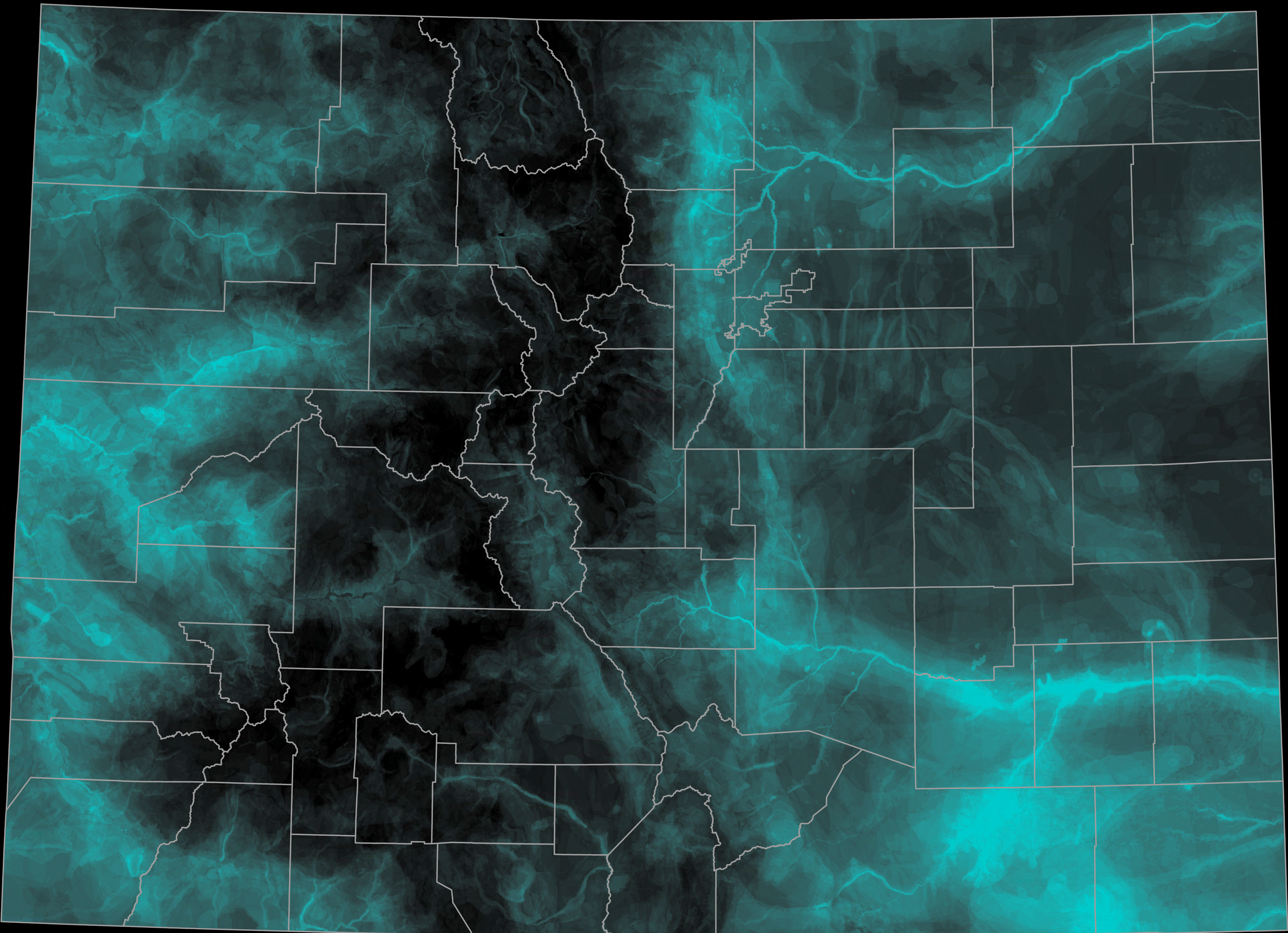


# COLORADO PARKS & WILDLIFE

## Important Habitat Areas of High Species Diversity in Colorado



This map was compiled with GIS data collected from CPW District Wildlife Managers, Biologists, and Researchers. Additional data includes USFWS Critical Habitat range, and BLM Protected Activity Centers. In total, 326 wildlife species range Feature Classes were used for 179 wildlife species. Habitat importance is superficially weighted by including multiple range layer types for species of priority for CPW. Species range layer overlap is summed on 300 x 300 meter grid cells. Areas brighter in color indicate a larger number of species range layer overlap.

95  
Number of Overlapping Species Range Layers

0  
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## Abstract

Colorado Parks and Wildlife (CPW) collects range data as GIS polygon Feature Classes for a variety of wildlife species occurring in Colorado. These data are created and maintained by the CPW GIS Unit working with District Wildlife Managers (Game Wardens), Biologists, and Researchers. Additional range data has also been collected from other agencies such as the U.S. Fish & Wildlife Service (USFWS) Critical Habitat layers , as well as Bureau of Land Management (BLM) Protected Activity Centers.

CPW GIS Unit staff began investigating how these data could be used to evaluate habitat selection and wildlife species diversity at a statewide scale. A preliminary review of overlapping wildlife species range data was conducted using graphic drawing techniques for a subset of these data. The map created from this exercise yielded extremely interesting results which prompted staff to take a more rigorous analytical approach to using these data to identify areas in the state that are most important to the largest number of wildlife species.

CPW used various range data (e.g. Overall Range, Winter Range, Winter Concentration Areas, etc.) from 326 ArcGIS Feature Classes for 179 wildlife species occurring in Colorado to count the number of these range layers that overlapped in 300 x 300 meter grid cells.

The results of this analysis indicate that river corridors and riparian areas support the highest amount of species use, followed by lower elevation plains. The higher elevation mountain wilderness areas of alpine forest support less species use.

## Introduction

Colorado Parks and Wildlife maintains 326 ArcGIS polygon Feature Classes containing various range distribution types for 179 wildlife species occurring in Colorado. CPW GIS Unit staff became curious about how these data could be used to evaluate areas of the state that supported high species diversity. In a preliminary investigation using graphical methods to view areas of high species range overlap for a subset of these data the resulting map prompted interest in pursuing a more analytical approach that would produce quantitative vs. qualitative results, be more robust to adding additional range data, and allow for potentially weighting certain range data more heavily than others to evaluate habitat areas that may be important to achieving and/or maintaining wildlife species viability or exceptional diversity. The following describes the approach we took to achieve this goal and the associated map presents the results of this effort.

## Acknowledgements

I'd like to acknowledge all the CPW GIS Unit staff, CPW District Wildlife Managers, Biologists, and Researchers for all the work and expertise they put into developing and maintaining CPW's wildlife species range data. Without the hard work, knowledge, and dedication they put into making these the best available data of this type, this analysis would not have been possible.

I'd especially like to thank Chris "Spiffy" Strobel for all his help and suggestions on the graphic design, and plotter printing, as well as work on the species range raster example maps. Any poor decisions on the map design and poster are mine alone and would have been much worse without his help.

I'd also like to thank Seth McClean, the CPW GIS Unit Supervisor for his support of all the work the CPW GIS Staff does, as well as his support of his staff attending the ESRI UC.

## Methodology



CPW GIS staff took advantage of the 64-bit processing of ArcGIS Pro 2.3 to develop a Python 3 script using the ArcPy API and SA module with ArcGIS Advanced and Spatial Analyst extension licenses. This Python script iterated over 326 chosen ArcGIS Feature Classes from two separate Enterprise ArcSDE databases.



Each Feature Class was converted to an ESRI File GeoDatabase Raster Dataset using the Conversion Polygon To Raster tool after setting the environment extent and snapRaster to a template Raster Dataset for the state of Colorado with a 300 x 300 meter grid.

The Spatial Analyst Reclassify tool was used to generate a "Value" integer field that remapped raster values of 1 to 1 and "NoData" to 0 and a reclassified Raster Dataset.

Once all the reclassified rasters were generated, the Python script iterated through each to generate a Python list that included the reclassified raster name, the field "Value", and a weighted value of 1. Each of these individual lists for each individual raster was then appended to another Python list.

After all the reclassified raster lists had been added to this Python list it was used to create an instance of the Weighted Sum Table (WSTable) Python object. This object was then passed to the Spatial Analyst Overlay Weighted Sum tool to generate a new weighted sum File Geodatabase Raster Dataset identifying the number of overlapping species range data in each 300 x 300 meter grid cell.

The weighted sum raster was added to an ArcMap map document and symbolized using a Stretched Color Ramp from 0 to 95 species range overlap to generate the accompanying map.

Using a 64-bit Windows 8.1 Pro 2.40 GHz Intel® Xeon® CPU desktop computer with 32.0 GB of RAM and the ArcGIS Pro 64-bit ArcPy API with Python 3 these 326 Feature Classes and Weighted Sum analysis were completed in approximately 5 hours.

While this methodology allows for assigning a different weight to each input species range raster, we chose to assign each a weight of 1 so the number represented in each 300 x 300 meter grid cell represents the total number of overlapping species range layers. However, habitat importance in this analysis is superficially weighted given that more range layer data is collected for big game and other economically important species, as well as species of significant conservation concern that represent priority species for CPW.

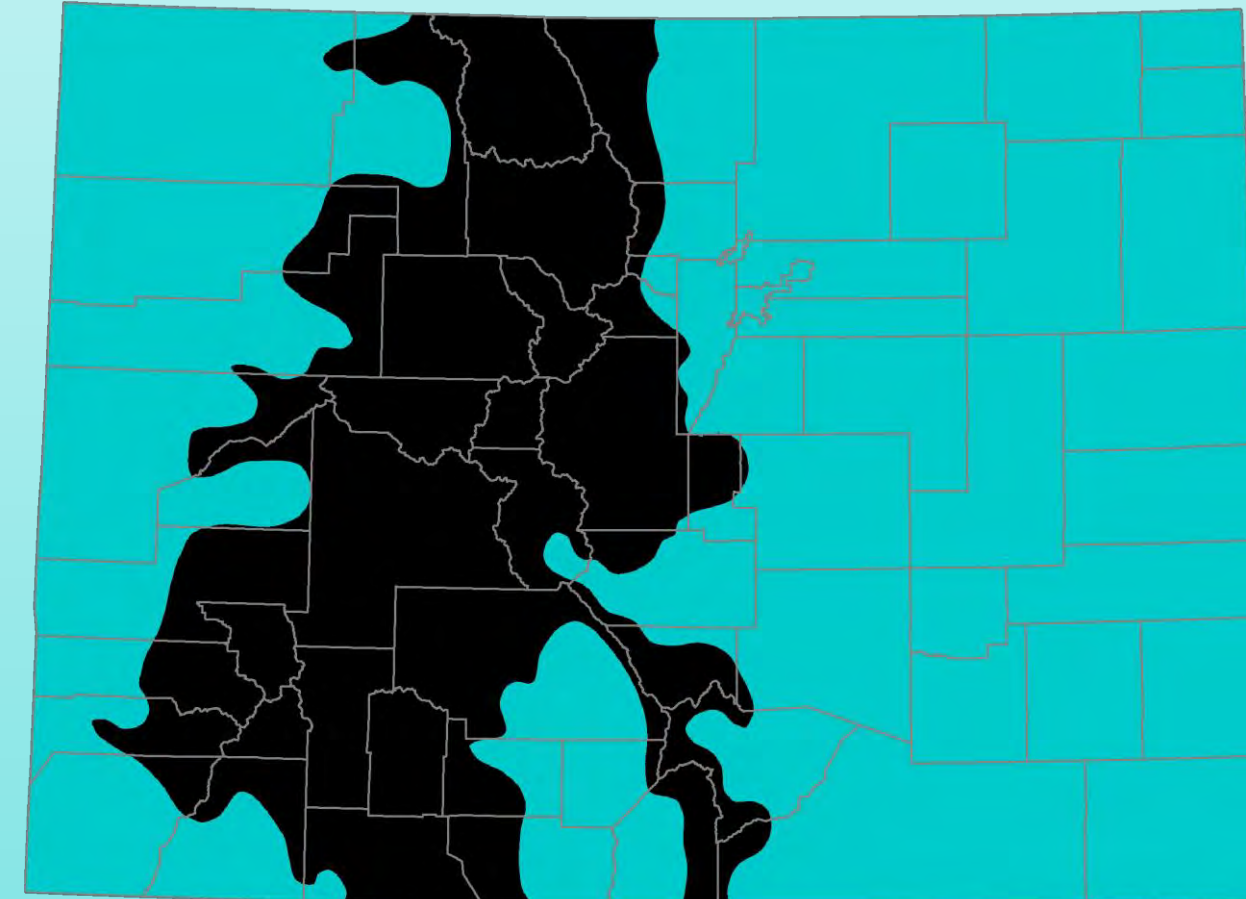
Now that this methodology has been developed we are looking forward to working with biologists and species experts to perform additional specialized analysis on select groups of species, as well as potentially assigning different ranges (e.g. Production Areas) a higher weighted ranking to evaluate various species habitat use across the state.

## Results

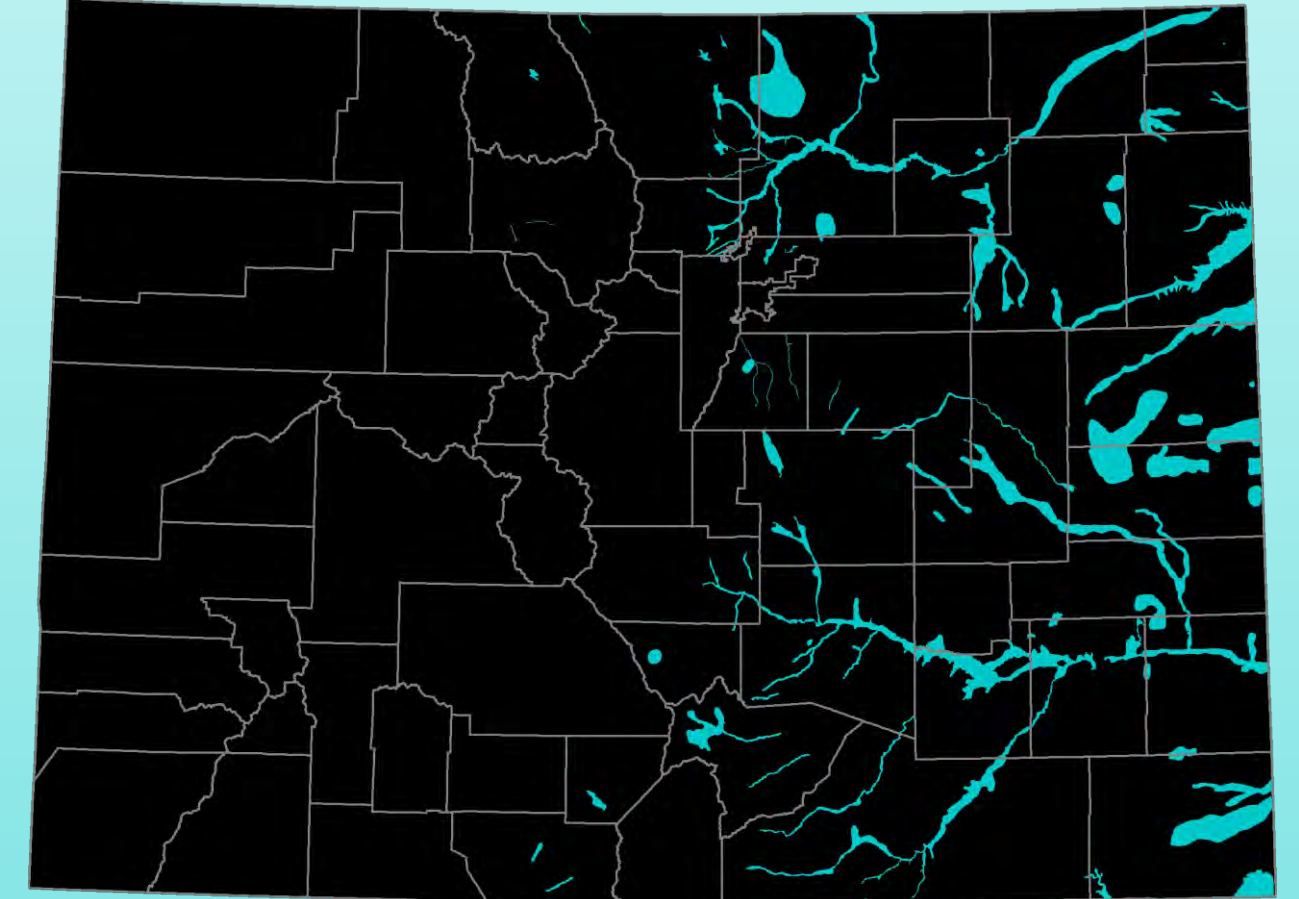
Evaluating this map and data, one of the most striking things is just how important river corridor and riparian areas may be for wildlife species and diversity. Colorado rivers and riparian areas are delineated and readily recognizable just from the high level of overlapping species range layers. Even more striking is that this occurs from primarily terrestrial species polygon range layers that are using riparian corridors as the fish species range data used for this analysis is at a larger Hydrologic Unit Code 12 boundary and not identified as stream or river segments. Also interesting is the relatively low species diversity occurring at high elevation alpine forests that contain the majority of Colorado's wilderness areas as compared to the lower elevation plains.

## Example Maps of Individual Wildlife Species Range Data Used in Analysis

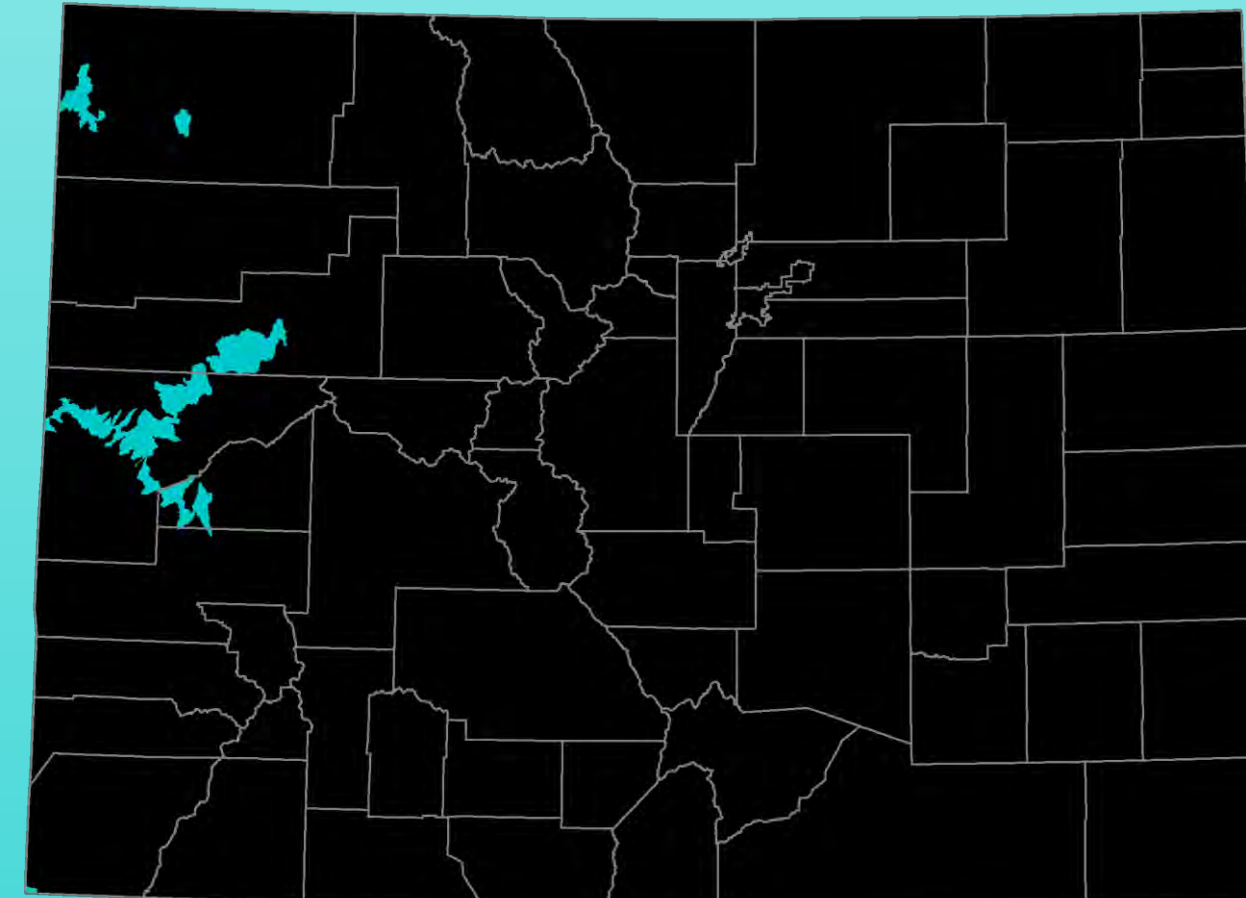
Prairie and Western Rattlesnake Overall Range



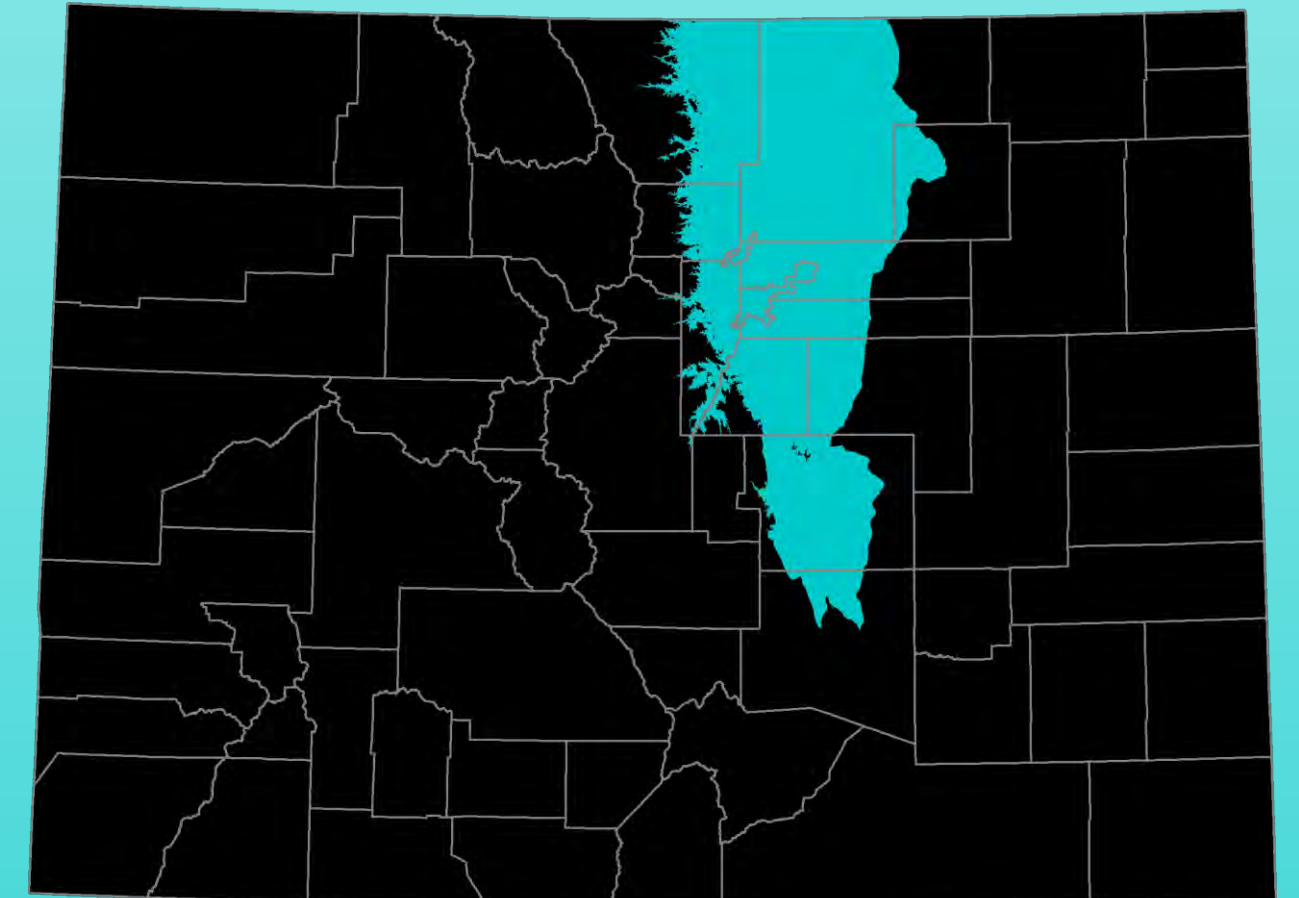
White-tailed Deer Concentration Area



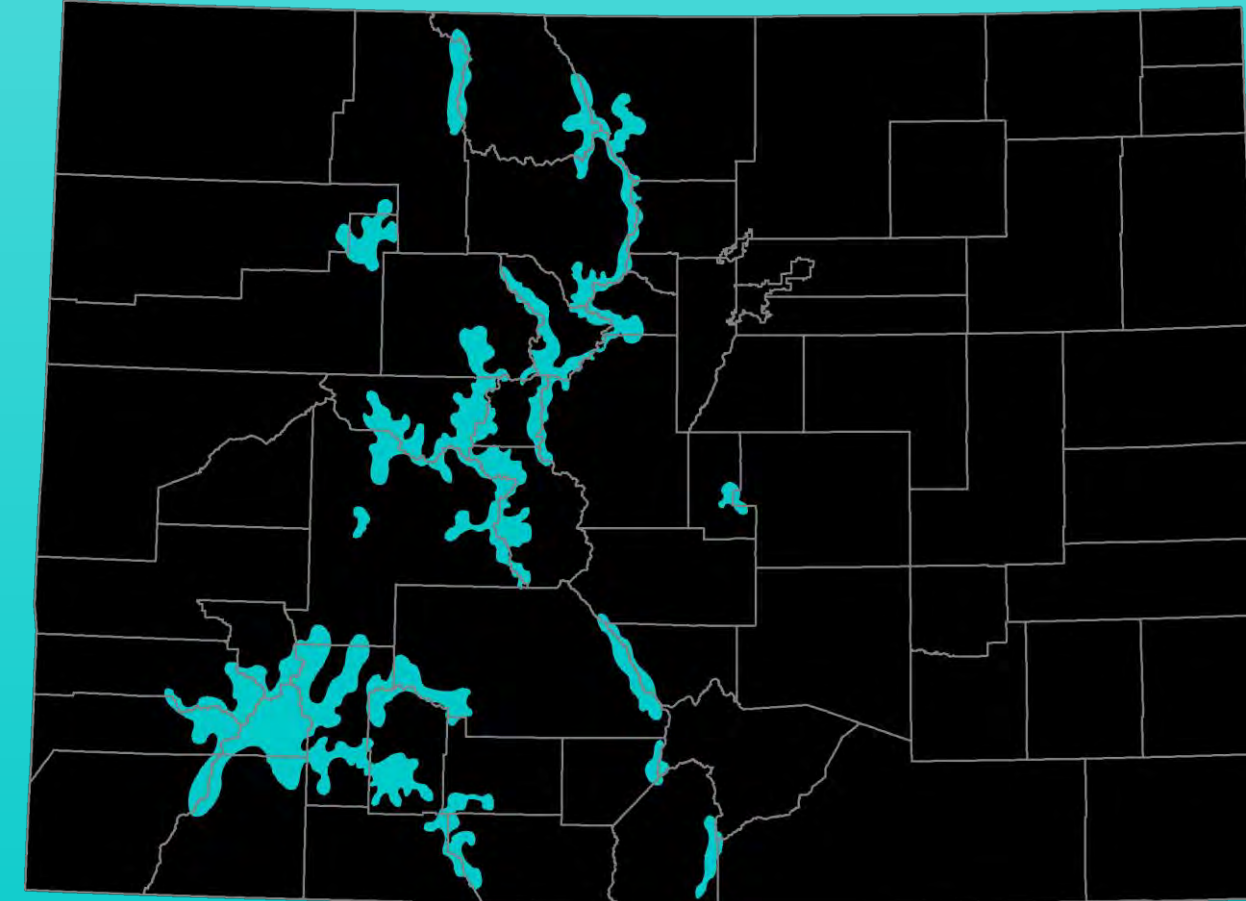
Razorback Sucker HUC 12 Presence



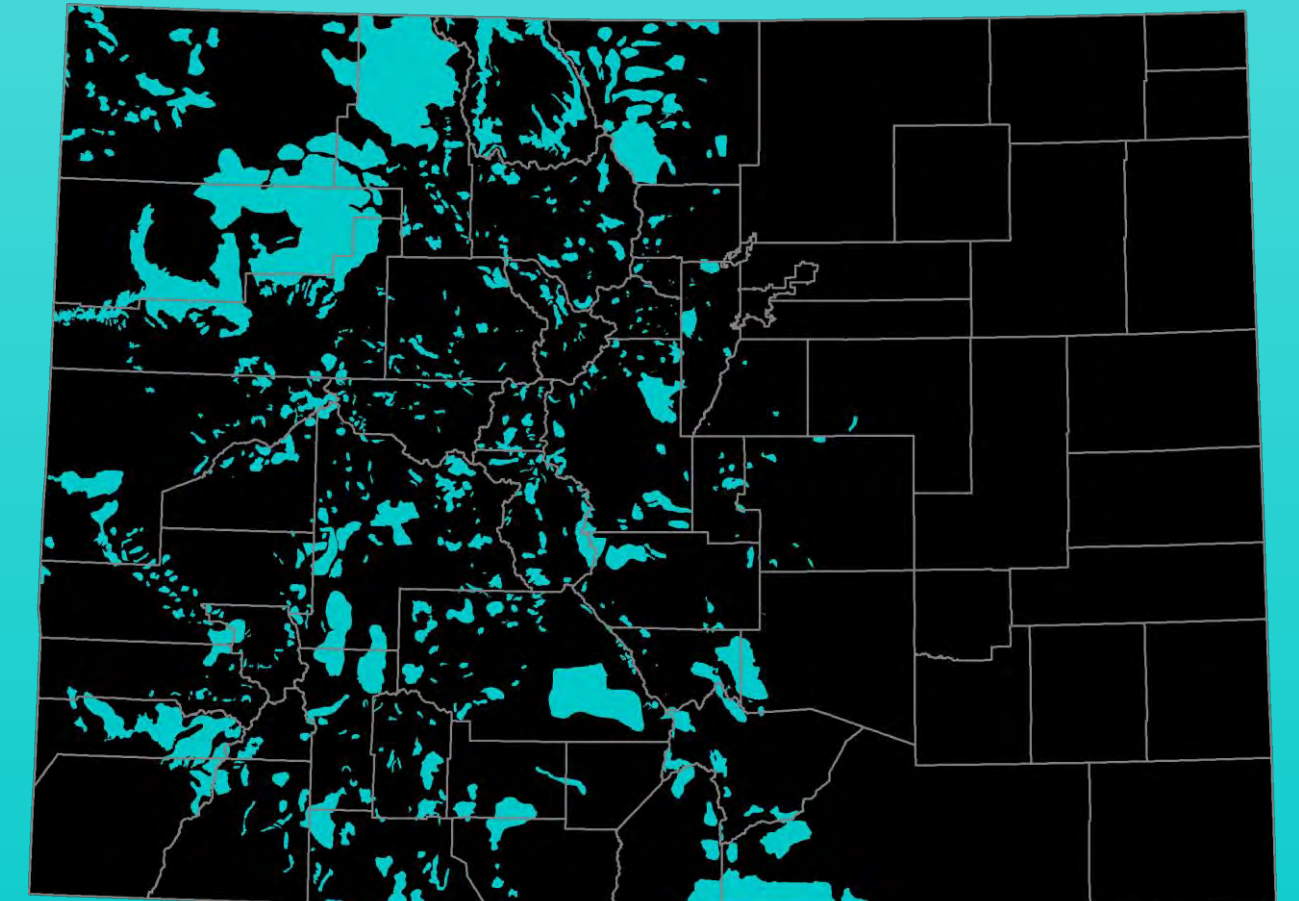
Preble's Meadow Jumping Mouse Overall Range



Brown-capped Rosy Finch Breeding Range



Elk Production Area







Wildlife Species Range Feature Classes Used In Analysis

|  |   |  |                                      |   |   |
|--|---|--|--------------------------------------|---|---|
| AbertsSquirrelOverallRange             | CanadaGeeseForagingArea                             | GreaterSandhillCraneForagingArea         | LongNosedSnakeOverallRange           | OrnateTreeLizardOverallRange                        | ScaledQuailConcentrationArea                    |
| ActiveRaptorNestSites(0.25milebuffer)  | CanadaGeeseMoltingArea                              | GreaterSandhillCraneMigPatterns          | LPChickenFocalAreas                  | OspreyForagingArea                                  | ScaledQuailOverallRange                         |
| AllensBigEaredBatOverallRange          | CanadaGeeseProductionArea                           | GreaterSandhillCraneNestSites            | LPChickenHistoricRange               | PaintedTurtleOverallRange                           | SilverHairedBatOverallRange                     |
| AmericanBitternBreedingRange           | CanadaGeeseWinterConcentrationArea                  | GreaterSandhillCraneNestSitesBuf         | LPChickenLekSites                    | PallidBatOverallRange                               | SixLinedRacerunnerOverallRange                  |
| ArkansasDarterHUC12Presence            | CanadaGeeseWinterRange                              | GreaterSandhillCraneOverallRange         | LPChickenOverallRange                | PeregrineForagingArea                               | SmithsBlackHeadedSnakeOverallRange              |
| BaldEagleCommunalRoosts                | CanyonBatOverallRange                               | GreaterSandhillCraneProductionArea       | LPChickenProductionArea              | PeregrineNestingArea                                | SmoothGreensnakeOverallRange                    |
| BaldEagleRoostSites                    | CassinFinchBreedingRange                            | GreaterSandhillCraneRoostSites           | LynxBreedingHabitat                  | PeregrinePotentialNesting                           | SnappingTurtleOverallRange                      |
| BaldEagleSummerForage                  | CassinSparrowBreedingRange                          | GreaterSandhillCraneStagingArea          | LynxPotentialHabitat                 | PheasantConcentrationArea                           | SnowGeeseWinterRange                            |
| BaldEagleWinterConcentration           | ChestnutCollaredLongspurBreedingRange               | GreatPlainsRatsnakeOverallRange          | MassasaugaOverallRange               | PheasantOverallRange                                | SouthernRedbellyDaceHUC12Presence               |
| BaldEagleWinterForage                  | CoachwhipOverallRange                               | GreatPlainsSkinkOverallRange             | MassasaugaPotentialHabitat           | PinyonJayBreedingRange                              | SpinySoftshellOverallRange                      |
| BaldEagleWinterRange                   | ColoradoPikeminnowHUC12Presence                     | GrSageGrouseBroodArea                    | McCownLongspurBreedingRange          | PipingPloverBreedingRange                           | SpottedBatOverallRange                          |
| BarrowGoldeneyeBreedingRange           | CommonGartersnakeOverallRange                       | GrSageGrouseHistoricHabitat              | MilksnakeOverallRange                | PipingPloverForagingArea                            | StonecatHUC12Presence                           |
| BatSites(0.25milebuffer)               | CommonKingsnakeOverallRange                         | GrSageGrouseLekSites                     | MooseConcentrationArea               | PipingPloverProductionArea                          | StripedWhipsnakeOverallRange                    |
| BFFerretReleaseSites                   | CommonLesserEarlessLizardOverallRange               | GrSageGrouseOverallRange                 | MooseMigrationCorridors              | PlainsBlackHeadedSnakeOverallRange                  | SuckermouthMinnowHUC12Presence                  |
| BFTBatForagingArea                     | CommonSagebrushLizardOverallRange                   | GrSageGrouseProductionArea               | MooseOverallRange                    | PlainsGartersnakeOverallRange                       | SwainsonHawkBreedingRange                       |
| BigBrownBatOverallRange                | CommonShinerHUC12Presence                           | GrSageGrouseSevereWinterRange            | MoosePriorityHabitat                 | PlainsHogNosedSnakeOverallRange                     | SwiftFoxOverallRange                            |
| BigFreeTailedBatOverallRange           | CommonSideBlotchedLizardOverallRange                | GrSageGrouseWinterRange                  | MooseSummerRange                     | PlainsMinnowHUC12Presence                           | SWWillowFlycatcherCriticalHabitatFinal_USFWS    |
| BighornMigrationCorridors              | COPikeminnowCriticalHabitatFinal_USFWS              | GrSGCoreAreas                            | MooseWinterRange                     | PlainsTopminnowHUC12Presence                        | TerrestrialGartersnakeOverallRange              |
| BighornMineralLick                     | CSTGrouseLekSites                                   | GrSGLinkages                             | MountainPloverBreedingRange          | PlateauStripedWhiptailOverallRange                  | TexasHornedLizardOverallRange                   |
| BighornOverallRange                    | CSTGrouseOverallRange                               | GrSGPPHPGH                               | MountainPloverNestSites              | PMJMCriticalHabitat_USFWS                           | TexasHornedLizardPotentialHabitat               |
| BighornProductionArea                  | CSTGrouseProductionArea                             | GunnPrairieDogColonies                   | MountainSuckerHUC12Presence          | PrairieFalconBreedingRange                          | TexasThreadsnakeOverallRange                    |
| BighornSevereWinterRange               | CSTGrouseWinterRange                                | GunnPrairieDogOverallRange               | MSOwlCriticalHabitat_USFWS           | PrairieLizardAndPlateauFenceLizardOverallRange      | TigerWhiptailOverallRange                       |
| BighornSummerConcentrationArea         | CutthroatTroutHUC12Presence                         | GunnSageGrouseBroodArea                  | MSOwlProtectedActivityCenter_BLM     | PrairieRattlesnakeAndWesternRattlesnakeOverallRange | TownsendBigEaredBatOverallRange                 |
| BighornSummerRange                     | DesertNightsnakeAndChihuahuanNightsnakeOverallRange | GunnSageGrouseCriticalHabitatFinal_USFWS | MtnGoatConcentrationArea             | PreblesMouseOccupiedRange                           | TriColoredBatOverallRange                       |
| BighornWaterSource                     | DesertSpinyLizardOverallRange                       | GunnSageGrouseHabitatStatus              | MtnGoatMigrationCorridors            | PreblesMouseOverallRange                            | TriploidCheckeredWhiptailOverallRange           |
| BighornWinterConcentrationArea         | DiploidCheckeredWhiptailOverallRange                | GunnSageGrouseHistHabitat                | MtnGoatMineralLick                   | PreblesMousePotentialHabitatHigh                    | TurkeyOverallRange                              |
| BighornWinterRange                     | EasternCollaredLizardOverallRange                   | GunnSageGrouseLekSites                   | MtnGoatOverallRange                  | PreblesMousePotentialHabitatLow                     | TurkeyProductionArea                            |
| BlackBearFallConcentration             | EasternHogNosedSnakeOverallRange                    | GunnSageGrouseOverallRange               | MtnGoatProductionArea                | PreblesMousePotentialHabitatMedium                  | TurkeyRoostSites                                |
| BlackBearHumanConflictArea             | ElkLimitedUseArea                                   | GunnSageGrouseProductionArea             | MtnGoatSummerRange                   | PronghornConcentrationArea                          | TurkeyWinterConcentrationArea                   |
| BlackBearMigrationCorridors            | ElkMigrationCorridors                               | GunnSageGrouseSevereWinterRange          | MtnGoatWinterRange                   | PronghornLimitedUseArea                             | TurkeyWinterRange                               |
| BlackBearOverallRange                  | ElkOverallRange                                     | GunnSageGrouseWinterRange                | MtnLionHumanConflictArea             | PronghornMigrationCorridors                         | UplandSandpiperBreedingRange                    |
| BlackBearSummerConcentration           | ElkProductionArea                                   | HernandezsShortHornedLizardOverallRange  | MtnLionOverallRange                  | PronghornOverallRange                               | VariableSkinkAndManyLinedSkinkOverallRange      |
| BlackNeckedGartersnakeOverallRange     | ElkResidentPopulationArea                           | HoaryBatOverallRange                     | MtnLionPeripheralRange               | PronghornPerennialWater                             | VeeryBreedingRange                              |
| BlackSwiftBreedingRange                | ElkSevereWinterRange                                | HumpbackChubCriticalHabitatFinal_USFWS   | MuleDeerConcentrationArea            | PronghornResidentPopulationArea                     | VirginiaWarblerBreedingRange                    |
| BlackTernBreedingRange                 | ElkSummerConcentrationArea                          | HumpbackChubHUC12Presence                | MuleDeerCriticalWinterRange          | PronghornSevereWinterRange                          | WesternGroundsnakeOverallRange                  |
| BlueheadSuckerHUC12Presence            | ElkSummerRange                                      | IowaDarterHUC12Presence                  | MuleDeerLimitedUseArea               | PronghornWinterConcentration                        | WesternRibbonSnakeOverallRange                  |
| BobolinkBreedingRange                  | ElkWinterConcentrationArea                          | JuniperTitmouseBreedingRange             | MuleDeerMigrationCorridors           | PronghornWinterRange                                | WesternSmallFootedMyotisOverallRange            |
| BonytailChubCriticalHabitatFinal_USFWS | ElkWinterRange                                      | KitFoxHistoricOverallRange               | MuleDeerOverallRange                 | PSTGrouseLekSites                                   | WesternSnowyPloverBreedingRange                 |
| BonytailHUC12Presence                  | FerruginousHawkBreedingRange                        | LakeChubHUC12Presence                    | MuleDeerResidentPopulationArea       | PSTGrouseOverallRange                               | WhiteFacedIbisBreedingRange                     |
| BorealToadOverallRange                 | FlannelmouthSuckerHUC12Presence                     | LarkBuntingBreedingRange                 | MuleDeerSevereWinterRange            | PSTGrouseProductionArea                             | WhPelicanForagingArea                           |
| BrassyMinnowHUC12Presence              | FlatheadChubHUC12Presence                           | LazuliBuntingBreedingRange               | MuleDeerSummerRange                  | PtarmiganOverallRange                               | WhPelicanNestingArea                            |
| BrazilianFreeTailedBatOverallRange     | FringedMyotisOverallRange                           | LeastTernBreedingRange                   | MuleDeerWinterConcentrationArea      | PtarmiganWinterRange                                | WhPelicanOverallRange                           |
| BrewerSparrowBreedingRange             | GBHeronForagingArea                                 | LeastTernForagingArea                    | MuleDeerWinterRange                  | PurpleMartinBreedingRange                           | WTDeerConcentrationArea                         |
| BrownCappedRosyFinchBreedingRange      | GBHeronHistoricNestArea                             | LeastTernProductionArea                  | NMJMOverallRange                     | RazorbackSuckerCriticalHabitatFinal_USFWS           | WTDeerOverallRange                              |
| BrownCappedRosyFinchOverallRange       | GBHeronNestingArea                                  | LesserSandhillCraneForagingArea          | NMMouseCriticalHabitatProposed_USFWS | RazorbackSuckerHUC12Presence                        | WTDeerWinterRange                               |
| BTPrairieDogColonyPotentialOccurrence  | GlossySnakeOverallRange                             | LesserSandhillCraneOverallRange          | NorthAmericanRacerOverallRange       | RedBatOverallRange                                  | WTPDManagementEmphasisArea                      |
| BTPrairieDogHighDensityArea            | GoldenEagleBreedingRange                            | LesserSandhillCraneRoostSites            | NorthernBobwhiteBreedingRange        | RingNeckedSnakeOverallRange                         | WTPrairieDogColonies                            |
| BTPrairieDogOverallRange               | GPChickenHistoricRange                              | LesserSandhillCraneStagingArea           | NorthernGoshawkBreedingRange         | RioGrandeChubHUC12Presence                          | WTPrairieDogOverallRange                        |
| BullsnakeOverallRange                  | GPChickenLekSites                                   | LewisWoodpeckerBreedingRange             | NorthernHarrierBreedingRange         | RioGrandeSuckerHUC12Presence                        | YellowBilledCuckooCriticalHabitatProposed_USFWS |
| BurrowingOwlBreedingRange              | GPChickenOverallRange                               | LinedSnakeOverallRange                   | NorthernRedbellyDaceHUC12Presence    | RiverOtterConcentrationArea                         | YellowMudTurtleOverallRange                     |
| BurrowingOwlPotentialHabitat           | GPChickenProductionArea                             | LittleBrownMyotisOverallRange            | NorthernWatersnakeOverallRange       | RiverOtterOverallRange                              | YumaMyotisOverallRange                          |
| BWQuailConcentrationArea               | GPDManagementEmphasisArea                           | LongBilledCurlewBreedingRange            | OliveSidedFlycatcherBreedingRange    | RiverOtterWinterRange                               |   |
| BWQuailOverallRange                    | GraceWarblerBreedingRange                           | LongEaredMyotisOverallRange              | OrangespottedSunfishHUC12Presence    | RoundtailChubHUC12Presence                          |   |
| CaliforniaMyotisOverallRange           | GrasshopperSparrowBreedingRange                     | LongLeggedMyotisOverallRange             | OrangethroatDarterHUC12Presence      | RoundTailedHornedLizardOverallRange                 |   |
| CanadaGeeseBroodConcentrationArea      | GrayVireoBreedingRange                              | LongNosedLeopardLizardOverallRange       | OrnateBoxTurtleOverallRange          | SageSparrowBreedingRange                            |   |