

California Department of Fish and Wildlife Wolf-Livestock Compensation Pilot Program

Calculation Methods for Determining Wolf Territories

PAY FOR PRESENCE (PRONG 3)

Information provided in this document supports Prong 3 of the California Department of Fish and Wildlife's (Department) Wolf-Livestock Compensation Pilot Program. It provides additional insight into the methods used to determine wolf pack territories in California for use in determining a livestock producer's eligibility for compensation. The Department uses the best available data (e.g., satellite collar data, cameras, depredation event, DNA) to identify each known wolf pack's territory and core area within that territory during each of two annual seasons (broadly characterized as "summer" and "winter"). If detailed location data for a given pack is not available, the Department may use other methods to estimate pack territories and/or core areas, as appropriate. More information about the Wolf-Livestock Compensation Pilot Program can be found on the Department's [Wolf-Livestock Compensation Program](#) webpage.

1. PACKS WITH AVAILABLE SATELLITE COLLAR DATA

The Department uses the most recent full year of satellite collar location data to create seasonal maps using a 95% Kernel Density Estimator (KDE) and 50% KDE. Kernel density estimation is a statistical technique for estimating probability density functions that is widely used in wildlife ecology. The kernel density estimator method is used by other programs, such as the interagency Mexican Wolf Program. It is one of the most statistically efficient methods available for estimating a wolf pack territory, when sufficient satellite data exists.

Soon after October 15 of each year, the Department calculates territories¹ for the summer and the previous winter, and their associated cores.

Territory calculation process:

- Satellite collar locations are filtered to remove autocorrelation. Autocorrelation occurs when spatial and temporal data are not independent (data are directly related to each other). Data sets with autocorrelation can underestimate territories and core areas.
- Only locations that have a minimum of 24 hours between points are used. This approach assumes that a wolf can travel to any place in its territory during each 24-hour period and theoretical independence of locations. This corrects for temporal correlation.
- Only one collar is used, preferably one of the breeding adult wolves, to achieve independence of temporal locations. Inclusion of more than one collar in the analysis would result in replicated data points and increase autocorrelation because wolves in a pack often travel together.

¹ For the purposes of this document, the term "territory" is used to describe a wolf pack use area; this term is synonymous with "home range".

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- Extraterritorial movement data is excluded. Extraterritorial movements are recognized as occasional and brief forays to areas that are spatially distinct from the pack's typically occupied area. These movements do not fit the concept of wolf "presence" which is the regular overlap of a pack of wolves with the same livestock within the pack territory, and therefore the potential for frequent and even regular interactions.
- The final wolf location points are grouped by season and the territory boundaries are calculated. This is important so that data from winter territory locations do not influence the summer territory and core areas and vice versa.
 - Summer: May 16 – October 15
 - Generate territory using a 95% KDE.
 - Generate core using a 50% KDE.
 - Winter: October 16 – May 15
 - Generate territory using a 95% KDE.
 - Generate core using a 50% KDE.
- When data is incomplete for a certain period (e.g., due to a failed satellite collar), location data for the missing period from the most recent available preceding year will be used.

2. PACKS WITH VERY LIMITED OR NO SATELLITE COLLAR DATA

The Department uses all available field location data, including confirmed wolf signs (e.g. scat, tracks), trail camera data, howling, visuals, DNA, and any satellite collar data that may exist.

Territory calculation process:

- Wolf sign and trail camera location data submitted by the public and verified by the Department to be both wolf and likely to be of the local pack are used.
- A 100% Minimum Convex Polygon (MCP) is created using the locations.
- The MCP is buffered so that the resulting buffered polygon is the size of the average California pack's seasonal territory (e.g., if the mean pack summer territory size was 250 mi², the MCP around summer locations would be buffered to a resulting polygon summer territory of 250 mi²).
- Core and seasonal areas within a territory boundary may not be defined in the calculations due to limited data.