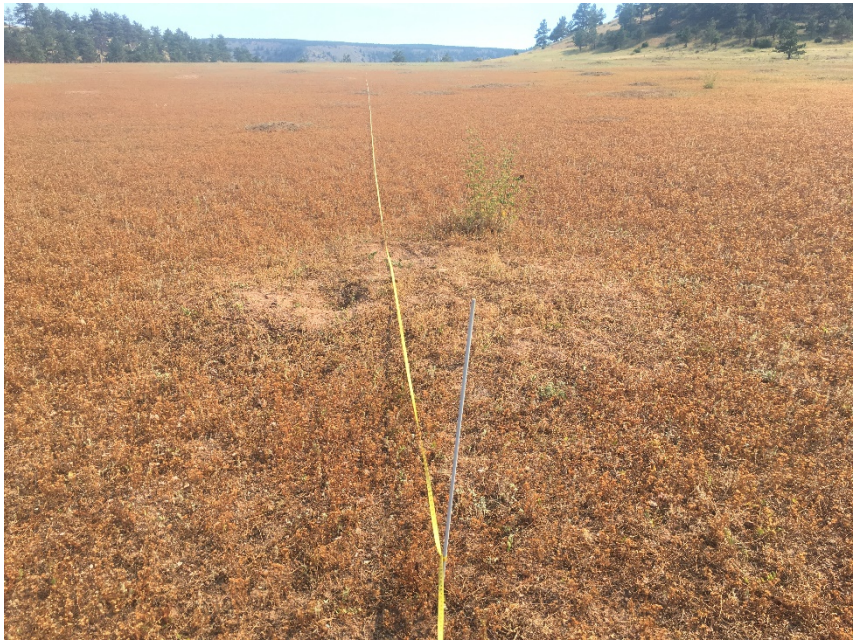


Photo 1. BPHA1 Origin – NW-facing view.

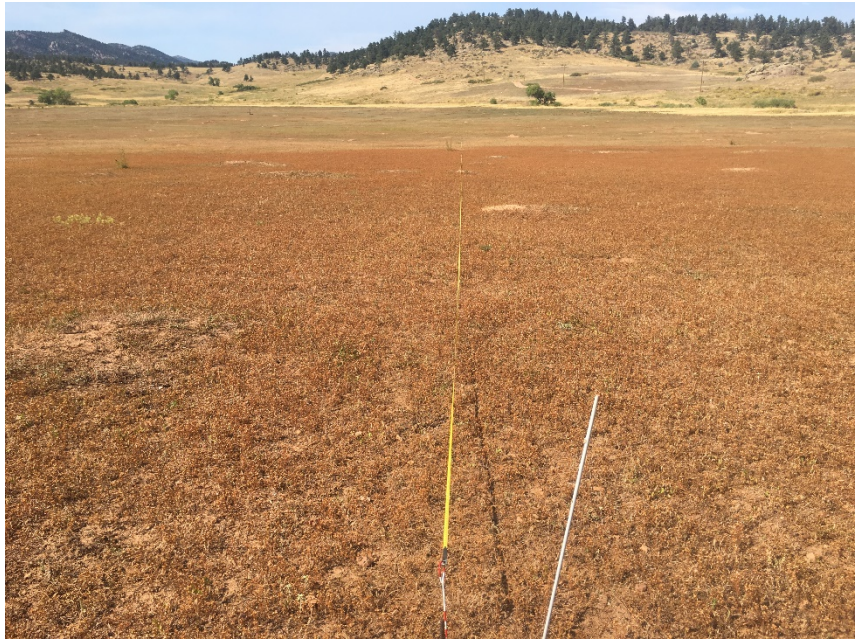


Photo 2. BPHA1 End – SE-facing view.

Photo 3. BPHA2 Origin – NW-facing view.

Photo 4. BPHA2 End – SE-facing view.

APPENDIX B Foliar Cover Data

Species	Common Name	BPHA1	2nd Hit	BPHA1 BASAL	BPHA2	2nd Hit	BPHA2 BASAL
NATIVE ANNUAL & BIENNIAL FORBS							
Dyssodia papposa	fetid marigold	31					
Plantago patagonica	woolly plantain	2					
Silene antirrhina	sleepy catchfly				P		
	TOTAL	**33**	**0**	**0**	**0**	**0**	**0**
INTRODUCED ANNUAL & BIENNIAL FORBS							
Arabis glabra	tower rockcress				P		
Camelina microcarpa	littlepod false flax				1		
Lactuca serriola	prickly lettuce				P		
Onopordum acanthium	Scotch cottonthistle				P		
Verbascum blattaria	moth mullein				1		
Verbascum thapsus	mullein				P		
	TOTAL	**0**	**0**	**0**	**2**	**0**	**0**
INTRODUCED ANNUAL GRASSES							
Anisantha tectorum	cheatgrass				3P	3	
Bromus japonicus	Japanese brome				2P	2	
	TOTAL	**0**	**0**	**0**	**0**	**5**	**0**
NATIVE PERENNIAL FORBS							
Ambrosia psilostachya var. coronopifolia	western ragweed	2			8		
Brickellia rosmarinifolia ssp. chlorolepis	brickellia	P					
Gaillardia aristata	blanketflower				P		
Geranium caespitosum ssp. caespitosum	small-leaf wild geranium				2		
Heterotheca foliosa	golden aster				1		
Heterotheca villosa	hairy golden aster				1P		
Lupinus argenteus	silvery lupine				1		
Oligosporus pacificus	field sagewort				1		
Oxybaphus linearis	umbrellawort				P		
Psoralidium tenuiflorum	prairie scurfpea	P					
Senecio spartioides	broom groundsel				P		
Symphyotrichum ericoides	white heath aster				1		
	TOTAL	**2**	**0**	**0**	**14**	**0**	**0**
INTRODUCED PERENNIAL FORBS							
Breea arvensis	Canada thistle	P					
Convolvulus arvensis	field bindweed	5					
Linaria genistifolia ssp. dalmatica	dalmation toadflax				P		
Marrubium vulgare	horehound	P					
Trifolium pratense	red clover	P					
	TOTAL	**5**	**0**	**0**	**0**	**0**	**0**
NATIVE PERENNIAL GRASSES (cool)							
Hesperostipa comata	needle-and-thread grass				4		
Pascopyrum smithii	western wheatgrass				1		
	TOTAL	**0**	**0**	**0**	**5**	**0**	**0**
INTRODUCED PERENNIAL GRASSES (cool)							
Poa compressa	Canada bluegrass				1		
	TOTAL	**0**	**0**	**0**	**1**	**0**	**0**
NATIVE PERENNIAL GRASSES (warm)							
Andropogon gerardii	big bluestem				1		
	TOTAL	**0**	**0**	**0**	**1**	**0**	**0**

Species	Common Name	BPHA1	2nd Hit	BPHA1 BASAL	BPHA2	2nd Hit	BPHA2 BASAL
NATIVE SUBSHRUBS							
Artemisia frigida	fringed sage				1		
	TOTAL	**0**	**0**	**0**	**1**	**0**	**0**
NATIVE SHRUBS							
Chrysothamnus nauseosus	rubber rabbitbrush				5		
Rosa woodsii	wood's rose	P					
	TOTAL	**0**	**0**	**0**	**5**	**0**	**0**
SUCCULENTS							
Opuntia macrorhiza	twistpine pricklypear cactus				P		
	TOTAL	**0**	**0**	**0**	**0**	**0**	**0**
Litter		22			7		
Rock		1			0		
Soil		37			3		
Standing Dead		0			1		
	TOTAL HITS	**100**			**100**		
	TOTAL VEGETATION COVER	**40**	**0**	**0**	**89**	**5**	**0**
	GROUND COVER	**63**			**97**		
	SPECIES DENSITY	**10**			**27**		

*P=Present within the 100 sqm belt transect.

Attachment F

Rangeland Vegetation Monitoring Report IRFQ

November
2022

Centennial Property
2022 Growing Season
Boulder County, Colorado

Prepared for:

Boulder County Parks and Open Space
Agricultural Division
5201 St. Vrain Road
Longmont, CO 80503

RANGELAND VEGETATION MONITORING REPORT IRFQ

Centennial Property
2022 Growing Season
Boulder County, Colorado

revision date: November 29, 2022

Executive Summary

This report is one of four reports prepared for Boulder County Parks and Open Space IRFQ 2050-22 and includes the results of the quantitative vegetation monitoring at the Centennial Property (Sample Sites CEN01, CEN02, CEN03, and CEN05). This report includes an introduction, background information, methods, results, and a discussion. Data is presented in both graphical and tabular formats and photographs are included. Microsoft Excel spreadsheet data files and photographs in jpg format accompany this report.

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1.0 Introduction

Quantitative vegetation sample plots have been established as part of a long-term monitoring program to help guide management decisions at Centennial Property. The four samples (CEN01, CEN02, CEN03, and CEN05) shown in Figure 1. These data were collected as a component of a comparison study of changes over time. While this report does not make any detailed comparisons to previous data collected, general changes are presented.

2.0 Relevant Background

The Agricultural Division of Boulder County Parks and Open Space Department (BCPOS) has implemented the long-term monitoring of rangeland vegetation to assess land health with continued leasing to grazing operations. Rangeland monitoring has been conducted annually in a rotating schedule of properties and vegetation was last monitored on the Centennial Property in 2015[1]. In addition, portions of the project site were subject to invasive species control with herbicides[2]. More specifically, the area surrounding CEN02 was sprayed with Glyphosate on February 25, 2019, to control cheatgrass for a single season so that the remaining native remnant species could be better identified. CEN01, CEN03, and CEN05 were located outside of sprayed areas. Previous visit data in 2015 indicated that all four samples supported active prairie dogs, and active prairie dogs were also observed in 2022.

3.0 Methods

Vegetation cover and species density data were collected at each transect location. Two photographs were taken at each sample, with one photograph taken at the origin and the other at the end of each transect, and oriented inward along the transect. Sampling occurred on September 18, 2022. The start and end points of the transects were previously recorded with a GPS unit, as was the slope and aspect of the start point and the transect orientation relative to the start. In order to ensure the correct transects were monitored in 2022, the start and end points of each transect were re-recorded using a BadElf GPSPro+ and emailed to BCPOS staff at the end of each field day.

Foliar cover data were collected as point-intercept data, using the Cover-Point optical scope along each 50 meter long transect. Point data were collected at each meter, with one point at 0.5m from the center line on both sides of the transect for a total of 100 points (2 points at each meter x 50 meters). Data were recorded as first-hit and second-hit data for vegetation and standing dead plant material; and ground cover hits were recorded separately for bare soil, rock, and litter. Rock was considered to be any inorganic material greater than 1 cm. in diameter. Standing dead was considered to be any organic material that was still standing and was produced in the previous growing seasons. All vegetation hits were recorded by species.

Separate and simultaneous collections of basal cover data were also conducted. Ground cover hits with no vegetation cover were identical in the two data sets (i.e., foliar cover vs. basal cover), but the foliar data included any above ground plant part while the basal data only included live plant parts that were at the soil surface.

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[1] Ecotone, 2015. Vegetation Monitoring of Rangeland Areas. Centennial Property, 2015 Report. Prepared by Patrick Murphy of Boulder, Colorado.

[2] Per email communication with Joe Swanson, Boulder County Senior Weed Specialist, on November 28, 2022.

Species density data were collected in a 2 meter x 50 meter plot that was centered on the 50 meter transect. Any species that occurred within the plot was recorded. The final density value is presented as the number of species per 100 square meters (sq.m.). Plant species nomenclature follows Weber & Wittmann 1992 (with 1999 addenda) and is consistent with previous reporting.

All field data were collected on paper data checked against the 2015 data to ensure data consistency among years. During the species inventory for density measurements, each sample was searched twice in the 2 m x 50 m plot. A voucher for any unknowns was also collected for later identification and all plant specimens are currently being held in the offices of [redacted]. Post-field, data were entered into Ecotone's DataPoint program using an Android tablet and exported into MS Excel to generate summary data as found in Tables 1 through 3 and Figures 2 through 5. [redacted]

4.0 Results

The sample specific data with summary information are presented in Tables 1, 2, and 3. Table 1 is the summary data for overall foliar cover, basal cover, and species density. Tables 2 and 3 present the foliar data summarized by lifeform and nativity for vegetative cover and species density, respectively. Table 4 shows the species-specific foliar cover and density data as well as averages and frequencies. Table 5 is similar to Table 4 but is composed of only the basal cover data and summary information, while Table 6 presents the tabulated data for both foliar and basal cover data. Finally, Table 7 presents the location data for each transect and any incidental observations.

Figure 2 provides the total vegetation cover results summarized in a bar graph. Figure 3 provides the relative cover by lifeform for all of the transects. Figure 4 provides the species density by lifeform for all of the transects. Figure 5 provides a bar graph of the basal data broken down into litter, bare soil, rock and vegetation. Photographs are presented in Section 8.0.

The climate as well as site specific disturbance events were likely contributors to changes in both vegetation cover and composition over the last several years. Figure 6 provides an estimate of the climatic changes over time using Thornthwaite climate diagrams that present the average monthly temperatures (blue line), precipitation (blue dashed fill), and potential evapotranspiration (red fill) from 2014 through 2022. These climate data were collected at Boulder[3], but probably provide a reasonable estimate of conditions at the sample sites although site specific weather events can be highly variable. The data show that there are typically wet springs followed by drier summers where evapotranspiration exceeds precipitation from about mid-May to October. The duration of soil saturation and the frequency and intensity of precipitation events can play a significant part in species composition. The sampling in September of 2022 was preceded by a drier than normal spring and early summer and an about average late summer and fall. [redacted]

5.0 Discussion

There were active prairie dogs at all four transects sampled in 2022 as well as in the previous sample year, 2015. CEN02 did receive a treatment of Glyphosate in February 2019 to control cheatgrass for one

[3] Boulder Climate Data: 39.992772,-105.266163 https://psl.noaa.gov/boulder/

season. As found in Table 1, absolute foliar vegetation cover at CEN01 (53%) was higher than CEN02 (29%), CEN03 (22%), and CEN05 (17%). Bare soil as found in the basal cover data was high in CEN01, CEN02, and CEN05, with values ranging from 33% to 43% and bare soil was very high at CEN03 at 69%. The following discussion references relative vegetation cover values as found on Table 2 and Figure 3. Detailed cover data by species is found in Table 4 (foliar cover), Table 5 (basal cover), and Table 6 (foliar and basal cover combined).

CEN01 was dominated by introduced cover (86.0%), mainly introduced annual and biennial forbs, with natives representing only 14.0% of relative vegetative cover. Non-natives, or introduced plants, were mainly comprised of *Salsola collina* [Russian thistle]; with lesser amounts of *Anisantha tectorum*, and *Convolvulus arvensis* [field bindweed]. Natives were dominated by the warm season grasses *Aristida purpurea* [purple three-awn] and *Chondrosum gracile* [blue grama grass]. CEN01 had a slightly lower 2022 absolute vegetative cover (53%) as compared to 2015 (55%) and a much lower 2022 species density (22/100 sq.m.) compared to the 40 species found in 2015. Native plants had a higher relative cover and species density in 2015 than in 2022. More specifically, there has been a dramatic increase of *Salsola collina* [Russian thistle], as this introduced weedy forb was only present (and not "hit") in the previous foliar cover data. Likewise, there has been a dramatic decrease in native cover from 2015 to 2022, with relative cover of native plants deceasing from over 60% in 2015 to less than 15% in 2022. Prairie dogs were active in 2015 at all Centennial sites and continued to be present in 2022.

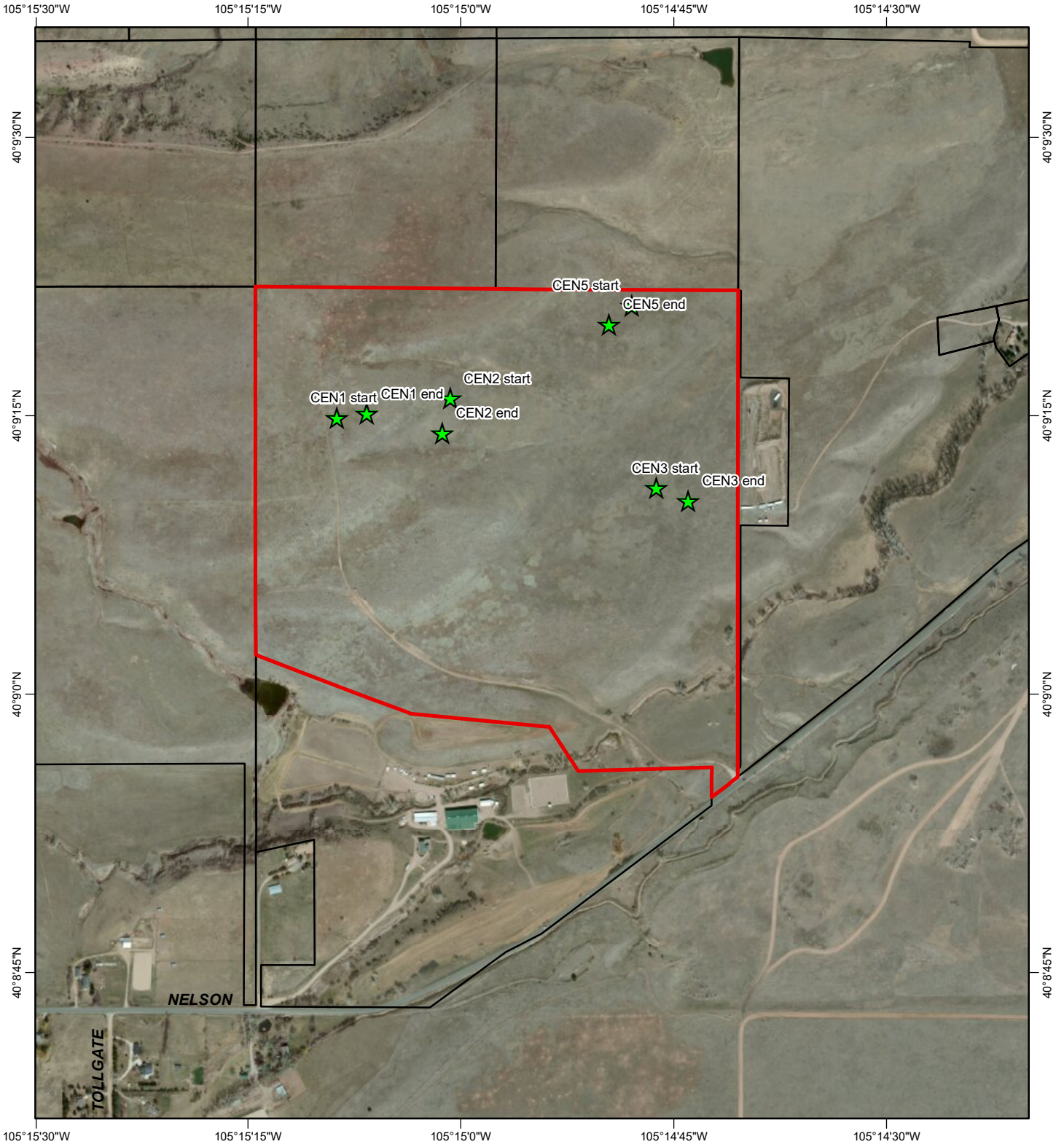
CEN02 was dominated by introduced plants (90.3%) with native plants comprising 9.7% of the relative cover. The introduced plants were dominated by non-native annual and biennial forbs namely *Salsola collina* [Russian thistle], with lesser amounts of *Carduus nutans* subsp. *macrolepis* [musk thistle] and *Erodium cicutarium* [filaree] as well as the non-native annual *Anisantha tectorum* [cheatgrass]. Native cover included a very sparse representation of *Aristida purpurea* [purple three-awn], *Artemisia frigida* [fringed sage], and *Virgulus falcatus* [white prairie aster]. CEN02 had a much lower 2022 absolute vegetative cover (29%) as compared to 2015 (77%) and a much lower 2022 species density (25/100 sq.m.) compared to the 37 species found in 2015. Native plants had over 85% relative cover in 2015 as compared to 2022 (9.7%). More specifically, there has been a dramatic increase of the weed *Salsola collina* [Russian thistle), and a dramatic decrease in subshrubs such as *Gutierrezia sarothrae* [snakeweed], perennial forbs such as *Artemisia frigida* [fringed sage] and the warm season perennial grass *Aristida purpurea* [purple three-awn]. Prairie dogs were active in 2015 at all Centennial sites and continued to be present in 2022. This transect received a treatment of Glyphosate in February 2019 to control cheatgrass for one season.

CEN03 was also dominated by introduced plants (82.6%) and native plants comprised 17.4% of the relative vegetation cover. Introduced plants mainly included *Convolvulus arvensis* [field bindweed], a perennial forb, along with the annual *Salsola collina* [Russian thistle], and the perennial forb *Marrubium vulgare* [horehound]. Natives were sparsely represented by *Artemisia frigida* [fringed sage], *Oligosporus dracunculus* [wild tarragon], and *Virgulus falcatus* [white prairie aster], which are all perennial forbs. CEN03 had a lower absolute vegetative cover (22%) in 2022 as compared to 2015 (43%), as well as a lower relative cover of native plants (17.4%) than in 2015 (~40%). The 2022 data lacked any hits on native warm season grasses, while there was a significant representation of these species in 2015 including *Buchloe dactyloides* [buffalo grass], *Chondrosum gracile* [blue grama grass], and *Aristida purpurea* [purple three awn] Species density was 15 in 2022 and 35 in 2022. Prairie dogs were active in 2015 at all Centennial sites and continued to be present in 2022.

CEN05 was dominated by introduced plants (94.1%) with native plants comprising 5.9% of the relative vegetative cover. Non-native introduced plants mainly included *Convolvulus arvensis* [field bindweed], a

perennial forb, along with the annual *Salsola collina* [Russian thistle]. The only native plant represented by the foliar cover included *Chenopodium incanum* [mealy goosefoot], a native annual forb. CEN05 had a lower absolute vegetative cover (17%) than in 2015 (59%). The 2022 sampling year also detected a much lower relative cover of native plants versus 2015 (about 5.9% in 2021 versus 20% in 2015). Species density was 12 in 2022 and 30 in 2015, with a similar allocation of native versus non-native plants. Prairie dogs were active in 2015 at all Centennial sites and continued to be present in 2022.

6.0 Figures



BASE: ESRI IMAGERY CLARITY
Grid Lat/Long WGS 1984

BOULDER COUNTY
COLORADO

N

Scale: 1:12,000
1 inch = 1,000 feet

Figure 1. Project Location Map
2022 Rangeland Vegetation Monitoring
Centennial Ranch Property
Boulder County Parks and Open Space

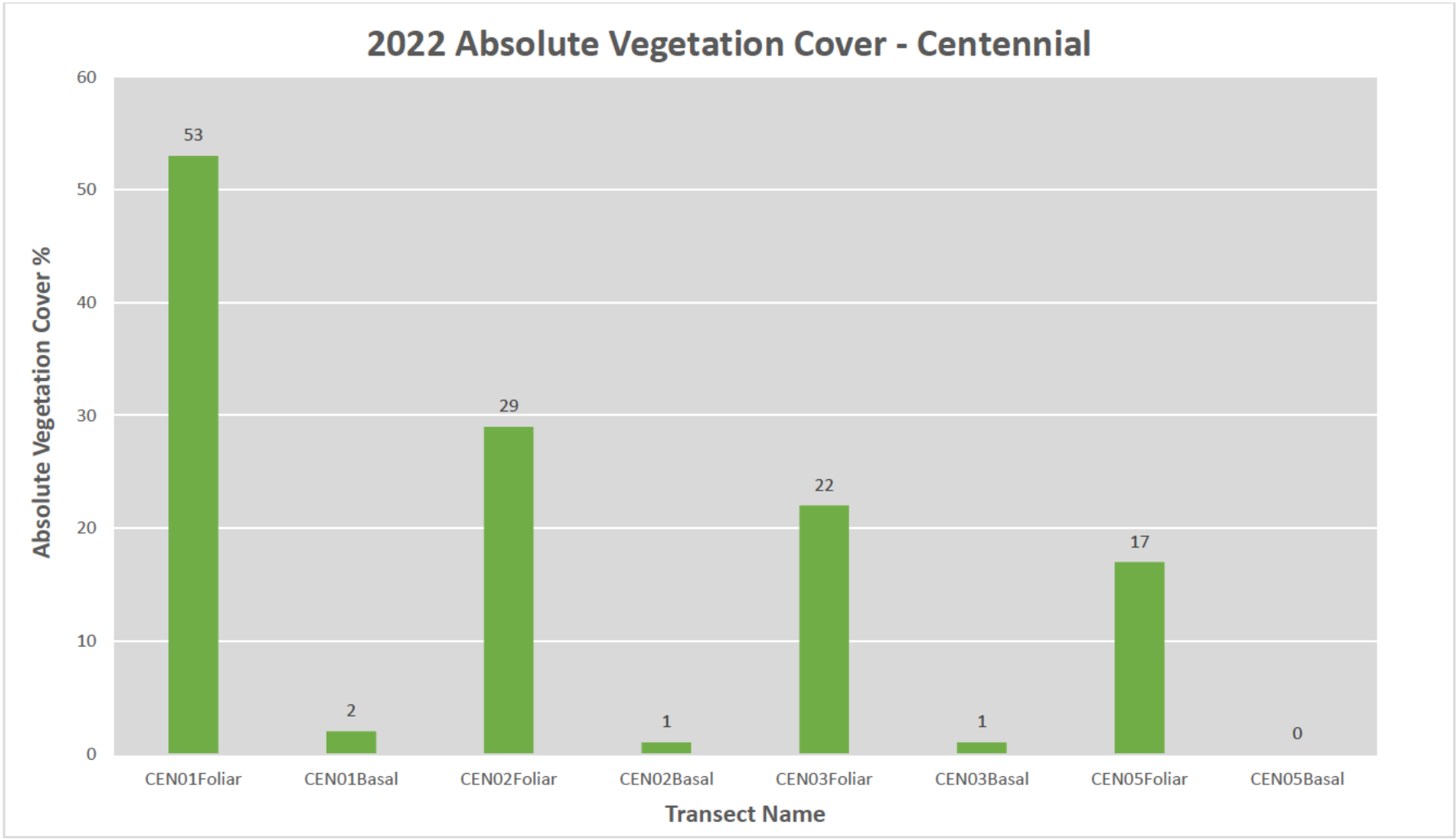


Figure 2. Total Vegetation Cover – Foliar & Basal - 2022

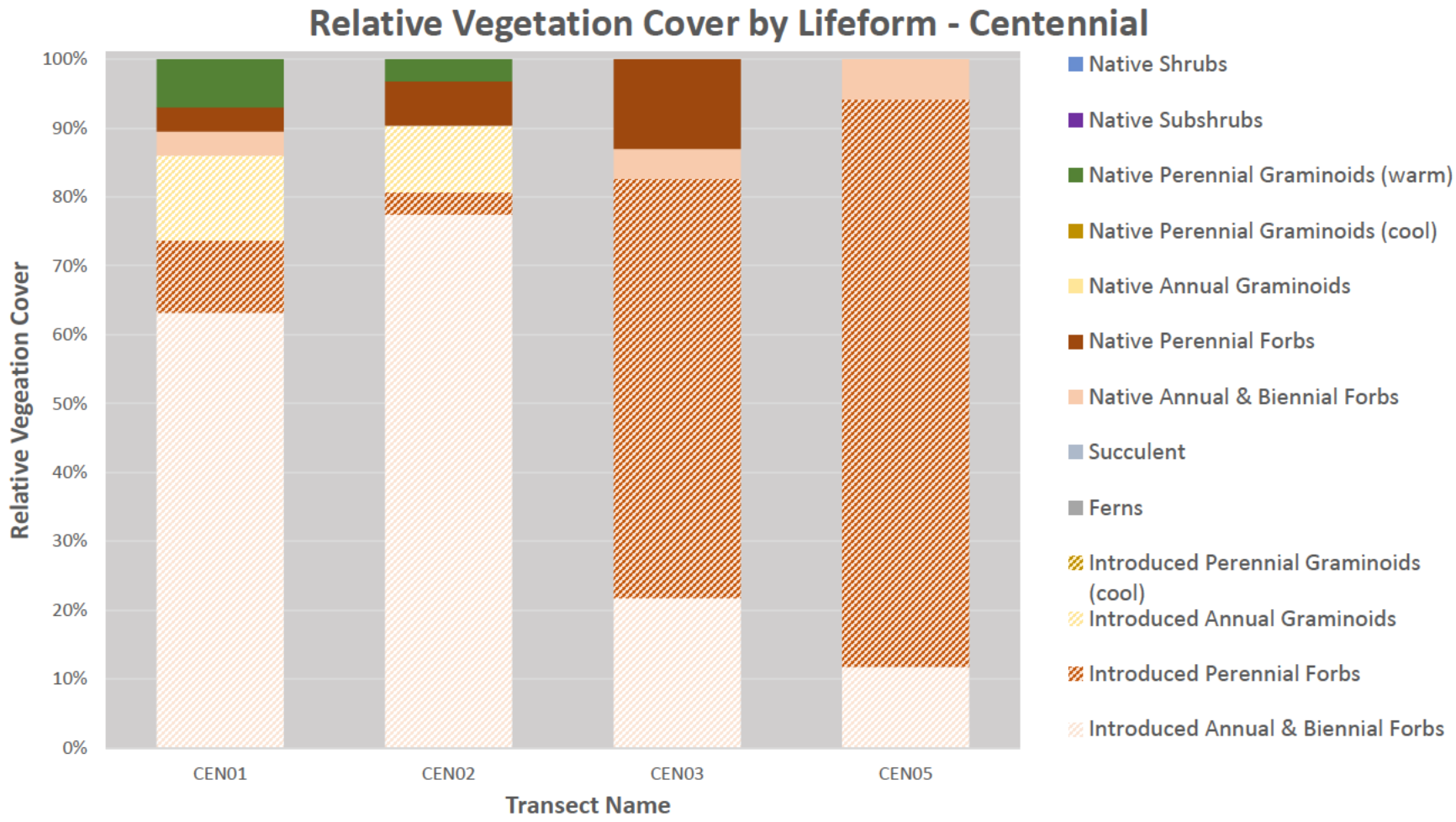


Figure 3. Relative Vegetation Cover by Lifeform - 2022

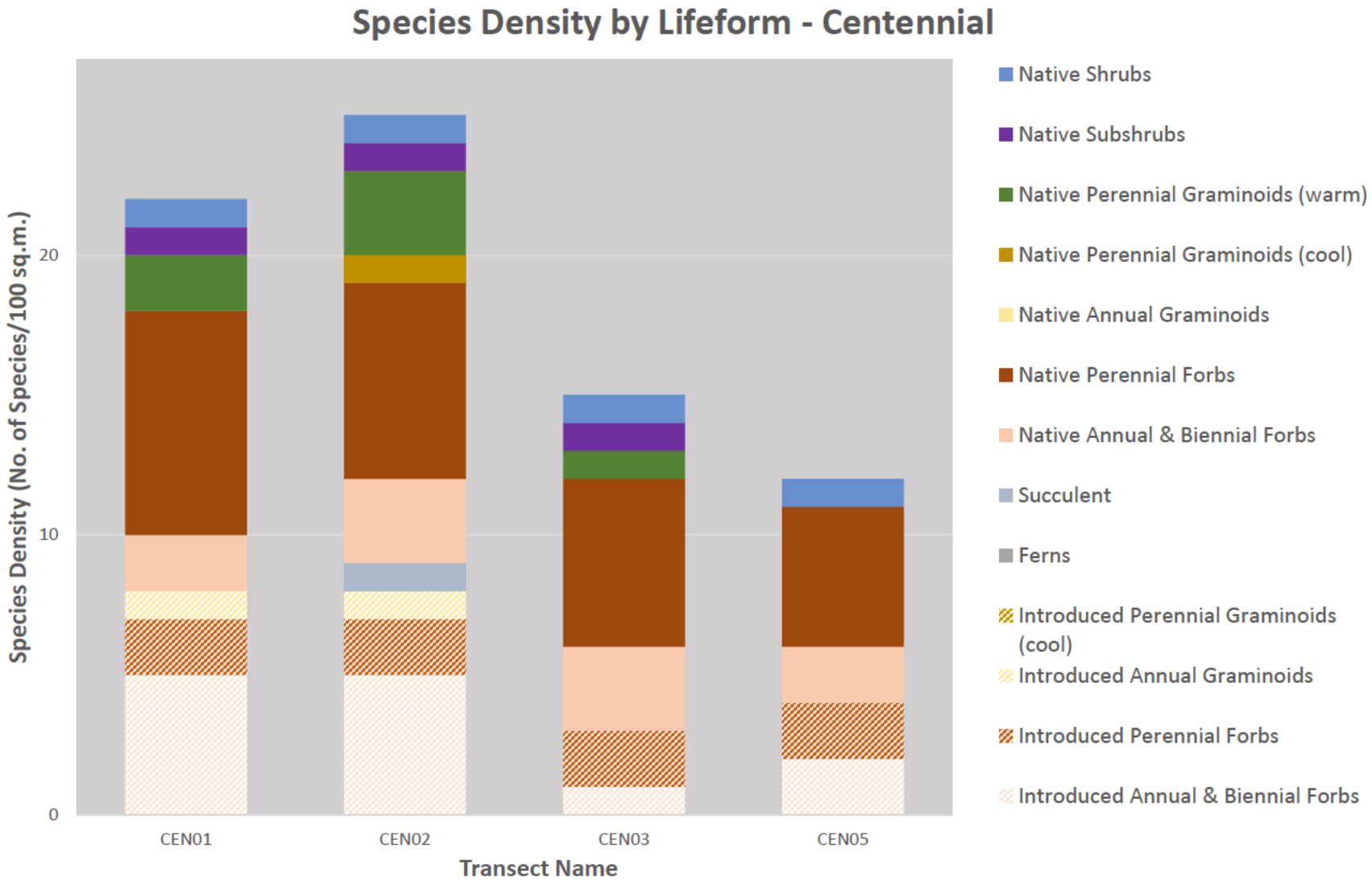


Figure 4. Species Density by Lifeform – 2022

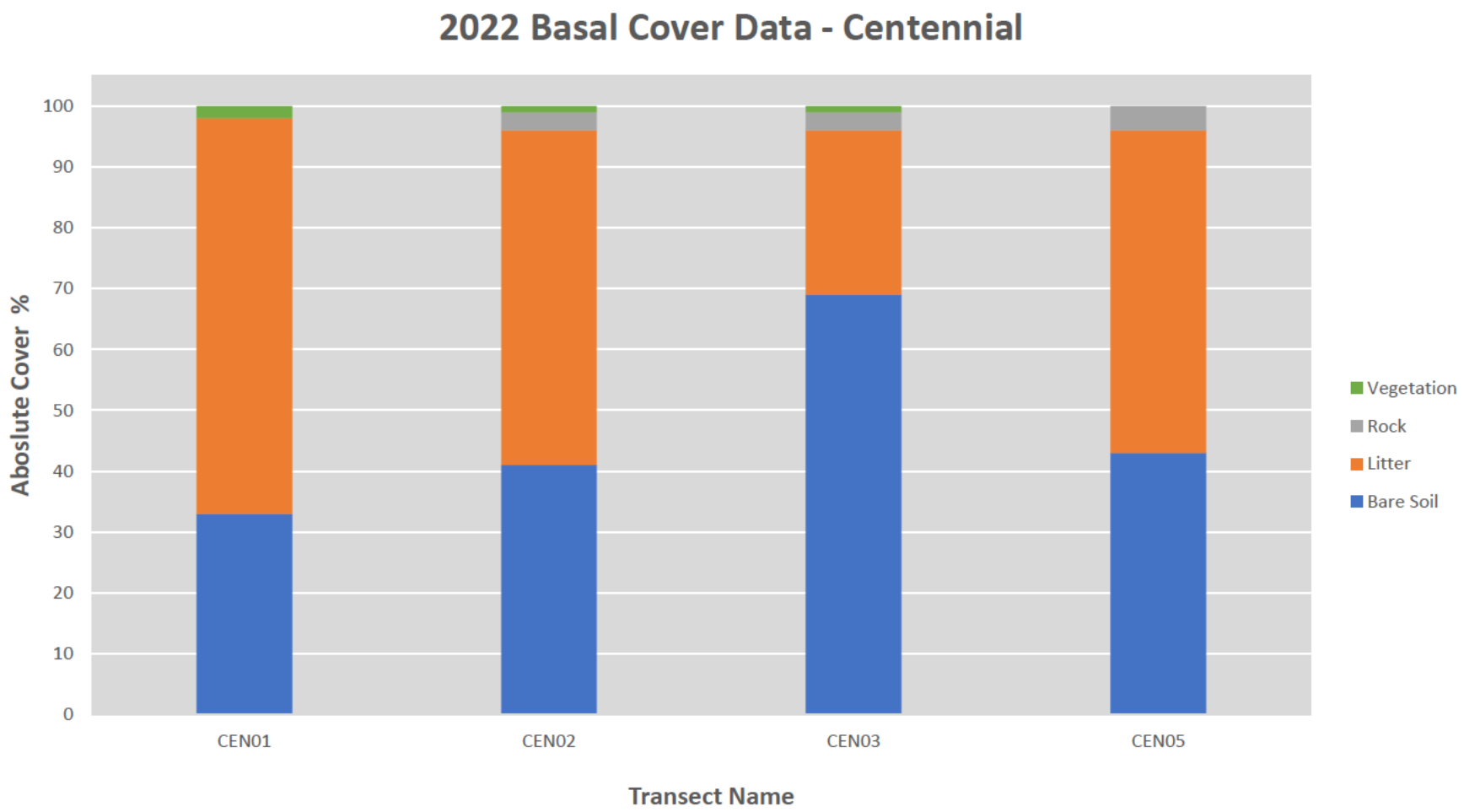


Figure 5. Basal Cover Data Details - 2022

7.0 Tables

TABLE 1. SUMMARY DATA FOR FOLIAR COVER, BASAL COVER, AND SPECIES DENSITY - 2022								
Cover Class	CEN01		CEN02		CEN03		CEN05	
	Foliar	Basal	Foliar	Basal	Foliar	Basal	Foliar	Basal
Litter	27	65	39	55	13	27	45	53
Bare Soil	20	33	31	41	62	69	36	43
Rock	0	0	1	3	3	3	2	4
Standing Dead	0	0	0	0	0	0	0	0
Absolute Vegetation Cover (%)	53(4)	2	29(2)	1	22(1)	1	17(0)	0
Ground Cover (Litter+Rock +Veg+StDead)	80(4)	67	69(2)	59	38(1)	31	64(0)	57
Species Density (#species/100 sq.m.)	22	2	25	1	15	1	12	0
Note: Data in parentheses are second hits								

TABLE 2. SUMMARY DATA FOR RELATIVE VEGETATION COVER BY LIFEFORM - 2022				
LIFEFORM	CEN01	CEN02	CEN03	CEN05
Native Shrubs	0.0%	0.0%	0.0%	0.0%
Native Subshrubs	0.0%	0.0%	0.0%	0.0%
Native Perennial Graminoids (warm)	7.0%	3.2%	0.0%	0.0%
Native Perennial Graminoids (cool)	0.0%	0.0%	0.0%	0.0%
Native Annual Graminoids	0.0%	0.0%	0.0%	0.0%
Native Perennial Forbs	3.5%	6.5%	13.0%	0.0%
Native Annual & Biennial Forbs	3.5%	0.0%	4.3%	5.9%
Succulent	0.0%	0.0%	0.0%	0.0%
Ferns	0.0%	0.0%	0.0%	0.0%
NATIVE RELATIVE COVER TOTAL	**14.0%**	**9.7%**	**17.4%**	**5.9%**
Introduced Perennial Graminoids (cool)	0.0%	0.0%	0.0%	0.0%
Introduced Annual Graminoids	12.3%	9.7%	0.0%	0.0%
Introduced Perennial Forbs	10.5%	3.2%	60.9%	82.4%
Introduced Annual & Biennial Forbs	63.2%	77.4%	21.7%	11.8%
INTRODUCED RELATIVE COVER TOTAL	**86.0%**	**90.3%**	**82.6%**	**94.1%**

TABLE 3. SUMMARY DATA FOR SPECIES DENSITY BY LIFEFORM - 2022				
LIFEFORM	CEN01	CEN02	CEN03	CEN05
Native Shrubs	1	1	1	1
Native Subshrubs	1	1	1	0
Native Perennial Graminoids (warm)	2	3	1	0
Native Perennial Graminoids	0	1	0	0
Native Annual Graminoids	0	0	0	0
Native Perennial Forbs	8	7	6	5
Native Annual & Biennial Forbs	2	3	3	2
Succulent	0	1	0	0
Moss	0	0	0	0
SPECIES DENSITY - NATIVE	14	17	12	8
Introduced Perennial Graminoids (cool)	0	0	0	0
Introduced Annual Graminoids	1	1	0	0
Introduced Perennial Forbs	2	2	2	2
Introduced Annual & Biennial Forbs	5	5	1	2
SPECIES DENSITY - INTRODUCED	8	8	3	4
SPECIES DENSITY TOTAL	22	25	15	12

Table 4. 2022 Centennial Foliar Cover Data			AVERAGE COVER (%)	FREQUENCY (%)	RELATIVE VEGETATION COVER (%)	AVERAGE COVER-ALL (%)	RELATIVE VEGETATION COVER-ALL (%)	CEN01D	CEN02D	CEN03D	CEN05D
SCIENTIFIC NAME	**SYNONYM**	**COMMON NAME**									
NATIVE ANNUAL & BIENNIAL FORBS											
Chenopodium incanum		MEALY GOOSEFOOT	0.50	75.00	1.65	0.50	1.56	1		P	1
Dyssodia papposa		FETID MARIGOLD	0.25	75.00	0.83	0.25	0.78	1	P	P	
Mesynium rigidum	LINUM RIGIDUM	YELLOW FLAX	0.00	75.00	0.00	0.25	0.78		P	(1)	P
Salvia aethiopis		MEDITERRANEAN SAGE	0.00	25.00	0.00	0.00	0.00		P		
TOTAL NATIVE ANN. & BIEN. FORBS			**0.8**	**100.0**	**2.5**	**1.0**	**3.1**	**2**	**P**	**(1)**	**1**
INTRODUCED ANNUAL & BIENNIAL FORBS											
Acosta diffusa	CENTAUREA DIFFUSA	TUMBLE KNAPWEED	0.00	25.00	0.00	0.00	0.00		P		
Alyssum parviflorum		ALYSSUM	0.00	50.00	0.00	0.00	0.00	P	P		
Carduus nutans ssp. macrolepis		MUSK THISTLE	0.75	50.00	2.48	0.75	2.34	1	2		
Erodium cicutarium		FILAREE	0.75	75.00	2.48	1.00	3.13	(1)	3		P
Salsola collina		RUSSIAN THISTLE	15.00	100.00	49.59	15.00	46.88	34	19	5	2
Sisymbrium altissimum		JIM HILL MUSTARD	0.00	25.00	0.00	0.00	0.00	P			
TOTAL INTRO. ANN. & BIEN. FORBS			**16.5**	**100.0**	**54.5**	**16.8**	**52.3**	**35(1)**	**24**	**5**	**2**
INTRODUCED ANNUAL GRASSES											
Anisantha tectorum	BROMUS TECTORUM	CHEATGRASS	1.75	50.00	5.79	2.50	7.81	5(2)	2(1)		
TOTAL INTRO. ANN. GRASSES			**1.8**	**50.0**	**5.8**	**2.5**	**7.8**	**5(2)**	**2(1)**	**---**	**---**
NATIVE PERENNIAL FORBS											
Argemone polyanthemos		PRICKLY POPPY	0.00	50.00	0.00	0.00	0.00	P			P
Artemisia frigida		FRINGED SAGE	0.75	100.00	2.48	0.75	2.34	1	1	1	P
Astragalus agrestis		FIELD MILKVETCH	0.00	75.00	0.00	0.00	0.00	P		P	P
Evolvulus nuttallianus	EVOLVULUS PILOSUS (ARGENTEUS)	SHAGGY DWARF MORNING-GLORY	0.00	25.00	0.00	0.00	0.00		P		
Gaura coccinea		GAURA	0.00	25.00	0.00	0.00	0.00	P			
Glandularia wrightii		SHOWY-VERVAIN	0.00	25.00	0.00	0.00	0.00				P
Heterotheca villosa	HETEROTHECA HORRIDA,CHRYSOPSIS VILLOSA	HAIRY GOLDEN ASTER	0.00	50.00	0.00	0.00	0.00	P	P		
Hybanthus verticillatus		GREEN VIOLET	0.00	25.00	0.00	0.00	0.00		P		
Liatris punctata		GAYFEATHER	0.00	25.00	0.00	0.00	0.00	P			
Lygodesmia juncea		SKELETONWEED	0.25	25.00	0.83	0.25	0.78	1			
Machaeranthera pinnatifida	HAPLOPAPPUS SPINULOSUS,MACHAERANTHERA SPINULOSA	TANSEY ASTER	0.00	25.00	0.00	0.00	0.00			P	
Oligosporus dracunculus ssp. glaucus	ARTEMISIA DRACUNCULUS SSP. GLAUCUS	WILD TARRAGON	0.25	25.00	0.83	0.25	0.78			1	
Oxybaphus linearis	MIRABILIS LINEARIS	UMBRELLAWORT	0.00	25.00	0.00	0.00	0.00		P		
Quincula lobata	PHYSALIS LOBATA	GROUND-CHERRY	0.00	50.00	0.00	0.00	0.00		P		P
Senecio spartioides		BROOM GROUNDSEL	0.00	25.00	0.00	0.00	0.00	P			
Sphaeralcea coccinea		COPPER MALLOW	0.00	25.00	0.00	0.00	0.00			P	
Virgulus falcatus	ASTER FALATUS, ASTER COMMUTATUS	WHITE PRAIRIE ASTER	0.50	50.00	1.65	0.50	1.56		1	1	
TOTAL NATIVE PERENNIAL FORBS			**1.8**	**100.0**	**5.8**	**1.8**	**5.5**	**2**	**2**	**3**	**P**
INTRODUCED PERENNIAL FORBS											
Convolvulus arvensis		FIELD BINDWEED	7.50	100.00	24.79	8.00	25.00	4(1)	(1)	12	14

Table 4. 2022 Centennial Foliar Cover Data			AVERAGE COVER (%)	FREQUENCY (%)	RELATIVE VEGETATION COVER (%)	AVERAGE COVER-ALL (%)	RELATIVE VEGETATION COVER-ALL (%)	CEN01D	CEN02D	CEN03D	CEN05D
SCIENTIFIC NAME	**SYNONYM**	**COMMON NAME**									
Linaria genistifolia ssp. dalmatica	LINARIA DALMATICA	DALMATION TOADFLAX	0.25	50.00	0.83	0.25	0.78	1	P		
Marrubium vulgare		HOREHOUND	0.50	50.00	1.65	0.50	1.56			2	P
TOTAL INTRO. PERENNIAL FORBS			**8.3**	**100.0**	**27.3**	**8.8**	**27.3**	**5(1)**	**(1)**	**14**	**14**
NATIVE PERENNIAL GRASSES (cool)											
Pascopyrum smithii	AGROPYRON SMITHII	WESTERN WHEATGRASS	0.00	25.00	0.00	0.00	0.00		P		
TOTAL NATIVE PERENNIAL GRASSES (c)			**0.0**	**25.0**	**0.0**	**0.0**	**0.0**	**---**	**P**	**---**	**---**
NATIVE PERENNIAL GRASSES (warm)											
Aristida purpurea	ARISTIDA FENDLERIANA,A. LONGISETA,A. WRIGHTII	PURPLE THREE-AWN	1.00	75.00	3.31	1.00	3.13	3	1	P	
Buchloe dactyloides		BUFFALOGRASS	0.00	25.00	0.00	0.00	0.00		P		
Chondrosum gracile	BOUTELOUA GRACILIS	BLUE GRAMA GRASS	0.25	50.00	0.83	0.25	0.78	1	P		
TOTAL NATIVE PERENNIAL GRASSES (w)			**1.3**	**75.0**	**4.1**	**1.3**	**3.9**	**4**	**1**	**P**	**---**
NATIVE SUBSHRUBS											
Gutierrezia sarothrae		BROOM SNAKEWEED	0.00	75.00	0.00	0.00	0.00	P	P	P	
TOTAL NATIVE SUBSHRUBS			**0.0**	**75.0**	**0.0**	**0.0**	**0.0**	**P**	**P**	**P**	**---**
NATIVE SHRUBS											
Chrysothamnus nauseosus	ERICAMERIA NAUSEOSUS VAR. NAUSEOSA	RUBBER RABBITBRUSH	0.00	50.00	0.00	0.00	0.00		P	P	
Yucca glauca		SPANISH BAYONET	0.00	50.00	0.00	0.00	0.00	P			P
TOTAL NATIVE SHRUBS			**0.0**	**100.0**	**0.0**	**0.0**	**0.0**	**P**	**P**	**P**	**P**
SUCCULENT											
Opuntia macrorhiza	OPUNTIA COMPRESSA	TWISTPINE PRICKLYPEAR CACTUS	0.00	25.00	0.00	0.00	0.00		P		
TOTAL SUCCULENT			**0.0**	**25.0**	**0.0**	**0.0**	**0.0**	**---**	**P**	**---**	**---**
LITTER				**100.0**				**27**	**39**	**13**	**45**
BARE SOIL				**100.0**				**20**	**31**	**62**	**36**
ROCK				**75.0**				**---**	**1**	**3**	**2**
TOTALS			**100.0**			**101.8**		**100**	**100**	**100**	**100**
TOTAL VEGETATION COVER			**30.3 (s=15.9)**		**100.0**	**32.0 (s=17.6)**	**100.0**	**53(4)**	**29(2)**	**22(1)**	**17**
GROUND COVER (Litter+Rock+Veg+St.Dead)			**62.8**			**64.5**		**80(4)**	**69(2)**	**38(1)**	**64**
SPECIES DENSITY (# of species/100 sq.m.)								**22**	**25**	**15**	**12**
(AVERAGE= 18.5 Std.Dev.= 6.0)											

Table Notes: Average Cover = 1st hits/Total hits (100 per transect). Frequency = % of transects with a particular species present. Relative Vegetation Cover = 1st hits divided by total number of vegetation 1st hits (varies per transect). 2nd hits are not recorde for Basal Data.

Table 5. 2022 Centennial Basal Cover Data			AVERAGE COVER (%)	FREQUENCY (%)	RELATIVE VEGETATION COVER (%)	AVERAGE COVER-ALL (%)	RELATIVE VEGETATION COVER-ALL (%)	CEN01U	CEN02U	CEN03U	CEN05U
SCIENTIFIC NAME	**SYNONYM**	**COMMON NAME**									
INTRODUCED ANNUAL & BIENNIAL FORBS											
Salsola collina		RUSSIAN THISTLE	1.00	100.00	25.00	1.00	25.00	1			
TOTAL INTRO. ANN. & BIEN. FORBS			**1.0**	**100.0**	**25.0**	**1.0**	**25.0**	**1**	**---**	**---**	**---**
NATIVE PERENNIAL FORBS											
Artemisia frigida		FRINGED SAGE	1.00	100.00	25.00	1.00	25.00		1		
TOTAL NATIVE PERENNIAL FORBS			**1.0**	**100.0**	**25.0**	**1.0**	**25.0**	**---**	**1**	**---**	**---**
INTRODUCED PERENNIAL FORBS											
Convolvulus arvensis		FIELD BINDWEED	1.00	100.00	25.00	1.00	25.00	1			
Marrubium vulgare		HOREHOUND	1.00	100.00	25.00	1.00	25.00			1	
TOTAL INTRO. PERENNIAL FORBS			**2.0**	**100.0**	**50.0**	**2.0**	**50.0**	**1**	**---**	**1**	**---**
LITTER				**100.0**				**65**	**55**	**27**	**53**
BARE SOIL				**100.0**				**33**	**41**	**69**	**43**
ROCK				**100.0**				**---**	**3**	**3**	**4**
TOTALS			**400.0**			**400.0**					
TOTALS (LAYER)								**100**	**100**	**100**	**100**
TOTAL VEGETATION COVER (LAYER)								**2**	**1**	**1**	**0**
TOTAL VEGETATION COVER			**4.0 (s=0.0)**		**100.0**	**4.0 (s=0.0)**	**100.0**				
GROUND COVER (Litter+Rock+Veg+St.Dead)			**53.5**			**53.5**		**67**	**59**	**31**	**57**
SPECIES DENSITY (# of species/100 sq.m.)											
(AVERAGE= 0.0 Std.Dev.= 0.0)											
SPECIES DENSITY (LAYER)								**2**	**1**	**1**	**0**

Table Notes: Average Cover = 1st hits/Total hits (100 per transect). Frequency = % of transects with a particular species present. Relative Vegetation Cover = 1st hits divided by total number of vegetation 1st & 2nd hits (varies per transect). 2nd hits are not recorded for Basal Data.

Table 6. 2022 CENTENNIAL COMBINED FOLIAR AND BASAL COVER			AVERAGE COVER	FREQUENCY	RELATIVE VEGETATION COVER	AVERAGE COVER-ALL	RELATIVE VEGETATION COVER-ALL								
SCIENTIFIC NAME	**SYNONYM**	**COMMON NAME**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	CEN01D	CEN01U	CEN02D	CEN02U	CEN03D	CEN03U	CEN05D	CEN05U
NATIVE ANNUAL & BIENNIAL FORBS															
Chenopodium incanum		MEALY GOOSEFOOT	2.00	100.00	1.60	2.00	1.52	1				P		1	
Dyssodia papposa		FETID MARIGOLD	1.00	100.00	0.80	1.00	0.76	1		P		P			
Mesynium rigidum	LINUM RIGIDUM	YELLOW FLAX	0.00	100.00	0.00	1.00	0.76			P		(1)		P	
Salvia aethiopis		MEDITERRANEAN SAGE	0.00	100.00	0.00	0.00	0.00			P					
TOTAL NATIVE ANN. & BIEN. FORBS			**3.0**	**100.0**	**2.4**	**4.0**	**3.0**	**2**	**---**	**P**	**---**	**(1)**	**---**	**1**	**---**
INTRODUCED ANNUAL & BIENNIAL FORBS															
Acosta diffusa	CENTAUREA DIFFUSA	TUMBLE KNAPWEED	0.00	100.00	0.00	0.00	0.00			P					
Alyssum parviflorum		ALYSSUM	0.00	100.00	0.00	0.00	0.00	P		P					
Carduus nutans ssp. macrolepis		MUSK THISTLE	3.00	100.00	2.40	3.00	2.27	1		2					
Erodium cicutarium		FILAREE	3.00	100.00	2.40	4.00	3.03	(1)		3				P	
Salsola collina		RUSSIAN THISTLE	61.00	100.00	48.80	61.00	46 21	34	1	19		5		2	
Sisymbrium altissimum		JIM HILL MUSTARD	0.00	100.00	0.00	0.00	0.00	P							
TOTAL INTRO. ANN. & BIEN. FORBS			**67.0**	**100.0**	**53.6**	**68.0**	**51.5**	**35(1)**	**1**	**24**	**---**	**5**	**---**	**2**	**---**
INTRODUCED ANNUAL GRASSES															
Anisantha tectorum	BROMUS TECTORUM	CHEATGRASS	7.00	100.00	5.60	10.00	7.58	5(2)		2(1)					
TOTAL INTRO. ANN. GRASSES			**7.0**	**100.0**	**5.6**	**10.0**	**7.6**	**5(2)**	**---**	**2(1)**	**---**	**---**	**---**	**---**	**---**
NATIVE PERENNIAL FORBS															
Argemone polyanthemos		PRICKLY POPPY	0.00	100.00	0.00	0.00	0.00	P						P	
Artemisia frigida		FRINGED SAGE	4.00	100.00	3.20	4.00	3.03	1		1	1	1		P	
Astragalus agrestis		FIELD MILKVETCH	0.00	100.00	0.00	0.00	0.00	P				P		P	
Evolvulus nuttallianus	EVOLVULUS PILOSUS (ARGENTEUS)	SHAGGY DWARF MORNING-GLORY	0.00	100.00	0.00	0.00	0.00			P					
Gaura coccinea		GAURA	0.00	100.00	0.00	0.00	0.00	P							
Glandularia wrightii		SHOWY-VERVAIN	0.00	100.00	0.00	0.00	0.00							P	
Heterotheca villosa	HETEROTHECA HORRIDA,CHRYSOPSIS VILLOSA	HAIRY GOLDEN ASTER	0.00	100.00	0.00	0.00	0.00	P		P					
Hybanthus verticillatus		GREEN VIOLET	0.00	100.00	0.00	0.00	0.00			P					
Liatris punctata		GAYFEATHER	0.00	100.00	0.00	0.00	0.00	P							
Lygodesmia juncea		SKELETONWEED	1.00	100.00	0.80	1.00	0.76	1							
Machaeranthera pinnatifida	HAPLOPAPPUS SPINULOSUS,MACHAERANTHERA SPINULOSA	TANSEY ASTER	0.00	100.00	0.00	0.00	0.00					P			
Oligosporus dracunculus ssp. glaucus	ARTEMISIA DRACUNCULUS SSP. GLAUCUS	WILD TARRAGON	1.00	100.00	0.80	1.00	0.76					1			
Oxybaphus linearis	MIRABILIS LINEARIS	UMBRELLAWORT	0.00	100.00	0.00	0.00	0.00			P					
Quincula lobata	PHYSALIS LOBATA	GROUND-CHERRY	0.00	100.00	0.00	0.00	0.00			P				P	
Senecio spartioides		BROOM GROUNDSEL	0.00	100.00	0.00	0.00	0.00	P							
Sphaeralcea coccinea		COPPER MALLOW	0.00	100.00	0.00	0.00	0.00					P			
Virgulus falcatus	ASTER FALATUS, ASTER COMMUTATUS	WHITE PRAIRIE ASTER	2.00	100.00	1.60	2.00	1.52			1		1			
TOTAL NATIVE PERENNIAL FORBS			**8.0**	**100.0**	**6.4**	**8.0**	**6.1**	**2**	**---**	**2**	**1**	**3**	**---**	**P**	**---**
INTRODUCED PERENNIAL FORBS															
Convolvulus arvensis		FIELD BINDWEED	31.00	100.00	24.80	33.00	25.00	4(1)	1	(1)		12		14	
Linaria genistifolia ssp. dalmatica	LINARIA DALMATICA	DALMATION TOADFLAX	1.00	100.00	0.80	1.00	0.76	1		P					
Marrubium vulgare		HOREHOUND	3.00	100.00	2.40	3.00	2.27					2	1	P	
TOTAL INTRO. PERENNIAL FORBS			**35.0**	**100.0**	**28.0**	**37.0**	**28.0**	**5(1)**	**1**	**(1)**	**---**	**14**	**1**	**14**	**---**

Table 6. 2022 CENTENNIAL COMBINED FOLIAR AND BASAL COVER			AVERAGE COVER	FREQUENCY	RELATIVE VEGETATION COVER	AVERAGE COVER-ALL	RELATIVE VEGETATION COVER-ALL								
SCIENTIFIC NAME	SYNONYM	COMMON NAME	(%)	(%)	(%)	(%)	(%)	CEN01D	CEN01U	CEN02D	CEN02U	CEN03D	CEN03U	CEN05D	CEN05U
NATIVE PERENNIAL GRASSES (cool)															
Pascopyrum smithii	AGROPYRON SMITHII	WESTERN WHEATGRASS	0.00	100.00	0.00	0.00	0.00			P					
TOTAL NATIVE PERENNIAL GRASSES (c)			**0.0**	**100.0**	**0.0**	**0.0**	**0.0**	**---**	**---**	**P**	**---**	**---**	**---**	**---**	**---**
NATIVE PERENNIAL GRASSES (warm)															
Aristida purpurea	ARISTIDA FENDLERIANA,A. LONGISETA,A. WRIGHTII	PURPLE THREE-AWN	4.00	100.00	3.20	4.00	3.03	3		1		P			
Buchloe dactyloides		BUFFALOGRASS	0.00	100.00	0.00	0.00	0.00			P					
Chondrosum gracile	BOUTELOUA GRACILIS	BLUE GRAMA GRASS	1.00	100.00	0.80	1.00	0.76	1		P					
TOTAL NATIVE PERENNIAL GRASSES (w)			**5.0**	**100.0**	**4.0**	**5.0**	**3.8**	**4**	**---**	**1**	**---**	**P**	**---**	**---**	**---**
NATIVE SUBSHRUBS															
Gutierrezia sarothrae		BROOM SNAKEWEED	0.00	100.00	0.00	0.00	0.00	P		P		P			
TOTAL NATIVE SUBSHRUBS			**0.0**	**100.0**	**0.0**	**0.0**	**0.0**	**P**	**---**	**P**	**---**	**P**	**---**	**---**	**---**
NATIVE SHRUBS															
Chrysothamnus nauseosus	ERICAMERIA NAUSEOSUS VAR. NAUSEOSA	RUBBER RABBITBRUSH	0.00	100.00	0.00	0.00	0.00			P		P			
Yucca glauca		SPANISH BAYONET	0.00	100.00	0.00	0.00	0.00	P						P	
TOTAL NATIVE SHRUBS			**0.0**	**100.0**	**0.0**	**0.0**	**0.0**	**P**	**---**	**P**	**---**	**P**	**---**	**P**	**---**
SUCCULENT															
Opuntia macrorhiza	OPUNTIA COMPRESSA	TWISTPINE PRICKLYPEAR CACTUS	0.00	100.00	0.00	0.00	0.00			P					
TOTAL SUCCULENT			**0.0**	**100.0**	**0.0**	**0.0**	**0.0**	**---**	**---**	**P**	**---**	**---**	**---**	**---**	**---**
LITTER				**100.0**				**27**	**65**	**39**	**55**	**13**	**27**	**45**	**53**
BARE SOIL				**100.0**				**20**	**33**	**31**	**41**	**62**	**69**	**36**	**43**
ROCK				**100.0**				**---**	**---**	**1**	**3**	**3**	**3**	**2**	**4**
TOTALS			**800.0**			**807.0**		**800**		**800**		**800**		**800**	
TOTALS (LAYER)								**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
TOTAL VEGETATION COVER (LAYER)								**53(4)**	**2**	**29(2)**	**1**	**22(1)**	**1**	**17**	**0**
TOTAL VEGETATION COVER			**125.0 (s=0.0)**		**100.0**	**132.0 (s=0.0)**	**100.0**	**125(7)**		**125(7)**		**125(7)**		**125(7)**	
GROUND COVER (Litter+Rock+Veg+St.Dead)			**58.1**			**59.0**		**80(4)**	**67**	**69(2)**	**59**	**38(1)**	**31**	**64**	**57**
SPECIES DENSITY (# of species/100 sq.m.)															
(AVERAGE= 0.0 Std.Dev.= 0.0)															
SPECIES DENSITY (LAYER)								**22**	**2**	**25**	**1**	**15**	**1**	**12**	**0**

Table Notes: Average Cover = 1st hits/Total hits (100 per transect). Frequency = % of transects with a particular species present. Relative Vegetation Cover = 1st hits divided by total number of vegetation 1st & 2nd hits (varies per transect). 2nd hits are not recorded for Basal Data.

Table 7. Sample Site Specifications - Centennial

Transect No.		Sampler(s)	Easting UTM	Northing UTM	Elevation	Orientation/Azimuth (magnetic N)	Aspect	Slope (deg.)	Slope (%)	2022 Comment	Sample Date
CEN01	origin	Rea Orthner	478502	4444895	5372.54	65	65	0.5	0.9	2 ft offset style no end marker. Monumnet and stake present at start. Did not sample offset. Active prairie	Sept-18-2022
	end		478552	4444902							
CEN02	origin	Rea Orthner	478691	4444927	5386.1	180	81	4	7	2 ft offset style. Monument at start, but not at end. Active prairie dogs.	Sept-18-2022
	end		478678	4444870							
CEN03	origin	Rea Orthner	479034	4444777	5359.42	100	28	0.5	0.9	Monument at start,no monument at end, but stake is present. Active prairie dogs. Offset style.	Sept-18-2022
	end		479087	4444756							
CEN05	origin	Rea Orthner	478994	4445080	5334	220	110	5	8.7	No monument at start, but stake is present. End has monumnet and stake. Active prairie dogs.	Sept-18-2022
	end		478956	4445049							

Note: UTMs take from AgMonitoring2022 GIS shapefile provided by BCPOS August 2022. Elevation, orientation, aspect and slope form Ecotone (2015).

8.0 Photographs

PHOTO 1. CEN01 ORIGIN. SEPTEMBER 18, 2022.

PHOTO 2. CEN01 END. SEPTEMBER 18, 2022.

PHOTO 3. CEN02 ORIGIN. SEPTEMBER 18, 2022.

PHOTO 4. CEN02 END. SEPTEMBER 18, 2022.

PHOTO 5. CEN03 ORIGIN. SEPTEMBER 18, 2022.

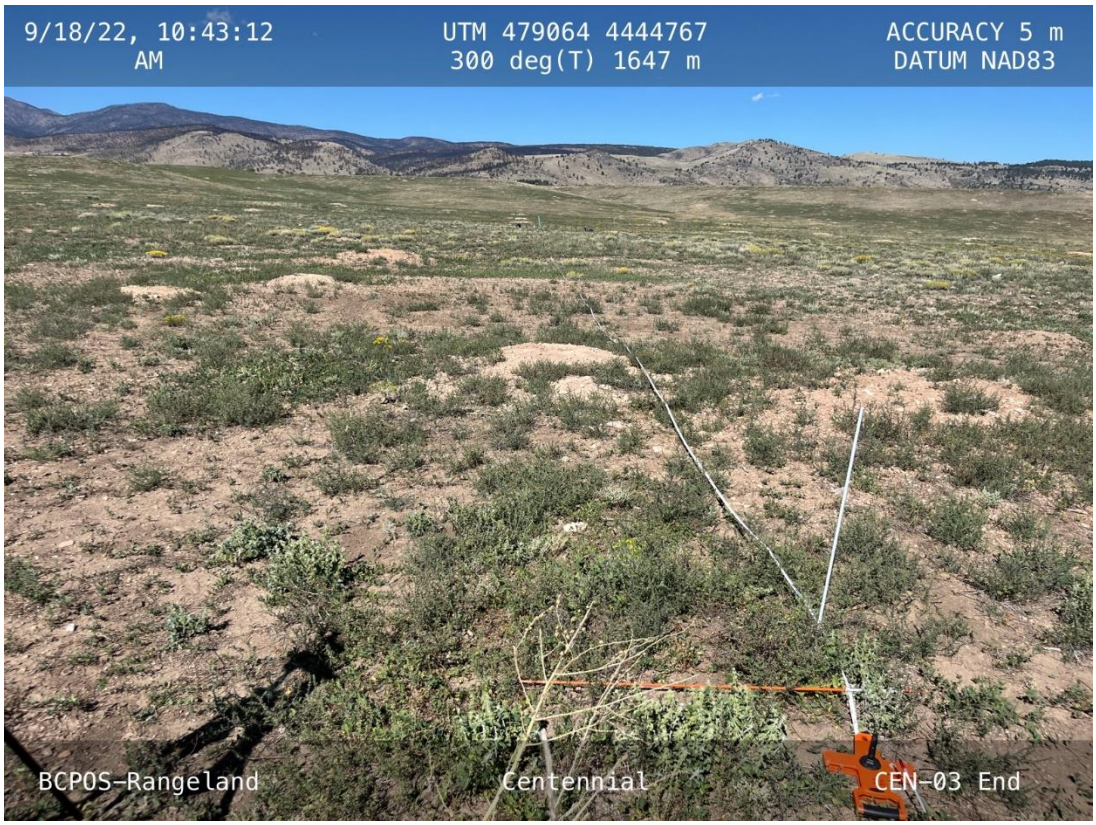


PHOTO 6. CEN03 END. SEPTEMBER 18, 2022.

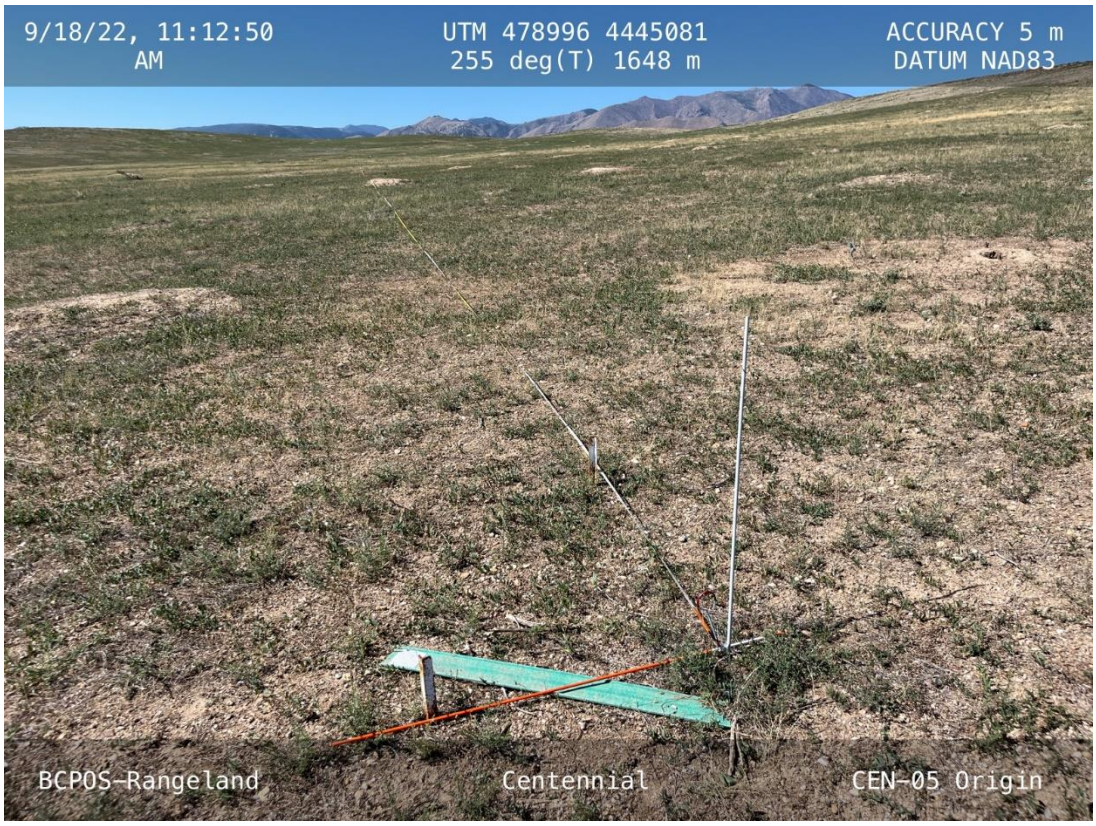


PHOTO 7. CEN05 ORIGIN. SEPTEMBER 18, 2022.

PHOTO 8. CEN05 END. SEPTEMBER 18, 2022.

1) The following GIS Data deliverables are required:

a) PLSS Monuments

i) Monument Points – spatial; high accuracy PLSS coordinate points

- delivered in a projected shapefile or geodatabase feature class.
- Include an attribute field called PointID and unique value entered for each point.

Standard Shapefile Name: PropertyNameMonuments.shp
Standard Feature Class Name: PropertyNameMonuments
Example Files: McLachlanMonuments.shp;
McLachlanMonuments.gdb/McLachlanMonuments

ii) Monument Point Accuracy Report - Data accuracy report for the monument points

- in the form of a spreadsheet or CSV file
- including a PointID column to correlate with 1.a.ii.2 of whatever document.

Standard file name: PropertyNameAccuracyReport.xlsx
Example file: McLachlanMetadata.xlsx

iii) Monument Photos – one photo of each point required so that notation is legible.

- name of each photo must correlate with 1.a.ii.2 of whatever document.
- photos do NOT have to be georeferenced

Standard file name: PropertyNamePoint323.jpg
Example file: McLachlanPoint323.jpg

b) Plat Survey – spatial; the property boundary

- Delivered in a projected shapefile or geodatabase feature class.

Standard Shapefile Name: PropertyNamePlat.shp
Standard Feature Class Name: PropertyNamePlat
Example Files: McLachlanPlat.shp; McLachlanPlat.gdb/McLachlanPlat

c) Topographic Survey -spatial; shows height, depth, size and location of manmade or natural features, as well as elevation contours

- Delivered in a projected shapeefile or geodatabase feature class

Standard Shapefile File Name: PropertyNameTopoSurvey.shp
Standard Feature Class Name: PropertyNameTopoSurvey
Example File: McLachlanTopoSurvey.shp;McLachlanTopoSurvey/McLachlanTopoSurvey

d) Other GIS Data -spatial; other contracted GIS data, such as monitoring, inventories, species mapping, etc.

- Delivered in a projected shapefile or geodatabase feature class

Standard File Name: PropertyName_DataDescription.shp
Standard Feature Class Name: PropertyNameDataDescription

Example File: McLachlanWetlandInventory.shp;
McLachlanWetlandInventory/McLachlanWetlandInventory

e) CAD Data – spatial; any additional spatial generated in CAD format
- Delivered in a projected shapeefile or geodatabase feature class

Standard file name: PropertyName_DataDescription_CAD.shp
Example file: McLachlan_AsBuilt_CAD.shp

2) How to deliver GIS Data

a) Data transfer will happen over Boulder County's secure FTP site. Refer to **Appendix B** for full instructions on how to download and install this connection.

b) Once in the interface of the SFTP site, create a new folder to store your deliverables (*see Figure 1).*

- Do this in the right pane by clicking New>Folder.
- Name the folder 'YourCompanyName_Date'.

Example folder name: CivilSomething_20210323

c) Drag and drop your 4 GIS data deliverables into the folder created above *(see Figure 1).*

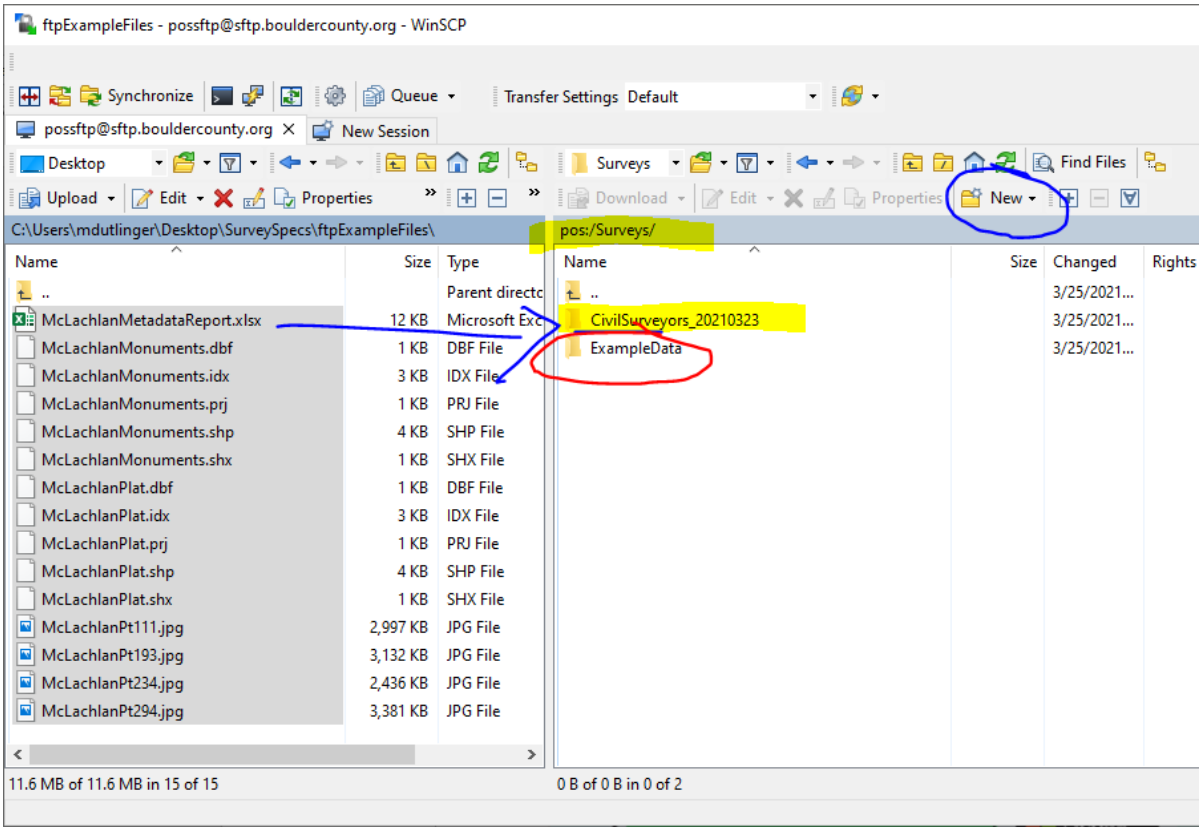


Figure 1

3) Example GIS Data deliverables

A collection of example data as described in a-d above has also been provided for reference.

- The data can be accessed here:
  Sftp://Surveys/McLachlanProperty_ExampleData.zip (See Figure 1)

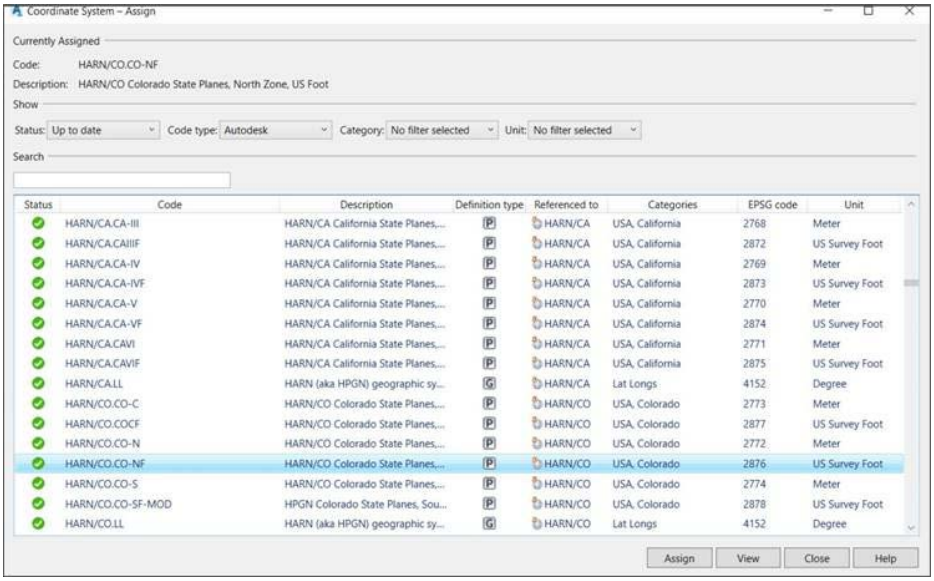
! All data produced in AutoCAD software that is to be integrated with Boulder County GIS data must be assigned and delivered in our standard projected coordinate system:

NAD_1983_HARN_StatePlane_Colorado_North_FIPS_0501_Feet

Follow these instructions when exporting AutoCAD data into GIS data so that it can be accepted and integrated with Boulder County GIS.

1. In your .dwg, assign a coordinate system by command: MAPCASSIGN.

2. Choose HARN/CO.CO-NF (*this is the code*) coordinate system in CAD. *See screenshot below.*



2. Go to the A at the top left of your .dwg, and then Export. Or, command: MAPEXPORT.

3. Set the File Type to Shapefile from Other GIS Formats.

4. Click OK to prompt the Export Dialog Box which has 3 tabs.

5. In the Selection tab, choose the Object Type, so either Point, Line, or Polygon.

6. In the Data tab, you can select attribute fields and values to export, when necessary.

7. In the Options tab, you can confirm the assigned coordinate system.

8. If you have a different assigned coordinate system, you can convert to HARN/CO.CO-NF here before exporting.

10. For polygons, be sure to 'Treat closed polylines as polygons'.

ATTACHMENT I

TERMS AND CONDITIONS

THE ARTICLES SPECIFIED ARE SUBJECT TO THE FOLLOWING CONDITIONS

1. The offer of seller, either orally or in writing, shall for all purposes be deemed accepted upon execution of this purchase order.

2. No terms additional to or different from those contained herein shall be valid or effective unless otherwise specified on this purchase order.

3. The Seller acknowledges that it has carefully reviewed and examined this purchase order with all of its incorporated documents attached, and the Seller will not make any claim to the Purchaser based upon or arising out of any misunderstanding or misconception on its part of the provisions and requirements of this purchase order: The seller acknowledges that it has fully examined and analyzed all conditions that could affect its performance and that no conditions exist which would affect the progress, performance, or price of this purchase order.

4. The making of payment shall not constitute an acceptance of any defective or incomplete work.

5. The failure of the Seller to perform any material obligation of this purchase order shall be deemed a default and Purchaser shall thereon be entitled, in addition to any other legal rights and remedies it may have, to cancel this purchase order. The Seller shall be responsible and liable to purchaser for all damages, costs, disbursements and expenses, including attorney's fees, incurred by the Purchaser as a result of the seller's breach or default of this purchase order.

6. This purchase order shall not be changed, modified, or altered except in writing and signed by Seller and Purchaser.

7. The right of cancellation in case of long delay in shipment is reserved.

8. No sales tax or use tax shall be included in or added to prices of materials on this order.

9. If the quantity shipped is short of the purchase order quantity, specify on the packing slip if that quantity is on backorder or canceled.

10. On prepaid freight shipments, copy of freight bill must accompany invoice.

11. This purchase order shall not be assigned in whole or in part nor shall any interest therein including the right to any proceeds and any such purported assignment shall be void.

12. Financial obligations of the county are contingent upon funds for that purpose being appropriated, budgeted, and otherwise made available as a result, the county reserves the right to terminate this agreement should necessary funds not be appropriated, budgeted, or otherwise made available.

13. If this purchase order covers equipment, materials, or containers thereof that are required by law to be constructed, packaged, labeled, or registered in a prescribed manner - such as, but not limited to, fabrics, poisons, combustibles gases, and any vehicles, storage tanks, and the like intended for transporting or storing the same. Seller hereby warrants that such equipment, materials, and containers will be in compliance with all such laws irrespective of whether Seller's shipments to Purchaser are interstate or intrastate. This provision applies whether or not a specification is furnished by Purchaser. No extra charges of any kind including charges for boxing, packaging, or cartage shall be allowed.

14. Seller hereby warrants for a period of one year after acceptance of all materials furnished hereunder by Purchaser, that all materials furnished hereunder will be free from all faults and defects, fit and sufficient for the purpose intended, merchantable, of good workmanship and in conformity with any specifications, drawings or samples specified or furnished herewith.

15. The validity, interpretation and performance of this Purchase Order shall be governed by the laws of the State of Colorado. Titles, captions or headings to any provisions, Articles, etc., shall not limit the full contents of same. If any term or provision of this purchase order is found invalid, it shall not affect the validity and enforcement of all remaining terms and provisions of this purchase order.

ATTACHMENT J
SAMPLE Continuing Services Contract

DETAILS SUMMARY	
Document Type	New Contract
OFS Number-Version	TBD
County Contact Information	
Boulder County Legal Entity	Boulder County
Department	PARKS AND OPEN SPACE
Division/Program	Resource Management Plant Ecology
Mailing Address	Boulder County Parks and Open Space Department Attn: ADMIN-Contracts 5201 St. Vrain Road Longmont, CO 80503
Contract Contact – *Name, email* Project Contact – *Name, email and cell phone* Main Office Telephone Number	TBD
Invoice Contact – *Name, email*	pospayables@bouldercounty.org
Contractor Contact Information	
Contractor Name	
Contractor Mailing Address	
Contact 1- *Name, title, email*	
Contact 2- *Name, title, email*	
Contract Term	
Start Date	The Start Date shall be the date of last party signature as set forth on the Signature Page of this Contract. NOTE: Work shall not commence until a Notice to Proceed is provided by County to Contractor in accordance with paragraph 3.
Expiration Date	12/31/2023 NOTE: Work must be performed during the time period set forth in paragraph 3.
Final End Date	12/31/2027
Contract Amount	
Contract Amount	TBD

NOTE: The Contract Amount, TBD, is a not-to-exceed amount for the Contract Term. The cost of services shall be established on a project-by-project basis consistent with the terms of this Contract.

Brief Description of Work

NOTE:
Work shall be assigned on a project-by-project basis according to the terms of this Contract and with each Project a Notice to Proceed will be issued.
SOQ# XXXX-23; ANNUAL VEGETATION MONITORING AND MAPPING SERVICES PROJECT

Contract Documents

a. Formal Procurement (RFP/Bid/SOQ) No. Bid Variable (the "Bid Documents")
b. Contractor's proposal in response to the Bid Documents (the "Proposal")
c. Project Details, including project-specific terms and a Scope of Work, attached as Exhibit A (the "Scope of Work")
d. Fee Schedule, attached as Exhibit B (the "Fee Schedule")

Purchasing Details – *County Internal Use Only*

Grant funded?	No
SOQ Number	
Award Date	
If no SOQ No., bid process used	Bid number provided above
COVID-19	NO
Project #	N/A
Purchasing Notes *(optional)*	

Contract Notes
Additional information not included above

ACCOUNT CODE: Project codes will be issued on a Project-by-Project basis and included in each Purchase Order issued.
ORIGINAL CSC

THIS CONTINUING SERVICES CONTRACT ("Contract") is entered into by and between the Board of County Commissioners on behalf of the County of Boulder, State of Colorado, a body corporate and politic, for the benefit of the Parks and Open Space Department ("County") and [Supplier] ("Contractor"). County and Contractor are each a “Party,” and collectively the “Parties.”

In consideration of the mutual covenants contained in this Contract, the receipt and sufficiency of which is hereby acknowledged, the Parties agree as follows:

1. Incorporation into Contract: The **Details Summary** is incorporated into this Contract. The **Contract Documents** are incorporated into this Contract by reference, except to the extent that the Proposal, if any is incorporated, contains any obligations placed upon County and not otherwise contained in this Contract.

2. Work to be Performed: County will assign work on a project-by-project basis. County may enter into continuing services contracts with other contractors who will compete with Contractor to receive individual projects. Contractor will only be paid for projects awarded to Contractor through a bid process. The scope of work, cost, start date, and any other relevant project/Work details must be mutually agreed upon in writing prior to any Work commencing; such project-specific documents shall be incorporated into this Contract upon their acceptance by both Parties. **Contractor acknowledges that a continuing service contract does not constitute a guarantee that Contractor will be awarded any projects or work of any kind**. Upon receipt of an assignment, Contractor will provide all labor and equipment and do all tasks necessary and incidental to performing the work as described in the **Details Summary**, **Contract Documents**, and the project-specific documents mutually agreed upon in writing (the "Work"). Contractor will perform the Work (a) in a good and workmanlike manner, (b) at its own cost and expense, (c) in accordance with recognized industry standards of care, skill and diligence for the type of work being performed, and (d) in strict accordance with the Contract.

3. Term of Contract: The **Contract Term** begins on the **Start Date** and expires on the **Expiration Date**, unless terminated sooner. Notwithstanding, Work shall not commence until the County has provided a NOTICE TO PROCEED to Contractor, which shall set forth the date that Contractor may begin the Work. All the Work must be performed during the **Contract Term**.

4. Payment for Work Performed: In consideration of the Work performed by Contractor, and subject to conditions contained in this Contract, County will pay the **Contract Amount** to Contractor in accordance with the **Contract Documents** and mutually agreed upon project-specific documents.

5. Invoicing: Contractor will promptly provide a copy of its Form W-9 and invoice template to County upon request. Contractor must submit an invoice to the County by the fifteenth (15th) day of the month for any part of the Work completed in the prior calendar month. All invoices submitted require the following components: Contractor’s name and address (submitted W-9 address must match remit address), detailed description of services, dates of services, itemization of labor and materials costs, “Bill to: Boulder County” language, payment remittance address, payer, name and address, date of invoice, unique invoice number, and total amount due. Contractor must send all completed invoices to the **Invoice Contact** in the **Details Summary**. County may require delivery of invoices by email. Failure to submit invoices in a timely manner and in accordance with the terms of this Contract may cause a delay in payment. County may recoup any damages

incurred because of Contractor's failure to submit invoices pursuant to the terms of this paragraph. County's acceptance or payment of an invoice will not constitute acceptance of any Work performed under this Contract.

6. Extra Time to Complete the Work (Additional Time only): If Contractor cannot complete the Work by the **Expiration Date**, Contractor may request extra time to complete the Work. County, in its sole discretion, may grant Contractor additional time to complete the Work by sending a written notice of extension to Contractor. An extension of time to complete the Work will not entitle Contractor to additional compensation from County.

7. Extension of Contract Term (Additional Time and Work): Upon mutual agreement of the Parties, this Contract may be extended until the **Final End Date**. During any extended **Contract Term**, the terms of this Contract will remain in full force and effect, unless otherwise amended in writing by the Parties. Where the Contractor will provide additional services for additional compensation beyond the initial **Contract Amount**, the Parties must execute a written amendment before the then-current **Expiration Date**. If necessary, the written amendment will incorporate an updated Scope of Work and updated Fee Schedule as exhibits. Contractor must provide a current Certificate of Insurance to the County that complies with the **Insurance Requirements** of this Contract, if any, prior to any extended **Contract Term**.

8. Schedule of Work: County may designate the hours (on a daily or weekly basis) during which Contractor may perform the Work, strictly for the purposes of minimizing inconvenience to the County and interference with County operations. Contractor will otherwise set its own work schedule.

9. Indemnity: Contractor will be liable for any damages to persons or property caused by or arising out of the actions, obligations, or omissions of Contractor, its employees, agents, representatives or other persons acting under Contractor's direction or control in performing or failing to perform the Work under this Contract. Contractor will indemnify and hold harmless County, its elected officials and appointed department heads, and its employees, agents and representatives (the "indemnified parties"), from any and all liability, claims, demands, actions, damages, losses, judgments, costs or expenses, including attorneys' fees, which may be made or brought or which may result against any of the indemnified parties as a result or on account of the actions or omissions of Contractor, its employees, agents or representatives, or other persons acting under Contractor's direction or control. This indemnification obligation will extend to claims based on Contractor's unauthorized use or disclosure of confidential information and intellectual property infringement. County will not be obligated to indemnify or defend Contractor under any circumstances. Contractor's obligations under this provision shall survive expiration or termination of this Contract. Nothing contained in this Contract or the **Contract Documents** is intended to limit or restrict the indemnification rights or obligations of any Party under this provision, or damages available for breaches of the obligations herein.

10. Nondiscrimination: Contractor will comply with the Colorado Anti-Discrimination Act, C.R.S. § 24-34-401, et seq., as amended, and all applicable local, State and Federal laws concerning discrimination and unfair employment practices. County prohibits unlawful discrimination on the basis of race, color, religion, gender, gender identity, national origin, age 40 and over, disability, socio-economic status, sexual orientation, genetic information, or any other status protected by applicable Federal, State or local law. Contractor must require that its subcontractors, if any, similarly comply with all applicable laws concerning discrimination and unfair employment practices.

11. Information and Reports: Contractor will provide to authorized County, State, and Federal government representatives all information and reports that may be required for any purpose authorized by law. Contractor will permit access to such representatives to Contractor's facilities, books, records, accounts, and any other relevant sources of information. Where information required by a representative is in the exclusive possession of a person or entity other than Contractor, Contractor must so certify to the County and explain what efforts it has made to obtain the information.

12. **Independent Contractor: Contractor is an independent contractor for all purposes in performing the Work. None of Contractor, its agents, personnel or subcontractors are employees of the County for any purpose, including the Federal Insurance Contribution Act, the Social Security Act, the Federal Unemployment Tax Act, the provisions of the Internal Revenue Code, the Colorado Workers' Compensation Act, the Colorado Unemployment Insurance Act, and the Public Employees Retirement Association. Accordingly, County will not withhold or pay any income tax, payroll tax, or retirement contribution of any kind on behalf of Contractor or Contractor's employees. As an independent contractor, Contractor is responsible for employing and directing such personnel and agents as it requires to perform the Work. Contractor will exercise complete authority over its personnel and agents and will be fully responsible for their actions.**

13. Termination

a. Breach: Either Party's failure to perform any of its material obligations under this Contract, in whole or in part or in a timely or satisfactory manner, will be a breach. The institution of proceedings under any bankruptcy, insolvency, reorganization or similar law, by or against Contractor, or the appointment of a receiver or similar officer for Contractor or any of its property, which is not vacated or fully stayed within thirty (30) days after the institution of such proceeding, will also constitute a breach. In the event of a breach, the non-breaching Party may provide written notice of the breach to the other Party. If the breaching Party does not cure the breach, at its sole expense, as reasonably determined by the non-breaching Party in its sole discretion, within thirty (30) days after delivery of notice, the non-breaching Party may exercise any of its remedies provided under this Contract or at law, including immediate termination of this Contract.

b. Non-Appropriation: The other provisions of this Contract notwithstanding, County is prohibited by law from making commitments beyond the current fiscal year. Payment to Contractor beyond the current fiscal year is contingent on the appropriation and continuing availability of funding in any subsequent year. County has reason to believe that sufficient funds will be available for the full **Contract Term**. Where, however, funds are not allocated for any fiscal period beyond the current fiscal year, County may terminate this Contract without penalty by providing seven (7) days' written notice to Contractor.

c. Convenience: In addition to any other right to terminate under this Section 13, County may terminate this Contract, in whole or in part, for any or no reason, upon seven (7) days' advance written notice to Contractor.

14. Contractor Obligations upon Termination or Expiration: By the **Expiration Date** or effective date of termination, if earlier, Contractor must (1) remove from County property all of its personnel, equipment, supplies, trash and any hazards created by Contractor, (2) protect any serviceable materials belonging to the County, and (3) take any other action necessary to leave

a safe and healthful worksite. Any items remaining on County property after the Expiration Date or the effective date of termination, if earlier, will be deemed abandoned by Contractor.

15. Payable Costs in Event of Early Termination: If County terminates this Contract before the **Expiration Date**, Contractor's payments (and any damages associated with any lawsuit brought by Contractor) are limited to only (1) payment for Work satisfactorily executed and fully and finally completed, as determined by County in its sole discretion, prior to delivery of the notice to terminate, and (2) the reasonable and actual costs Contractor incurred in connection with performing the Work prior to delivery of the notice to terminate. Contractor explicitly waives all claims it may have against the County for any other compensation, such as anticipatory profits or any other consequential, special, incidental, punitive or indirect damages

16. Remedies for Non-Performance: If Contractor fails to perform any of its obligations under this Contract, County may, at its sole discretion, exercise one or more of the following remedies (in addition to any other remedy provided by law or in this Contract), which shall survive expiration or termination of this Contract:

a. Suspend Performance: County may require that Contractor suspend performance of all or any portion of the Work pending necessary corrective action specified by the County and without entitling Contractor to an increase in compensation or extension of the performance schedule. Contractor must promptly stop performance and incurring costs upon delivery of a notice of suspension by the County.

b. Withhold Payment Pending Corrections: County may permit Contractor to correct any rejected Work at the County 's discretion. Upon County 's request, Contractor must correct rejected work at Contractor's sole expense within the time frame established by the County. Upon full and final completion of the corrections satisfactory to the County, County will remit payment to Contractor.

c. Deny Payment: County may deny payment for any Work that does not comply with the requirements of the Contract or that Contractor otherwise fails to provide or fully and finally complete, as determined by the County in its sole discretion. Upon County request, Contractor will promptly refund any amounts prepaid by the County with respect to such non-compliant Work.

d. Removal: Upon County 's request, Contractor will remove any of its employees or agents from performance of the Work, if County, in its sole discretion, deems any such person to be incompetent, careless, unsuitable, or otherwise unacceptable.

17. Binding Arbitration Prohibited: County does not agree to binding arbitration by any extra-judicial body or person.

18. Conflicts of Interest: Contractor may not engage in any business or personal activities or practices or maintain any relationships that conflict in any way with the full performance of Contractor's obligations.

19. Notices: All notices provided under this Contract must be in writing and sent by Certified U.S. Mail (Return Receipt Requested), electronic mail, or hand-delivery to the other Party's **Contact** at the address specified in the **Details Summary**. For certified mailings, notice periods will begin to run on the day after the postmarked date of mailing. For electronic mail or hand-

delivery, notice periods will begin to run on the date of delivery.

20. Statutory Requirements: This Contract is subject to all statutory requirements that are or may become applicable to counties or political subdivisions of the State of Colorado generally, including but not limited to: C.R.S. § 38-26-107, which requires withholding funds where the County receives a claim for payment from a supplier or subcontractor of Contractor upon notice of final settlement (required for public works contracts that exceed $150,000); C.R.S. § 8-17-101 et seq.; C.R.S. § 18-8-301, et seq.; and C.R.S. § 18-8-401, et seq.

21. No Suspension or Debarment: Contractor certifies, and warrants for the Contract Term, that neither it nor its principals nor any of its subcontractors are debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this Contract by any Federal or State department or agency. Contractor shall comply, and shall require its subcontractors to comply, with subpart C of 2 C.F.R. § 180.

22. Entire Agreement/Binding Effect/Amendments: This Contract represents the complete agreement between the Parties and is fully binding upon them and their successors, heirs, and assigns, if any. This Contract terminates any prior agreements, whether written or oral in whole or in part, between the Parties relating to the Work. This Contract may be amended only by a written agreement signed by both Parties.

23. Assignment/Subcontractors: This Contract may not be assigned or subcontracted by Contractor without the prior written consent of the County. If Contractor subcontracts any of its obligations under this Contract, Contractor will remain liable to the County for those obligations and will also be responsible for subcontractor's performance under, and compliance with, this Contract.

24. Governing Law/Venue: The laws of the State of Colorado govern the construction, interpretation, performance, and enforcement of this Contract. Any claim relating to this Contract or breach thereof may only be brought exclusively in the Courts of the 20th Judicial District of the State of Colorado and the applicable Colorado Appellate Courts.

25. Breach: The failure of either Party to exercise any of its rights under this Contract will not be deemed to be a waiver of such rights or a waiver of any breach of the Contract. All remedies available to a Party in this Contract are cumulative and in addition to every other remedy provided by law.

26. Severability: If any provision of this Contract becomes inoperable for any reason but the fundamental terms and conditions continue to be legal and enforceable, then the remainder of the Contract will continue to be operative and binding on the Parties.

27. Third-Party Beneficiary: Enforcement of the terms and conditions and all rights and obligations of this Contract are reserved to the Parties. Any other person receiving services or benefits under this Contract is an incidental beneficiary only and has no rights under this Contract. Notwithstanding, where the beneficiary **Department** is led by an Elected Official, such Elected Official shall be considered a third-party beneficiary.

28. Colorado Open Records Act: County may disclose any records that are subject to public release under the Colorado Open Records Act, C.R.S. § 24-72-200.1, et seq.

29. Conflict of Provisions: If there is any conflict between the terms of the main body of this Contract and the terms of any of the **Contract Documents** or the project-specific documents, the terms of the main body of the Contract will control.

30. Governmental Immunity: Nothing in this Contract shall be construed in any way to be a waiver of the County's immunity protection under the Colorado Governmental Immunity Act, C.R.S. § 24-10-101, et seq., as amended.

31. Representations and Warranties: Contractor represents and warrants the following:

a. Execution of this Contract and performance thereof is within Contractor's duly authorized powers;

b. The individual executing this Contract is authorized to do so by Contractor;

c. Contractor is authorized to do business in the State of Colorado and is properly licensed by all necessary governmental and public and quasi-public authorities having jurisdiction over the Work and the Contractor; and

d. Contractor and its subcontractors, if any, are financially solvent, able to pay all debts as they mature, and have sufficient working capital to complete the Work and perform all obligations under the Contract.

32. Legal Compliance: Contractor assumes full responsibility for obtaining and maintaining any permits and licenses required to perform the Work. Contractor is solely responsible for ensuring that its performance under this Contract and the Work itself will comply with all Federal, State, and local laws, regulations, ordinances and codes. County approval of the Work or any aspect of Contractor's performance, such as plans, designs, or other Contractor-drafted documents, shall not be interpreted to mean that Contractor has satisfied its obligations under this Section.

33. Litigation Reporting: Contractor is not currently involved in any action before a court or other administrative decision-making body that could affect Contractor's ability to perform the Work. Contractor will promptly notify the County if Contractor is served with a pleading or other document in connection with any such action.

34. Tax Exemption: County is exempt from payment of Federal, State, and local government taxes. Contractor shall collect no tax from the County, and the County shall not be liable to pay any taxes imposed on Contractor. County shall provide its tax exemption status information to Contractor upon request.

35. Delegation of Authority: The Parties acknowledge that the Board of County Commissioners has delegated authority to the Department Head or Elected Official that leads the beneficiary Department and their designees to act on behalf of the County under the terms of this Contract, including but not limited to the authority to terminate this Contract.

36. Ownership of Work Product: All work product, property, data, documentation, information or materials conceived, discovered, developed or created by Contractor pursuant to this Contract ("Work Product") will be owned exclusively by the County. To the extent possible, any Work Product will be deemed to be a work made for hire. Contractor unconditionally and irrevocably transfers and assigns to the County all right, title and interest in and to any Work Product.

37. Publicity Releases: Contractor will not refer to this Contract or the County in commercial advertising without prior written consent of the County. This provision shall survive expiration or

termination of this Contract.

38. Execution by Counterparts; Electronic Signatures: This Contract may be executed in multiple counterparts, each of which will be deemed an original, but all of which will constitute one agreement. The Parties approve the use of electronic signatures, governed by the Uniform Electronic Transactions Act, C.R.S. §§ 24 71.3 101 to 121. The Parties will not deny the legal effect or enforceability of this Contract solely because it is in electronic form or because an electronic record was used in its creation. The Parties will not object to the admissibility of this Contract in the form of electronic record, or paper copy of an electronic document, or paper copy of a document bearing an electronic signature, because it is not in its original form or is not an original.

39. Limitation on Public Statements and Lobbying Activity. During the term of this Contract, Contractor may receive from the County its confidential data, work product, or other privileged or confidential information that is protected by law. To maintain the fact and appearance of absolute objectivity, Contractor shall not, without the prior written consent of the County, which shall not be unreasonably withheld, do any of the following: (a) disclose information obtained because of this contractual relationship to any third party; (b) lobby any State or Federal agency on any pending matter while this Contract is effective; or (c) make any public statements or appear at any time to give testimony at any public meeting on the subject matters regarding which Contractor is or was retained by the County. County may set reasonable conditions on any disclosure authorized by the County under this provision. Notwithstanding, Contractor may make disclosures as required by law, and to law enforcement officials in connection with any criminal justice investigation.

40. Sustainability: County encourages Contractor to consider the procurement and use of environmentally preferable products and services while performing services under this Contract. "Environmentally preferable purchasing" means making purchasing choices for products and services that have a lesser or reduced adverse effect on human health and the environment when compared with competing products and services that serve the same purpose. Environmentally preferable purchasing is consistent with the County's commitment to protecting our air, water, soil, and climate for current and future generations. County encourages Contractor to incorporate the following actions into Contractor's performance of the Work: environmentally preferable supplies and services; conservation of water; efficient energy use; waste prevention; reuse and recycle construction and de-construction materials in a manner that maximizes reuse of materials; sustainable transportation choices, including consideration to business communication software such as Skype alternative to air travel and public transit or carpooling for in-person meetings; pollution prevention; low toxicity for public health & safety; and reduced emissions to address climate change.

41. Limitation of Liability: COUNTY SHALL NOT BE LIABLE TO CONTRACTOR FOR ANY SPECIAL, CONSEQUENTIAL, INCIDENTAL, PUNITIVE, OR INDIRECT DAMAGES ARISING FROM OR RELATING TO THIS CONTRACT, REGARDLESS OF ANY NOTICE OF THE POSSIBILITY OF SUCH DAMAGES. COUNTY'S AGGREGATE LIABILITY, IF ANY, ARISING FROM OR RELATED TO THIS CONTRACT, WHETHER IN CONTRACT, OR IN TORT, OR OTHERWISE, IS LIMITED TO, AND SHALL NOT EXCEED, THE AMOUNTS PAID OR PAYABLE HEREUNDER BY COUNTY TO CONTRACTOR. ANY CONTRACTUAL LANGUAGE LIMITING CONTRACTOR'S LIABILITY SHALL BE VOID.

42. Legal Interpretation. Each Party recognizes that this Contract is legally binding and acknowledges that it has had the opportunity to consult with legal counsel of its choice about this

Contract. The rule of construction providing that any ambiguities are resolved against the drafting Party will not apply in interpreting the terms of this Contract.

43. Insurance: Prior to commencing the Work, Contractor will provide a Certificate of Insurance to the County demonstrating adequate insurance coverage as required by this paragraph. All policies evidencing coverage required by the Contract will be issued by insurance companies satisfactory to the County. Contractor will forward Certificates of Insurance directly to the **County Department** and **Contact** listed in the **Details Summary**.

a. Boulder County as Additional Insured: Boulder County shall be named as an additional insured for General Liability, Umbrella/Excess Liability, and Pollution Liability, as designated in this Contract. Additional insured shall be endorsed to the policy.

THE ADDITIONAL INSURED WORDING SHOULD BE AS FOLLOWS*: County of Boulder, State of Colorado, a body corporate and politic, is named as Additional Insured*.

b. Notice of Cancellation: Each insurance policy required by this Contract shall provide the required coverage and shall not be suspended, voided or canceled except after thirty (30) days' prior written notice has been given to the County except when cancellation is for non-payment of premium, then ten (10) days' prior notice may be given. If any insurance company refuses to provide the required notice, Contractor or its insurance broker shall notify the County any cancellation, suspension, or nonrenewal of any insurance policy within seven (7) days of receipt of insurers' notification to that effect.

c. Insurance Obligations of County: County is not required to maintain or procure any insurance coverage beyond the coverage maintained by the County in its standard course of business. Any insurance obligations placed on the County in any of the **Contract Documents** shall be null and void.

d. Deductible: Any and all deductibles contained in any insurance policy shall be assumed by and at the sole risk of Contractor.

e. Primacy of Coverage: Coverage required of Contractor and its subcontractors, if any, shall be primary over any insurance or self-insurance program carried by the County.

f. Subrogation Waiver: All insurance policies in any way related to this Contract secured or maintained by Contractor as required herein shall include clauses stating that each carrier shall waive all rights of recovery, under subrogation or otherwise, against County, its organizations, officers, agents, employees, and volunteers.

g. Requirements: For the entire duration of this Contract including any extended or renewed terms, and longer as may be required by this Contract, Contractor shall procure and maintain at its own expense, and without cost to the County, the following kinds and minimum amounts of insurance to insure the liability risks that Contractor has assumed under this Contract:

i. **Commercial General Liability**

This coverage should be provided on an Occurrence Form, ISO CG001 or equivalent, with Minimum limits of $1,000,000 Each Occurrence, $2,000,000 General Aggregate and $2,000,000 Products Completed Operations Aggregate.

ii. **Automobile Liability**

Bodily Injury and Property Damage for any owned, hired, and non-owned vehicles used in the performance of the Contract. Minimum limits $1,000,000 Each Accident.

iii. **Workers' Compensation and Employer's Liability**

Workers' Compensation must be maintained with the statutory limits. Employer's Liability is required for minimum limits of $100,000 Each Accident/$500,000 Disease-Policy Limit/$100,000 Disease-Each Employee.

v. **Professional Liability (Errors and Omissions)**

Professional liability coverage with minimum limits of $1,000,000 Per Loss and $1,000,000 Aggregate. Professional Liability provisions indemnifying for loss and expense resulting from errors, omission, mistakes or malpractice is acceptable and may be written on a claims-made basis. The contractor warrants that any retroactive date under the policy shall precede the effective date of this Contract; and that either continuous coverage will be maintained or an extended discovery period will be exercised for a period of two (2) years beginning at the time work under this Contract is completed.

44. Geographic Information System (GIS) Data:

Contractors are required to meet 100% compliance for all data deliverables. Payment will be retained until the data submitted is 100% compliant with the County's requirements as detailed:

In order for Contractors to access the Boulder County Secure FTP site to download the files, Contractors will need to install and use the WinSCP freeware program to connect to Boulder County SFTP server.

a. Any contracted GIS data, such as monitoring, inventories or species mapping will be delivered, by Contractor, in GIS format.

b. All GIS data (including high-accuracy PLSS monuments and survey plat) are required to be delivered, by Contractor, in an ESRI 10.x compatible format, either shapefile or file geodatabase feature class.

c. All spatial or georeferenced (both GIS and CAD) data are required to be provided, by the Contractor, in the following coordinate system:

Name: NAD 1983 HARN State Plane Colorado North FIPS 0501 Feet
Unit: Foot US
Projection: Lambert Conformal Conic
Horizontal Datum: North American Datum 1983 HARN
Vertical Datum: North American Vertical Datum 1988
Spheroid: GRS 1980

NON-SPTIAL DATA REVIEW:

1. Non-spatial data is a tabular representation of facts, concepts, or instructions. While this data may contain spatial location (such as latitude and longitude coordinates) it is not contained within a spatial enabled format, such as an Esri geodatabase or geoJSON file.

Common tabular data formats include Excel spreadsheets, CSV files, or SQL database tables.

2. Data contained within reports is not sufficient for BCPOS usage. Any data presented within a report will also be delivered as a tabular data file.

3. Some BCPOS examples of non-spatial data include regularly repeated monitoring point observational data, survey results, or small grant research results.

4. Tabular data delivered to BCPOS must adhere to the following best practices:

a. Only include data in a data file; do not include figures or analyses.

b. Aggregate like data into fewer large files, rather than many small ones or separate tabs within a spreadsheet.

c. Column headers only use alphanumeric characters or underscores. Column headers do not include spaces. Use only the first row to identify a column header.

d. All cell data format type is formatted properly. Date fields should be in a consistent date format throughout the dataset.

e. Do not rely on special formatting for tables.

f. Do not hide columns or rows.

g. Do not use zeros or blanks to represent missing data. Common alternative conventions include: -9999, NA, or NULL.

h. Table must contain a unique identifier for each record in the table.

i. Tabular data linking to geospatial data must contain the foreign key or identifier for the spatial feature.

j. Metadata (information that includes data about the data) will accompany data file(s). It will be in a separate, associated word or text document, except in the case of Excel, where it should be included in an additional sheet within the workbook.

[Signature Page to Follow]

IN WITNESS WHEREOF, the Parties have executed and entered into this Contract as of the latter day and year indicated below.

SIGNED for and on behalf of Boulder County	**SIGNED for and on behalf of Contractor**
Signature:	Signature:
Name:	Name:
Title:	Title:
Date:	Date:
↓↓*For Board-signed documents only*↓↓	
Attest Signature: *Initial*	
Attestor Name:	
Attestor Title:	