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**PAD-US (CBI Edition) Version 2:
Standards and Procedures**

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Introduction to PAD-US (CBI Edition) Version 2

Protected areas are the cornerstones around which regional, national and international conservation strategies are developed. Through these designations, lands are set aside in perpetuity to preserve functioning natural ecosystems, provide refuges for species and maintain ecological processes. Working from this foundation, public agencies, private organizations and corporations develop and implement complementary conservation strategies to designate land for the sustainable use of natural resources, the protection of significant geologic or cultural features and for the provision of ecosystem services.

On October 31, 2012 the Conservation Biology Institute released PAD-US (CBI Edition) Version 2. This dataset portrays the nation's protected areas with a standardized spatial geometry and numerous valuable attributes on land ownership, management designations and conservation status (using national GAP and international IUCN coding systems). The PAD-US (CBI Edition) Version 2 defines *protected area* to include all fee lands dedicated to the preservation of biology diversity and to other natural, recreation and cultural uses, and managed for these purposes through legal or other effective means (adapted from IUCN definition). PAD-US (CBI Edition) Version 2 has been redesigned from previous version to include only fee lands and to be used along with the National Conservation Easement Database (NCED), to visualize the entire terrestrial conservation estate of the United States. Our database does not distinguish a protection threshold above which biodiversity is considered secure. Instead, a complete suite of protected area attributes are provided for each polygon with the purpose of giving users the information they need to define the most relevant conservation thresholds for their own objectives and requirements.

This GIS-based dataset was created to help people integrate protected areas data into their daily work (e.g. mapping, planning, analyses, and problem-solving). For example, this database makes it easy for users to address important conservation and resource questions pertaining to climate change adaptation, green energy development, infrastructure planning and wildlife connectivity. State and regional planners and managers will appreciate this dataset as it provides critical contextual information for their work. Institutions responsible for national and international reporting will find this database full of reliable, accurate information for their purposes. The scientific and conservation community will similarly benefit from having this standardized base map to carry out their research and planning objectives.

Policies and Procedures For Aggregating and Reviewing PAD-US (CBI Edition) Version 2 Data Sources

PAD-US (CBI Edition) Version 2 is a comprehensive geospatial data set of United States protected areas, including detailed information on land ownership, management and conservation status. Our goal is to regularly compile and publish national, state and local protected areas information (public and private) that we obtain through an established network of data providers. Protected areas data are collected from these sources and aggregated into a standard framework. Challenges related to the incompleteness of source data, varied formats, data structures and accuracy are reconciled as much as possible, but this effort is an ongoing process of steady improvement. A unique collaborative process with leading data providers across the nation ensures that source information flows into this database and back to the providers in an iterative fashion. PAD-US (CBI Edition) Version 2 provides the spatial foundation by which users can conceptualize our national conservation landscape.

To build PAD-US (CBI Edition) Version 2, CBI utilized ESRI's geodatabase technology. The purpose of this document is to define the policies and procedures used to aggregate protected areas data into the PAD-US (CBI Edition) Version 2 staging and production database.

I. Compile and Review data sources and documentation

- 1) Download source data. Confirm all project files open appropriately in ArcMap.**
- 2) Review source metadata to confirm Federal Geographic Data Committee (FGDC) standards are met. Coordinate with the source to update source metadata, if needed.**
- 3) Confirm that basic tabular data is available from the source dataset to populate PAD-US (CBI Edition) Version 2 attributes.**
 - a) Primary Designation
 - b) Owner Type
 - c) Owner Name
 - d) Secondary Designation
 - e) Primary Protected Area Name
 - f) State Name

II. Apply the PAD-US (CBI Edition) Version 2 Schema

- 1) **Confirm core attribute properties** See Appendix A for a list of attribute fields.
- 2) **In *Primary, Secondary and Tertiary Designation Name* fields, conform new parcel names to list of standard designation names.** See Appendix B.
 - a) Standardize parcel names (no acronyms, no spelling errors, proper case, overarching name-no units) in Primary, Secondary and Tertiary Designation Name. The purpose of this exercise is to enable searches for an entire protected area by name, regardless of how many disparate polygons comprise the area.
 - b) Where new data contains unknown parcel names, every attempt should be made to request some type of identification method from the data source.
 - c) Select by attributes where 'parcel name LIKE %WMA%', for example. Search for common acronyms (WMA, RNA, ONA, NP, GMA etc.) in parcel names to enable review of records prior to using 'find and replace' (use match case) tool to repopulate WMA with Wildlife Management Area. Review is required to crosscheck management designation as some acronyms have dual meaning (e.g. NP = Nature Preserve and National Park).
 - d) Update attributes to 'proper case' after 'find and replace' step is complete, e.g. initials become proper case.
 - e) Compare Local Designation and Primary Designation Type. Where obvious discrepancies exist, correct Primary Designation Type to match the information provided by the local designation field. Note: Primary Designation Type is a general description of management type.
- 2) **Apply standard designation to new parcels.**
 - a) See Appendix B information and link to standard designations.
 - b) If new owner or designation names need to be added, confirm revisions with the team.
 - c) Reattribute *water* to reflect appropriate designations. Whenever a water polygon is completely surrounded by a polygon with similar ownership and one management designation, merge the water body into the designation polygon (e.g. Yellowstone Lake is completely contained within Yellowstone National Park. The lake should be merged into the park boundary so there is no differentiation between land and water, so that only the protected area is represented.
- 3) **Assign GAP Status Codes to data.**

- a) GAP Status Codes are a measure of management intent to conserve biodiversity. If GAP Status Codes are available from a third party source incorporate them into the data. In all others cases, assign GAP Status Codes using the Designation Type Crosswalk List (see appendix B).

4) Assign FIA Ownership Codes and Forest Reserve Status.

- a) FIA Ownership Codes are a tool intended for use by the US Forest Service Forest Inventory Assessment (FIA) to further facilitate their work using PAD-US (CBI Edition) data. These codes will also help CBI and the USFS FIA to engage in future collaborative QA/QC of protected areas data. FIA Ownership Codes are assigned using the Designation Type Crosswalk List (see appendix B).
- b) Forest Reserve Status is a new field identifying, "lands withdrawn by law(s) prohibiting the management of land for the production of wood products (not merely controlling or prohibiting wood-harvesting methods). Such authority is vested in a public agency or department, and supersedes rights of ownership. The prohibition against management for wood products cannot be changed through decision of the land manager (management agency) or through a change in land management personnel, but rather is permanent in nature." (Andrew Gray, 2009). Using primary designation type of federal lands assign reserve status (i.e. "reserved" or "not reserved") (see appendix B).

III. Aggregate Datasets into PAD-US (CBI Edition) Version 2

1) Identify state-by state update schedule

2) Load updates into edit geodatabase

- a) Confirm geodatabase projection and datum:
USA_Contiguous_Albers_Equal_Area_Conic_USGS_version and Geographic coordinate system – GCS North American 1983.
- b) Load updates into the edit geodatabase individually to ensure fields are mapped and documented correctly. The Data Loader tool in ArcMap and the Simple Data Loader in ArcCatalog are both helpful in ensuring that attribute fields are populated correctly.
- c) Compact geodatabase intermittently to improve performance.
- d) Check geometry and repair errors.

3) Use overlay tool to combine attributes and linework

4) Obtain national boundary file to create seamless coverage

- a) It may be necessary for the data developer to overlay state update source files with a standard source to create a private lands polygon, using the Update and Merge tools.
- b) CBI used the US States 2010, 500K state boundaries and shoreline data from the National Oceanic and Atmospheric Administration.

5) Private Unprotected Lands Matrix

The Private Unprotected Lands Matrix fills in the un-protected lands between the state boundary and the protected area parcels. This feature creates seamless coverage across the national dataset and provides an additional analysis tool for users.

- a) Using the National Boundary and Shorelines mentioned above, create a closed polygon feature, attributed as Private Unprotected Lands.
- b) In ArcCatalog choose the Analysis Tools->Proximity->Buffer, create a buffer of 1,000m along the state boundaries.
 - i) This buffer will ensure that any protected area that fall outside of the NOAA state and shoreline boundary will be retained in the output dataset.
- c) In ArcCatalog choose the Identity tool, enter the state boundary (with the new buffer) polygon feature, then the protected areas. The tool will cut the protected areas into the Private Unprotected Lands Matrix.
- d) Attribute the new Private Unprotected Lands Matrix polygon appropriately:
 - i) Owner Type: Private Land
 - ii) Owner Name: Private Land
 - iii) Designation Type: Private Unprotected Land
 - iv) Primary Designation Name: Private Unprotected Land
- e) In ArcMap use the Explode Multi-part Feature tool on the Advanced Editing toolbar to explode the multi-part polygon called Private Unprotected Land Matrix.
 - i) Remove the buffer around the state boundary
- f) In the attribute table, calculate geometry in the acres field.

IV. QA/QC Review

1) Internally review each state dataset for QA/QC

- a) Validate geodatabase domains meet PAD-US (CBI Edition) Version 2 domain standards and are all assigned. Use the *select by attributes* tool -> *Get unique values* function to confirm that all designations in list have approved domains.
- b) Search each state for stacked polygons (two records with the same geometry). If the topology error inspection tool 'must not overlap' is ineffective, sort the GIS_Acres field and look for polygons of the same size. Determine the appropriate attributes for the polygon and delete the duplicate record.
- c) Review each state to ensure the combination of updated line work with existing attributes (or vice versa) was implemented correctly (e.g. new line work from COMAP assigned to PAD-US (CBI Edition) Version 2 attributes). Identify random polygons, with effort scaled to represent the level of updates incorporated, to compare attributes between the two layers.
- d) Validate state names are spelled out and properly assigned.
- e) Validate GAP codes range from 1-4 and Unknown, only.
- f) Validate geodatabase field properties match PAD-US (CBI Edition) Version 2 standards.
- g) Run topology using "must not have gaps" and "must not overlap" rules to do a final topology error check.
 - i) PAD-US (CBI Edition) Version 2 will include minor error corrections, as defined in this section. A separate topology correction free feature class will not be maintained, due to time constraints. PAD-US (CBI Edition) Version 2 will include outstanding (gross) topology errors that cannot be fixed in compliance with PAD-US (CBI Edition) Version 2 Policies and Procedures.
 - ii) Procedures for Minor Error Corrections – errors < 5 acres:
 - (1) Overlap Errors: Repair with topology tool to the most geometrically simple line-work.
 - (2) Gap errors: Repair with topology tool to the most geometrically simple line-work.
 - iii) Using the Select by Attributes tool, identify polygons < 5 acre:

- (1) Select attribute records with p_loc_nm= "Private Unprotected Land" and acres < 5.
 - (2) Review each individual selected record to identify the nature of the polygon (i.e. sliver or inholding) Slivers are polygons between two protected areas or between a protected area and a state boundary which is a result of variations in geometry or techniques between different agencies.
 - (3) Slivers less than 5 acres should be merged using the Editor tool, to the adjacent protected area, which will create the simplest geometry.
 - (4) Slivers along shorelines or state boundary that area less than 5 acres should be snapped to the shoreline or state boundary.
- iv) Error Correction Procedures – errors > 5 acres:
- (1) Document all errors > 5 acres.
 - (2) Overlapping errors > 5 acres, can be resolved using “nesting” in the attribute table (example: Wilderness Area within a National Forest, Primary designation – Wilderness Area and Secondary designation – National Forest).
 - (a) If three designations is required to represent the geometry accurately choose the two most common designations to be represented in the PAD-US (CBI Edition) Version 2 attribute table and the third designation is records on a companion document. This will ensure that no information is lost, and will allow the data to be entered back into the dataset in future versions if the schema changes.
 - (3) Contact source data provider about line-work conflicts:
 - (a) Request their review of all errors > 5 acres: *Why were these errors left in the dataset? How would they like us to make corrections?*
 - (b) Confirm their allowance of error corrections < 5 acres.
 - (c) If time allows, resolve errors as requested by original data source.
 - (d) If no time, errors to be resolved in next version, using guidance provided by the source.

Consideration of future needs

CBI will release an updated version of PAD-US annually. This version should substantially improve our national inventory of protected lands; however, there is always more work to be done. We identify the following needs for consideration in future versions.

- 1) A collaborative network of data providers: Aggregating a nation's protected areas into a national standard is a collaborative process. Each edition is built in partnership with numerous data providers and reviewers. Only by working together can we assure the highest quality. Before we commence work on the next version, we will communicate with our data network to identify important additions and synchronize update schedules. Several sources published new state and regional protected areas datasets close to our release date. Therefore, these datasets could not be incorporated into PAD-US (CBI Edition) Version 2, but will be added to the next version.
- 2) Line-work conflicts: When aggregating multiple source datasets in a geographic region, the geometric representations of protected area polygons and boundaries often do not agree among the different sources. CBI will continue to develop sustainable mechanisms for detecting, avoiding and resolving the conflicts that will be present in data provided by our sources.
- 3) Improvements to the standard designations: Our current list of standard designations is an adaption of the PAD-US Master Stewardship Codes. We represent standard designations rather than codes with the purpose of providing users with the summary information they need to assess, summarize and communicate the scope of their choosing. Our database does not distinguish a protection threshold above which biodiversity is considered secure. Instead, a complete suite of protected area attributes are provided for each polygon with the purpose of giving users the information they need to define the most relevant conservation thresholds for their own objectives and requirements. We plan to work with our user community to better tailor our standardizations to their needs.
- 4) Incorporation of local review: With a large database of this type, errors do occur. For our vision to be achieved, the conservation landscape represented in CBI products should match your understanding. A process is being developed on the Data Basin Protected Areas Center for soliciting, documenting and incorporating local review in the development of future products. We will request feedback on the following: Known and digitized protected lands are accurately represented; attributes related to owner, manager, designation, etc. are correct; and linework accurately represents protected area boundaries. This information allows us to establish the proper communication channels and relationships to ensure the corrections are made and future errors are avoided.

Appendix A: PAD-US (CBI Edition) Version 2 Attribute Table

Field Name	Description	Domain
Owner Type	General land owner description (e.g. Federal Land, Native American Land, State Land, Local Land, Private Conservation Land and Private Land) standardized for nation	Look up table
Owner Name	Primary agency or entity who owns the parcel, detailed name	
Manager Name Detailed	Primary agency or entity responsible for the management of the parcel, detailed manager name	
Primary Designation Type	Primary land management description or designation expected to overlap another designation, standardized for national (e.g. Wilderness Area resides in this field while National Forest General Public Land resides in Secondary Manager Description)	Look up table
Primary Local Designation Type	Primary land management description or designation as provided by data source, not standardized for nation	
Primary Designation Name	Name of parcel standardized to enable searches for protected area by name	Standardized field
Primary Local Name	Name of parcel as provided by source, not standardized	
Secondary Designation Type	Overarching management of a polygon under which another may overlap (e.g. a National Forest is listed here, when a Wilderness Area "overlaps" and therefore is the primary designation type)	Look up table
Secondary Local Designation Type	Land management description or designation as provided by data source, not standardized for nation	
Secondary Designation Name	Name of parcel standardized to enable searches for protected area by name	Standardized field
Secondary Local Name	Name of parcel as provided by source, not standardized	
Tertiary Designation Type	Tertiary land management description or designation expected to overlap two other designations, standardized for the nation	
Tertiary Local Designation Type	Land management description or designation as provided by data source	
Tertiary Designation Name	Name of parcel standardized to enable searches for protected area by name	
Tertiary Local Name	Name of parcel as provided by source.	
Status	Proposed - Site has approval on a local government level but is awaiting legal declaration/decree; Designated - Site has been legally decreed; Recommended - Site has been put forward by local/international, non governmental organization or national agency	
State Name	Name of state spelled out	State Domain
GAP Status Code	Measure of long-term biodiversity protection according to GAP 1-4 scale. GAP "Unknown" is where GAP codes are currently unavailable	GAP Codes (1-4)

IUCN Category	IUCN management categories, codes assigned using Designation Type Crosswalk List	IUCN code (Ia, Ib, II, III, IV, V, VI)
GIS Source	Source of GIS spatial and attribute information.	
GIS Source Date (Year)	Date GIS information was published according to source field metadata	
GIS Acres	Acres calculated from polygons-calculate geometry command	
Comments	Any comments from either the source or the aggregator	
FIA Owner Code	Forest Inventory Assessment ownership code (11= National Forest, 12= National Grassland, 13= Other Forest Service, 21= National Park Service, 22= Bureau of Land Management, 23= Fish and Wildlife Service, 24= Department of Defense/Energy, 25= Other Federal, 31= State, 32= Local, 33= Other Non Federal Pubic, 40= Private Lands)	
Reserve Status	Identifies federal lands that are reserved or not reserved based on PA designation type. Reserved land is withdrawn by law(s) prohibiting the management of land for the production of wood products (not merely controlling or prohibiting wood-harvesting methods). Such authority is vested in a public agency or department, and supersedes rights of ownership. The prohibition against management for wood products cannot be changed through decision of the land manager (management agency) or through a change in land management personnel, but rather is permanent in nature.	
Shape Length	Shape Length, meters	
Shape Area	Shape Area, meters	

Appendix B: PAD-US (CBI Edition) Version 2 Standard Designation Domains

PAD-US (CBI Edition) Version 2 provides a comprehensive picture of United States protected area coverage at a variety of scales. To do so, we standardize several summary land ownership fields: owner type (e.g. federal, state, local) and owner name (i.e. agency name), as well as primary, secondary, and tertiary designation type (Table 1). This method allows for easy, standardized searches of common protected area designations across political boundaries.

Federal and Native American designations are summarized by federal ownership name, e.g. *Wilderness Area (Bureau of Land Management)*, *Wilderness Area (Fish and Wildlife Service)*.

State lands summarizations are more complex, as individual states retain the right to regulate and manage land designations as they choose, with no required consistency in owner or designation name across jurisdictional boundaries. In an attempt to standardize state designation patterns, we group state lands by a generalized description of owner name. For example, all state lands managed by an agency charged with natural resource management are grouped under the owner name *State Land Managing Natural Resources*, regardless of more localized owner and designations names. This format allows users to quickly compare similar owner and designation names across states. Give differences in bureaucratic structures across state agencies, a designation name may be duplicated across multiple owner name domains, e.g. a State Wildlife Refuge designation may be classified as a State Agency Managing Conservation or Preservation, State Agency Managing Fish & Game or a State Agency Managing Natural Resources. Each owner name domain is explicitly defined in our standard designation domain table. However, it is beyond the scope of PAD-US (CBI Edition) Version 2 to differentiate management intent.

Regional, city and county designations and private conservation lands are grouped into summary categories. Private lands without protection are classified as such.

We hope the common nomenclature we offer provides the conservation community with useful metrics for assessing, summarizing and communicating the scope of work to preserve natural values across political boundaries.

A complete list of standard PAD-US (CBI Edition) Version 2 standard designation domains. To view the full Designation Type Crosswalk go to (<http://consbio.org/products/projects/pad-us-cib-edition>)