CDFW Projection and Datum Guidelines

Purpose: To provide an overview of map projections and datums used in California and recommendations for CDFW GIS users.
GIS Support: GeoData@wildlife.ca.gov

Contents

1. Introduction

This document provides map projection and datum guidance for California Department of Fish and Wildlife (CDFW) GIS users. It is intended to provide help when working with California-based GIS data and making maps but is not a complete reference. Software discussion is focused on ArcGIS. The content was compiled by CDFW's Will Patterson.

2. Terminology

A map projection transforms the three-dimensional shape of the earth onto a two-dimensional surface that can be printed on paper or viewed on a computer screen. There are many map projections, each trying to preserve one or more real world properties such as area, shape, distance, and direction. No single projection preserves all these properties - some focus on a particular property while others partially preserve multiple properties as a compromise projection.

A horizontal datum is a set of parameters and control points used to define the shape of the earth. Datums provide a frame of reference for measuring locations, and may be determined for local, regional, or worldwide extents. There are also vertical datums used for elevation measurements. In this document, datum refers to a horizontal datum.

A coordinate system provides a method of locating a position on the earth's surface using a particular unit of measure (which may be based on a projection). The terms coordinate system and projection are sometimes used interchangeably. In ArcGIS, a geographic coordinate system (GCS) is based on a datum and a projected coordinate system (PCS) is based on a GCS and a projection.

3. Datums used in California

North American Datum of 1927 (NAD27) was used on many historic USGS topo maps, including the popular 7.5-minute quadrangle printed maps produced until the early 1990s. It is referenced in ArcGIS as GCS_North_American_1927.

North American Datum of 1983 (NAD83) replaced NAD27 and was adopted as the official datum for California and the United States. It is an earth-centered datum based on ground control points and satellite observations. It is referenced in ArcGIS as GCS_North_American_1983. Refinements of

NAD83 also exist for high precision mapping and surveying, examples include NAD83 (2011), NSRS2007, and HARN.

World Geodetic System of 1984 (WGS84) is an earth-centered datum that was primarily defined for use with the Global Positioning System (GPS). It is referenced in ArcGIS as GCS_WGS_1984.

For general mapping purposes, WGS84 and NAD83 can be considered equivalent. For example, data collected in WGS84 can be treated as NAD83, unless you are trying to map locations more accurately than about 1 meter.

4. Projections and coordinate systems used in California

Geographic (Latitude/Longitude, Lat/Lon) is a worldwide coordinate system that is technically not a projection but treated as one. Also referred to as "unprojected", most GIS references to geographic coordinates assume the coordinates (units of measure) are formatted in decimal degrees, although other formats are used. Longitude is usually indicated as negative since California is in the Western Hemisphere (west of the Greenwich Prime Meridian). Latitude is positive as California is in the Northern Hemisphere (north of the Equator). It is important to remember that longitude is the X value (east to west), and latitude is the Y value (north to south).
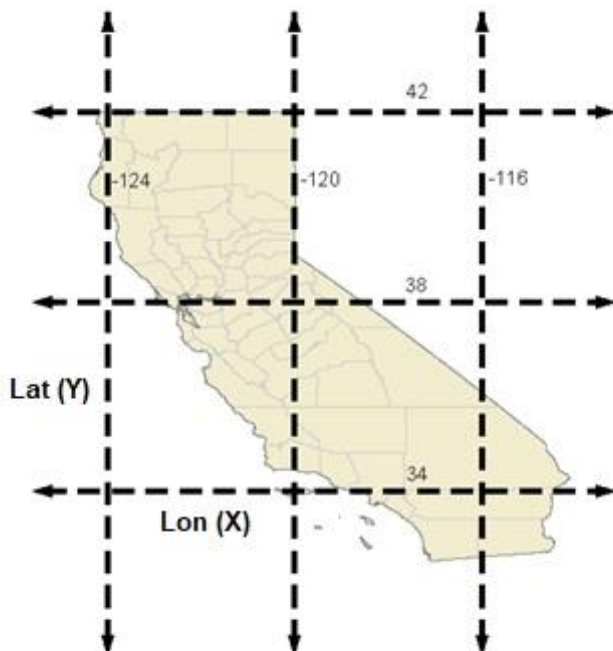
Here are example formats of coordinate pairs in Lat/Lon:
Decimal Degrees (DD): 38.75438, -120.57834
Degrees Minutes Seconds (DMS): 33 45 29, -117 24 35
Degrees Decimal Minutes: 41 23.1, -123 50.459,
Degrees Minutes Decimal Seconds: 38 23 12.49, -118 10 40.35

California (Teale) Albers is an adaptation of the Albers Conical Equal Area projection as defined by the former State of California Teale Data Center GIS Solutions Group. It is a California-specific projection optimized for area calculations, making it popular to map statewide resources. It may be referred to as "Teale Albers", "California Albers", or just "Albers" (however, be aware that adaptations of the Albers projection exist for other areas). The projection divides California into four quadrants. Coordinate values (units of measure) are in meters from the origin (0, 0) near the center of the state.
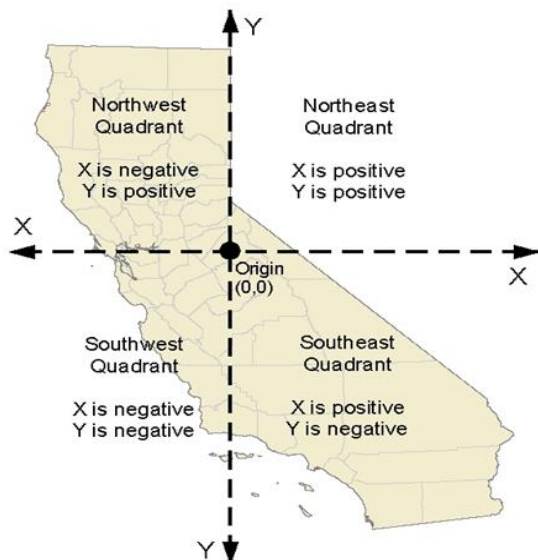
Web Mercator is a projection popularized by online mapping applications such as Google Maps, Bing Maps, and ArcGIS Online. It is optimized for world maps on the web because of a unique data tiling system. Many map services available to ArcGIS are also served in this projection. However, it contains a great deal of distortion and is not recommended for calculations such as area and distance. Use caution with this projection.

Universal Transverse Mercator (UTM) is a worldwide coordinate system based on the Transverse Mercator projection. The globe (excluding polar regions) is divided into 60 zones each covering six degrees of longitude. California is covered by UTM zones 10 and 11, with the boundary between them through the middle of the state. Because of the two zones, it is typically not used for statewide data. Coordinate values (units of measure) are in meters with the x value also called easting and the y value called northing. A few organizations in California have used the Transverse Mercator projection with custom parameters that do not follow the UTM convention (may be called "UTM Zone 10.5"). The CA Department of Water Resources and the US Bureau of Land Management have both used this, each implementing slightly different parameters.

State Plane Coordinate System (SPCS), also known as the California Coordinate System (CCS), is commonly used by surveying professionals and within local municipalities (cities, counties, regional governments). The California SPCS has 6 zones in NAD83 and 7 zones in NAD27, with Los Angeles County as the unique Zone 7 in NAD27 (it is Zone 5 in NAD83). Coordinate values (units of measure) are in meters or survey feet in NAD83 and survey feet in NAD27. The x value may be called easting and the y value may be called northing.

5. Recommendations

Projections and Datums
California (Teale) Albers in NAD83 is recommended for statewide datasets and other datasets as appropriate (such as a regional dataset spanning UTM zones 10 and 11). It is also preferred for datasets submitted to CDFW's BIOS application. In ArcGIS it is implemented as:

NAD 1983 California (Teale) Albers (Meters)
NAD_1983_California_Teale_Albers

Other Projections in NAD83, NAD83 refinements, or WGS84 are acceptable if California (Teale) Albers in NAD83 is not convenient or appropriate. NAD27 is not recommended.

GCS (Datum) Transformations
Within ArcMap, if a dataset's GCS differs from the data frame's GCS, the user may be prompted to select a transformation to improve alignment. A transformation may also be needed for tools that (re)project data.

For use between GCS_North_American_1983 and WGS_1984
WGS_1984_(ITRF00)_To_NAD_1983 is recommended.
NAD_1983_to_WGS_1984_5 is recommended if the above transformation is not available.

For use between GCS_North_American_1927 and GCS_North_American_1983
NAD_1927_To_NAD_1983_NADCON is recommended.