A science-based framework for conservation and resilience of Golden Eagles (*Aquila chrysaetos*) in San Diego County

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Prepared for:
San Diego Association of Governments

Prepared By: Thomsen, Sarah K.[1], Emily Perkins[1], Yvonne C. Moore[2], Kris Preston[1], and Robert N. Fisher[1]
[1]U.S. Geological Survey, Western Ecological Research Center, San Diego Field Station, San Diego, CA 92101
[2]Independent Scientist, Murrieta CA 92563

With contributions from the Southern California Golden Eagle Working Group, including but not limited to:

Pete Bloom, Bloom Biological Inc (BBI)
Melanie Burlaza, CDFW
Gonzalo De León-Girón, UABC
Thomas Dietsch, USFWS
James Gannon, BLM
Robert Lee Hamm, USDA FS
Alison Kalinowski, CDFW
Melanie Madden, USN NAVFAC
James Molden, USFWS
Hans Petermann, Wildlife Research Institute (WRI)
Jennifer Price, SD County
Bethany Principe, SD County
Katie Quint, WRI
Ismael Ramirez, BLM
Jeff Rangitsch, SD County
Beth Roesler, USGS
Tom Scott, UCR
Jeremy Sebes, USGS
Hans Sin, CDFW
LaReina Van Sant, BLM
Julia Varnergardner, SDGE
Kirsten Winter, USDA FS
Susan Wynn, USFWS

Cover: Image showing golden eagle (*Aquila chrysaetos*) flying. Photograph taken by a trail camera.

Suggested citation: Thomsen, S.K., E. Perkins, Y. C. Moore, K. Preston, and R. N. Fisher, with contributions from the Southern California Golden Eagle Working Group. (2025). A science-based framework for conservation and resilience of Golden Eagles (*Aquila chrysaetos*) in San Diego County. USGS Cooperator report prepared for: San Diego Association of Governments Transnet Environmental Mitigation Program.
DOI: 10.13140/RG.2.2.24001.67682

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Conversion Factors

International System of Units to U.S. customary units

Multiply	By	To obtain
	Length	
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
	Area	
square meter (m^2)	0.0002471	acre
square kilometer (km^2)	247.1	acre
hectare (ha)	0.003861	square mile (mi^2)
square kilometer (km^2)	0.3861	square mile (mi^2)
	Speed	
kilometer per hour (km/h)	0.6214	mile per hour (mi/h)

Abbreviations

AKDE	Auto-Correlated Kernal Density Estimates
AMEC	AMEC Earth and Environmental, Inc.
APHIS	Animal and Plant Health Inspection Service
APLIC	Avian Power Line Interaction Committee
BLM	Bureau of Land Management
BMP	Best Management Practices
CalFire	California Department of Forestry and Fire Protection
CDFA	California Department of Food and Agriculture
CDFW	California Department of Fish and Wildlife
CDPH	California Department of Public Health
CNF	Cleveland National Forest
EMP	Environmental Mitigation Program
FRAP	Fire Resource Assessment Program
GEMA	Golden Eagle Management Area
GIS	Geographic Information System
GSOB	Goldspotted Oak Borer
HEXID	Hexagon Identification Number
HPAI	Highly Pathogenic Avian Influenza
I -	Interstate
MBTA	Migratory Bird Treaty Act
MHCP	Multiple Habitat Conservation Program
MSCP	Multiple Species Conservation Program
MSP Roadmap	Management and Monitoring Strategic Plan Roadmap
MSPA	MSP Roadmap Area
MU	Management Unit
NCCP	Natural Community Conservation Plan or Natural Community Conservation Planning
PFAS	Per- and Polyfluoroalkyl Substances
RHDV2	Rabbit Hemorrhagic Disease Virus Type 2
SANDAG	San Diego Association of Governments
SDGE	San Diego Gas & Electric
SDMMP	San Diego Management and Monitoring Program
SO	Species occurrence(s) at risk of loss. See Definitions: Category SO Species
SR -	State Route
TNC	The Nature Conservancy
USFWS	U.S. Fish and Wildlife Service
US	United States
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
VID	Vista Irrigation District
WERC	Western Ecological Research Center
WNV	West Nile Virus
WRI	Wildlife Research Institute
WUI	Wildland Urban Interface

Definitions

Best Management Practices (BMPs) - BMPs are those practices determined to be the most efficient, practical, and cost-effective to guide a particular activity or to address a particular problem.

Category SO Species - As defined in the 2017 Management and Monitoring Strategic Plan Roadmap (MSP Roadmap; SDMMP and TNC 2017, page V1.2-33), "species whose persistence of one or more significant occurrences in the MSPA is at high risk of loss without immediate management action above and beyond that of daily maintenance activities."

Covered Species - Those species addressed in a natural community conservation plan or habitat conservation plan for which conservation measures will be implemented and for which authorization for take is sought under Section 2835 of the California NCCP and/or Section 10 of the federal Endangered Species Act.

Conserved lands - As defined in the 2017 Management and Monitoring Strategic Plan (MSP Roadmap; SDMMP and TNC 2017, page xxvii), "Conserved lands are those lands that are legally conserved to (1) Protect natural habitats, species, and open space (including agricultural lands that are important components of the regional habitat preserve design); (2) Contribute to the existing and planned regional habitat preserve system; and (3) Managed to protect the open space or natural resources into the future. The conservation occurs through public or private acquisitions, conservation easements, land dedications, mitigation, mitigation banks, covenants, or other mechanisms that ensure the land will not be developed." The Conserved Lands geodatabase tracks lands conserved in western San Diego County.

Enhancement - Prescriptive action to reduce threats to the habitat, such as shrub thinning or weed removal.

Management and Monitoring Strategic Plan for Conserved Lands in Western San Diego County: A Strategic Habitat Conservation Roadmap (MSP Roadmap) - The MSP Roadmap (along with an online MSP Portal available at sdmmp.com) provides management and monitoring goals and objectives for species, vegetation communities, and threats across the regional preserve system on conserved lands in western San Diego County. The MSP Roadmap covers 5-year planning horizons and is evaluated every 5 years to update and prioritize the species list, management categories, and management and monitoring objectives. There have been three planning horizons of the MSP thus far (2012–2016, 2017–2021, and 2022–2026).

MSP Roadmap Area (MSPA) - Area of western San Diego County covered by the MSP Roadmap and comprising the regional preserve system. This includes conserved lands extending from the Eastern Peninsular Mountain Range peaks west to the coast and from the northern border with Orange and Riverside counties south to the International Border with Mexico.

Multiple Species Conservation Program (MSCP) - A comprehensive conservation planning process that addresses the needs of multiple plant and animal species in southwestern San Diego County. The MSCP is a subregional habitat conservation planning program that was approved in 1998 for multiple jurisdictions to conserve 85 Covered Species and their habitats. Currently, San Diego County and the Cities of San Diego, Poway, Chula Vista, and La Mesa have completed MSCP subarea plans. Separate MSCPs for North County and East County are under development.

Natural Community Conservation Planning (NCCP) Program - CDFW's NCCP program is an effort by the State of California, and numerous private and public partners that takes a broad-based ecosystem approach to planning for the protection and perpetuation of biological diversity. A NCCP identifies and provides for the regional or area wide protection of plants, animals, and their habitats, while allowing compatible and appropriate economic activity.

Population - A population or sometimes genetic population is defined as a regional linked group of individuals where gene flow occurs between them.

Regional preserve system – Preserve lands acquired as part of implementing multiple species conservation programs are combined with previously conserved lands (for example, U.S. Forest Service and California State Parks lands) into a regional preserve system in western San Diego County. The regional preserve system protects natural habitats and rare, threatened and endangered species.

Restoration - Prescriptive action of planting new plants within a habitat to restore it to its former state.

Stakeholders - Stakeholders is defined as those groups who have an investment or interest in conservation management in the San Diego region and includes, but is not limited to, landowners, land managers, funding entities, scientists, the wildlife agencies, development interests, regional management and monitoring programs, non-profit institutions, environmental consultants, and cities and County of San Diego.

Territory - The core area, or the area of more concentrated use, within a home range in which a mating pair of birds uses for nesting and foraging.

TransNet -*TransNet* is a half-cent sales tax for local transportation projects that was first approved by San Diego County voters in 1988, and then extended in 2004 for another 40 years. The program is administered by SANDAG. During the 60-year life of the program, more than $17 billion will be generated and distributed among highway, transit, and local road projects in approximately equal thirds. The *TransNet* Environmental Mitigation Program (EMP) provides funds through *TransNet* to protect, preserve, and restore native habitats as offsets to disturbance caused by the construction of regional and local transportation projects.

Wildlife Agencies / Public Lands Agencies - Collectively, the U.S. Fish and Wildlife Service, Bureau of Land Management, U.S. Forest Service and the California Department of Fish and Wildlife.

1. Introduction

Golden eagles (*Aquila chrysaetos*) are a large and long-lived raptor found particularly in the rugged habitats of the western US, including in southwestern California. With wingspans of up to over 2 meters (nearly 7 feet) and talons up to 6.3 centimeters in size (2.5 inches; Bortolotti 1984, Lish et al. 2016), they are equipped to prey on ground squirrels, rabbits, and various other species (Olendorff 1976; Bedrosian et al. 2017). Golden eagles usually nest in cliffs away from human disturbance and have some of the largest home ranges of all birds in this region (Katzner et al. 2020). As a result, golden eagles are highly sensitive to changes in habitat quality and can be regarded as an indicator species (Scott 1985; Natsukawa and Sergio 2022). Despite their significance, they face many threats throughout their range (USFWS 2016), and their abundance has undergone a long-term decline in the region and in San Diego County specifically (Scott 1985; WRI 2010). These declines have led to increasing conservation concern for this apex avian predator, and this document is aimed at supporting the long-term resilience of golden eagles in the region.

The golden eagle is covered by multiple laws and regulations both federally and statewide in California as well as in other states. The Bald and Golden Eagle Protection Act, amended in 1962 to include the golden eagle (16 United States Code 668–668d, USFWS 2016), and the Migratory Bird Treaty Act (MBTA; United States Code 703-712), prohibit "take" or possession of eagles, their parts (e.g., feathers), nests, and eggs along with killing, injuring, harassment or disturbance of their nests. The California Department of Fish and Wildlife (CDFW) considers golden eagles "fully protected"; prior to 2023 there was generally no take allowed except as authorized and permitted for research and recovery activities (California Fish and Game Code Section 3511), or since 2011 as part of a Natural Community Conservation Plan (NCCP; See Definitions above, California SB 618). In 2023, a number of new exceptions were added that allow incidental take for transportation and energy projects (California SB 147). The USFWS 'Eagle Rule' was also amended in 2024 which includes tiered permits for allowable take for energy projects and specifies mitigation options (USFWS 2024).

Golden eagles occur across San Diego County and are included as covered species in at least two existing conservation plans in the county (City of San Diego 1997; County of San Diego 1997; City of San Diego 1998, AMEC Earth and Environmental [AMEC] et al. 2003), and may be included in additional future conservation plans such as in the north and eastern portions of the county. The plans call for conservation of a regional preserve system designed to include lands with important habitat values, sensitive species, and connectivity between core preserve areas (County of San Diego 1997; AMEC et al. 2003). These plans have preserve-level management and monitoring requirements for lands conserved by participating entities. The San Diego Association of Governments (SANDAG) Environmental Mitigation Program (EMP) provides funding and oversight of the San Diego Management and Monitoring Program (SDMMP), which is responsible for developing and coordinating regional monitoring and management activities across the regional preserve system (SANDAG 2004).

1.1 Purpose and Need

The overall purpose of this document is to identify science-informed management strategies for the golden eagle in San Diego County based on analyses of data collected by USGS scientists and others. The SDMMP developed a *Management and Monitoring Strategic Plan for Conserved Lands in Western San Diego County: A Strategic Habitat Conservation Roadmap* (MSP Roadmap; SDMMP and TNC 2017) to provide regional goals and objectives for sensitive natural resources and threats/stressors on conserved lands within a 1.7 million-acre MSP Roadmap area (MSPA; See Definitions, SDMMP and TNC 2017). The MSP Roadmap provides a biologically based foundation that can support decision making that guides priorities for funding and managing the monitoring of prioritized species, vegetation communities, and threats/stressors across western San Diego County. The golden eagle was designated a "Category SO" species within the MSPA, defined as a species whose persistence at one or more significant occurrences in the planning area is at high risk of loss without immediate management action above and beyond that of daily maintenance activities (SDMMP and TNC 2017). This document has been prepared to provide science information and support for advancing and fulfilling the MSP Roadmap goals and objectives established for conservation of golden eagle in the MSPA. The MSP Roadmap goal for golden eagle is as follows:

> *Expand and then maintain a self-sustaining golden eagle population to ensure long term persistence (>100 years) on Conserved Lands in the MSPA by: improving reproductive success through protection of active and inactive nest sites from human disturbance; reducing anthropogenic mortality; managing large mosaics of grassland and open shrublands for optimal prey availability, especially during drought; and by minimizing human impacts to foraging eagles.*

The specific MSP Roadmap management objective relating to the MSP goal and the need for this document is as follows:

> *…develop a comprehensive Golden Eagle Management Plan for managing golden eagle territories with nesting, roosting, and foraging habitat on Conserved Lands within the MSPA[…]. The plan should include recommendations for managing important foraging habitat to minimize human disturbance to foraging eagles and to improve habitat quality to enhance prey availability, especially during drought periods. The plan should also include specifications to control human disturbance that could discourage nesting, cause nest abandonment, or adversely affect the survival of nestlings, and for managing unstable nest ledges or tree nest sites that are critical to maintaining a breeding pair in territories with limited nesting sites.*

Therefore, based on the goals and objectives identified in the MSP Roadmap, this document includes potential science-informed management strategies that focus on:

- Protecting occupied and potentially occupied nesting areas from human disturbance.
- Enhancing nest and roost sites to improve reproductive success.

- Protecting foraging habitat from human disturbance.
- Enhancing foraging habitat to optimize prey.
- Reducing mortality from anthropogenic activity.

This document does not replace existing preserve level management plans, daily maintenance activities at existing preserves, or prior obligations negotiated with the U.S. Fish and Wildlife Service (USFWS), Forest Service, BLM, and CDFW (collectively "Wildlife Agencies/Public Lands Agencies"). Rather, this document provides a science-based framework to assist with regional conservation efforts by listing potential management strategies.

1.2 Approach and Study Area

The approach used to develop this framework document was as follows:

- Consulted with the Wildlife Agencies/ Public Lands Agencies and other stakeholders (e.g. the Southern California Golden Eagle Working Group; hereafter referred to as the "working group") to ensure that the most current information regarding golden eagle biology, ecology, management, threats, regulations, human use, conserved lands, management strategies, and best management practices were included.
- Initiated field studies in 2014 to address key information gaps including movement patterns (Duerr et al. 2019; Sur et al. 2020; Poessel et al. 2022), habitat relationships (Tracey et al. 2018, Tracey et al. 2020a; Wiens et al. 2022), and seasonal home range sizes (Thomsen et al. 2025).
- Reviewed literature on golden eagles and the known and potential threats to the species and summarized possible management and mitigation strategies for those threats from the literature as well as working group suggestions.
- Developed a GIS-based decision support tool to ensure spatially explicit mapping of known and potential threats in relation to golden eagle nesting and foraging areas. Conducted workshops in May and June 2024 (aka Threats Workshops) where participants in the working group used the tool as needed to create lists of known and potential threats to prioritized Golden Eagle Management Areas (GEMAs) as part of a semi-structured expert elicitation process (Yamada et al. 2003).
- Using all the information above, ranked threats into categories and listed potential strategies for managing specific threats/stressors within prioritized golden eagle nesting areas.

This document specifically applies to golden eagles utilizing conserved lands within the Management Strategic Plan Area (MSPA) but may have utility to the larger southwestern California region as a whole. The MSPA is currently divided into 11 management units (MUs)

based on similar geographic features, vegetation communities, and threats/stressors, and are intended to facilitate coordinated management across multiple preserves (Figure 1). An additional Management Unit (MU12) was created for the eastern portion of the County to address golden eagle areas that occur east of the current MSPA. The potential management strategies described are tailored to the specific needs of golden eagles with regards to habitat, nesting, foraging, and survival (Katzner et al. 2020). Potential regional and preserve-level management strategies are included for specific threats/stressors to allow collaboration among stakeholders and preserve managers and also assist in providing feedback for making appropriate modifications. This document is based on information currently available for golden eagles and could be modified as new information is obtained and/or the MSPA is modified.

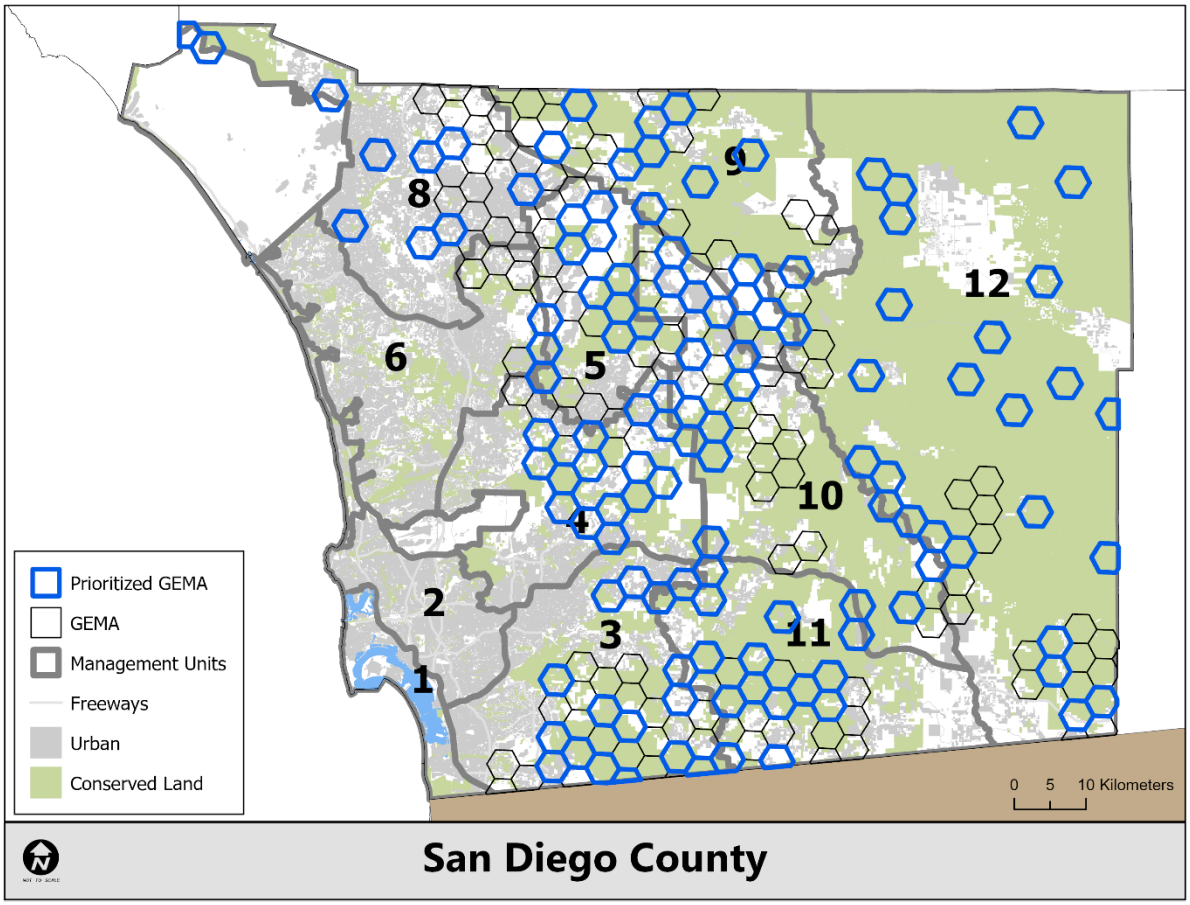

Figure 1. Map of San Diego County and the boundaries of the 11 Management Units from the MSP Roadmap, as well as an additional Management Unit 12 that covers the eastern portion of the county. Hexagons show Golden Eagle Management Areas (GEMAs) that were identified as potential areas known to overlap with existing or historic nest locations and foraging areas, with those prioritized for this document highlighted in blue (n=103). Areas from which golden eagles are documented to have been extirpated are not included as a GEMA as well as those exclusively on military lands. Data from SDMMP 2024, SDMMP and TNC 2017, SANDAG 2019, and County of San Diego 2000.

For the decision support tool, several GIS data layers were included to assist with mapping of threats to golden eagles. First, a hexagonal grid (~863 hexagons) was overlaid on the region and clipped to San Diego County boundaries. Each hexagon is 13.9 km^2 (5.36 mi^2), which is the same size recently used to predict occupancy of golden eagles in the San Diego County area (Wiens et al. 2022). Next, we included the best available data on extant, potential and historic nest site and foraging locations from various sources, methods, and time periods. From this, we were able to filter the hexagon layer to display all GEMAs (Figure 1). A non-random subset of those locations known to be in occupied or potentially occupied territories were then selected to be among the prioritized GEMAs, highlighted in blue in Figure 1, which are also described in more detail in Section 4.

Next, we added GIS layers corresponding to potential threats to golden eagles. Land cover information included urban edge (SANDAG 2019), conserved land ownership (SDMMP 2024), and major roads (County of San Diego 2000). Electrical transmission lines were also included (California Energy Commission 2024), as well as the number of fires in the previous 30 years (CalFire 2022). Different types of recreation were included, such as climbing routes and locations (OpenBeta 2023). The intensity of human activity along hiking and recreational trails was visualized with data georeferenced from Strava (Strava 2024). Lastly, potential foraging habitat was included, which was defined as shrub- or herbaceous-dominated vegetation types that had less than 50% shrub or tree cover as determined with LIDAR (FRAP 2016; Perkins and Kus 2022). More data layers could be added for any subsequent revisions of this document.

With the decision support tool, we were able to combine expert elicitation insights with available data to conduct a rapid assessment of the variety of threats found in prioritized Golden Eagle Management Areas (GEMAs), which are described in Section 4. This approach was flexible in highlighting localized threats and contextual factors of the available data layers, and helped inform the potential conservation strategy outlined in Section 5.

1.3 How to Use this Document

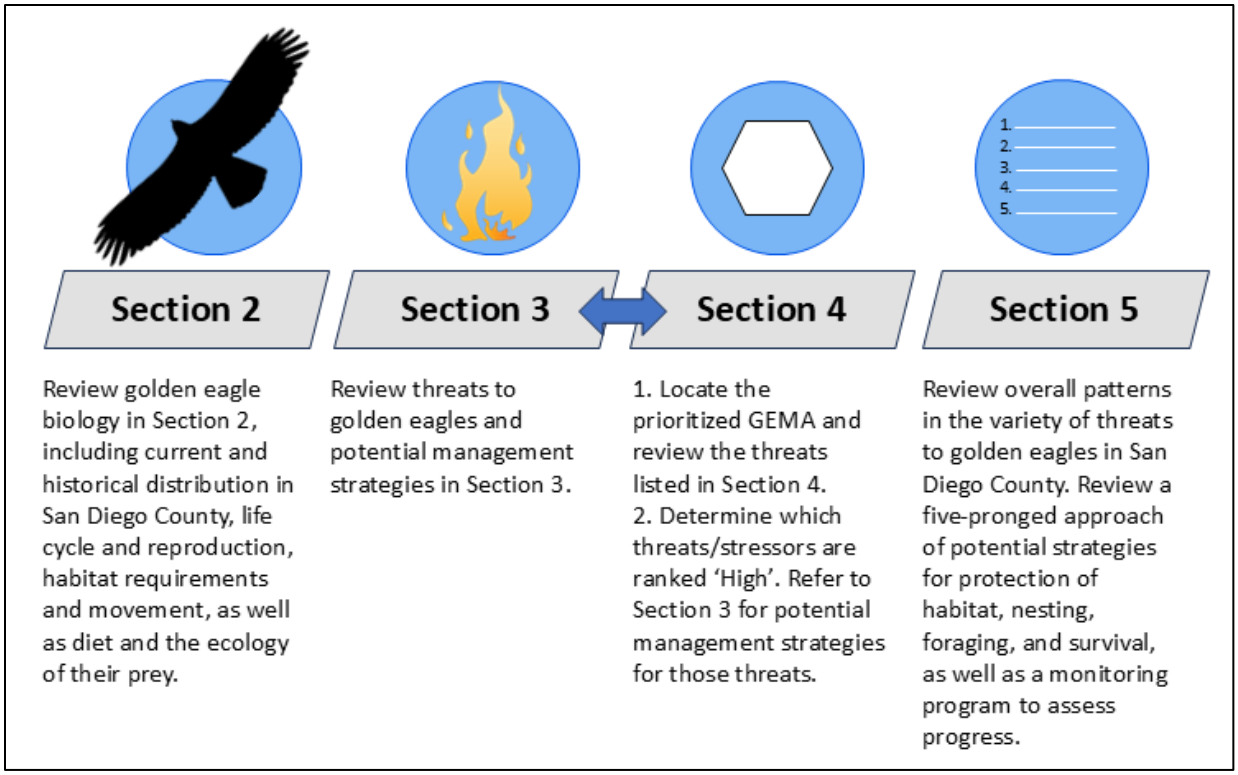

Figure 2. Diagram showing steps for how to use this document.

2. Species Description and Biology

Extensive species accounts and exhaustive literature reviews are available elsewhere (Watson 2010, USFWS 2016, Katzner et al. 2020), therefore here we present a summary that is focused on the most relevant research to conservation of golden eagles in Southern California.

2.1 Current Distribution and Historical Locations

Golden eagles occur in California and Mexico in a diverse range of habitats. Southwestern California and northwestern Baja California in Mexico have a mediterranean-type ecosystem, with habitats consisting of coastal sage scrub and chaparral, patches of non-native grasslands, oak woodlands, montane woodland/scrub, and high desert scrub. The coastal area of San Diego County is mostly developed, and beyond which are the foothills, canyons and peaks of the Transverse and Peninsular Mountain ranges that parallel the ocean coastline. The mountains create a rain shadow under which lies the edge of the Colorado region of the Sonoran Desert (Schoenherr 2017). It was recently estimated that approximately 60 pairs (95% CI = 19–151 pairs) of golden eagles are distributed in an area that includes San Diego County and parts of Orange and western Riverside Counties (Wiens et al. 2022). Relative abundance of golden eagles is highest in the middle third of the county (Fink et al. 2023, Figure 3).

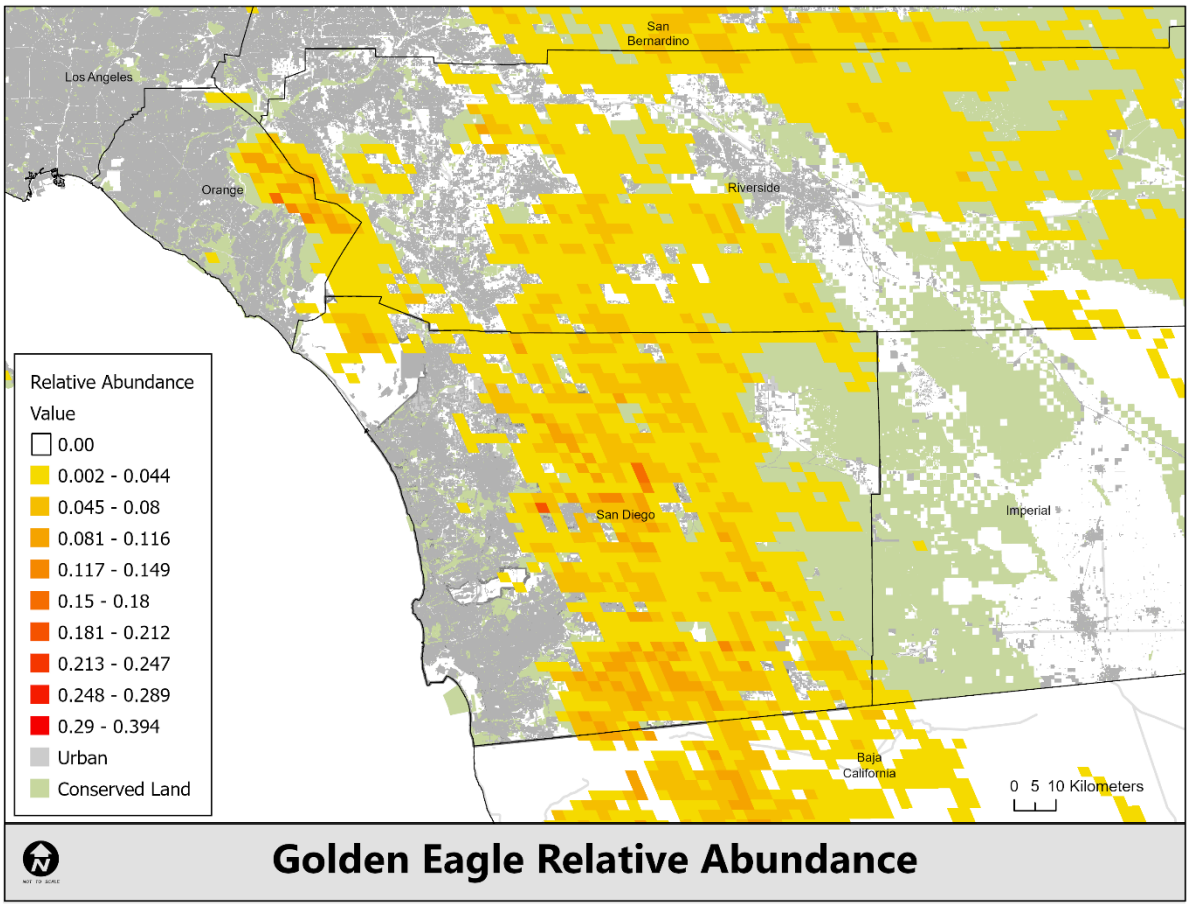

Figure 3. Relative abundance of golden eagles based on reported sightings on eBird during Feb-May in the San Diego County area. Data from 2008-2022, Fink et al. 2023 as well as SANDAG 2019 and SDMMP 2024 for urban and conserved land, respectively.

There is a long history of studies of golden eagles in San Diego County that gives perspective on their current status and distribution. Dixon (1937) monitored 27 eagle territories in the northwest part of the county from the turn of the century until the 1930s. It was noted by 1974 that many of those same nests were unoccupied (Thelander 1974), and Scott (1985) detailed how the disappearance of territories was associated with increasing urbanization over the previous decades. Additional territories within San Diego County that had been documented to be occupied previously by Dixon (1937) were considered extirpated by 2010 (WRI 2010), although some territories remain occupied. Across the region, there is other evidence of similar long-term decline. For example, by the 1990s there were no longer occupied golden eagle nests in the Santa Monica Mountains of California (Cooper et al. 2021). Similarly, a decline in the number of occupied territories in the Santa Ana Mountains has been observed (Bloom et al., in prep).

2.2 Life Cycle and Reproduction

Golden eagles in San Diego County are a non-migratory resident population and generally do not leave territories once established (Dixon 1937), leading to a breeding season that extends from late fall with the start of courtship and nest building, and can last into August when nestlings have fledged and start to gain independence from parental care. Nest construction can begin as soon as in the fall (Dixon 1937), and courtship involves vocalizing, stick-carrying, and aerial displays (Katzner et al. 2020). Eagles often perform undulating flights during the breeding season on their territories, where they dive quickly towards the ground and then glide upwards before diving again, which may be for both pair bonding and territorial display (Watson 2010; Katzner et al. 2020). Most eggs are laid in February (Scott 1985; Unitt 2004), ranging from late January to early March, but possibly into early April (Bloom 1991). They lay 1-3 eggs, but usually 2 (Dixon 1937). Incubation can start with the first egg and hatching is roughly 41-45 days later (Watson 2010). Both sexes incubate but it is mostly done by the female with short periods of relief by the male during the day (Collopy 1984). For about the first 3 weeks after hatching, nestlings are dependent on female adults to regulate their temperature by brooding or shading (Watson 2010). Both sexes hunt and bring prey to the nest to feed nestlings (Collopy 1984). Fledging occurs when nestlings reach about 64 days of age, although this can range from 45 to 81 days old (Katzner et al. 2020). Only one brood is raised per year (Dixon 1937). After fledging, juveniles stay within the natal territory perhaps until October while gaining independence (Katzner et al. 2020), and may overlap the same home range area as their adult parents beyond that (Murphy et al. 2017; Hemery et al. 2024).

Golden eagles may live over 30 years and generally only start breeding after attaining adult plumage in their fifth summer (Katzner et al. 2020). Before establishing a territory, these subadults and nonbreeding adults can range far within California and beyond (Tracey et al. 2020b; Poessel et al. 2022). However, eagles likely settle into a territory not far from their natal territory, perhaps ranging from 7 to 65 km away (4.3 to 40.4 miles; Katzner et al. 2020). Adults without territories are “floaters” and can become territory holders when a vacancy opens up and thus contribute to population stability (Hunt et al. 2017). They are usually monogamous although some mate switching happens (Watson 2010).

2.3 Habitat Requirements and Movement

Nests are placed mostly on cliff ledges or shallow caves on cliff sides, but in San Diego County, perhaps 20% are placed in trees (Scott 1985). Most of those are oak trees (*Quercus* spp), although other species can sometimes be used (Wiens et al. 2022). Tree nests are often located in the largest and tallest trees in a stand (Menkens and Anderson 1987), while nests placed in a cliff will usually have an elevated view of the surrounding area (Scott 1985). Nest sites may be used for decades (Dixon 1937), but golden eagles often build alternative nests and any one of them might be used in a given year for a breeding attempt (Millsap et al. 2015). As many as 39 years between uses of alternative nests have been documented (Kochert and Steenhof 2012). Alternative nests tend to be located in the areas of more concentrated use of their home range

("core area"; see also Definitions above for "territory", Watson et al. 2014; Millsap et al. 2015). Alternative nest sites are important since eagles may still successfully breed even if there are habitat disturbances in their home range otherwise (Millsap et al. 2015).

Nests are located near foraging habitat (Camenzind 1968), which facilitates reduced energetic demands and increased breeding success (Watson 2010). Occupancy by territorial eagles in the San Diego County area was positively associated with increasingly rugged terrain and with low intermediate amounts of scrubland cover (Wiens et al. 2022), which likely broadly describes foraging habitat. Occupancy was also negatively associated with human development (Wiens et al. 2022), likely because eagles avoid urban areas (Tracey et al. 2018; Tracey et al. 2020a), as well as agriculture and some grasslands that are not associated with primary prey species (Marzluff et al. 1997). Perch sites are typically in trees, on cliffs and bluffs, as well as power poles (Katzner et al. 2020), from which they hunt for prey. Eagles also hunt from flight, and require updrafts for efficient flight, either from orographic lift which are predictably found with changes in elevation such as near ridgetops or from thermal soaring (Duerr et al. 2019). Once prey has been captured, eagles can use updrafts to take an indirect route back to the nest with prey by moving first to a location where updrafts would bring them aloft (Dixon 1937), and reduce energy expended.

All movement patterns and selection of habitat are components of an individual's home range area (Burt 1943). A territory is the core defended part of the home range that tends to have nest sites (Steenhof et al. 2017), though the home range and territory can sometimes be similar for golden eagles (Katzner et al. 2020). Both have important implications for spacing and carrying capacity of an area. The boundaries of golden eagle home ranges can be relatively stable over time, even across decades, in the absence of major habitat disturbance and loss (Marzluff et al. 1997; Kochert and Steenhof 2012; Watson et al. 2014). Home range size in the San Diego County region varies by age category (adult or subadult), season and environmental conditions. Mean home range size calculated with autocorrelated kernel density estimates (95% AKDE) was 359.6 km^2 (~138 mi^2) and 50% core areas averaged 59.3 km^2 (~23 mi^2), although there was considerable variability (Thomsen et al. 2025). However, some adult individuals traveled vast distances and then returned, as far north as Canada, east to Wyoming, and south to Mexico (Tracey et al. 2020b; Poessel et al. 2022). The home ranges of adults with territories increased dramatically in size during the 2012-2016 drought as eagles searched further out for prey (Thomsen et al., accepted).

2.4 Diet and Prey

Important prey species for golden eagles throughout their range are predominantly mammals such as squirrels (sciurids) and rabbits (leporids). In San Diego County, this includes California ground squirrels (*Otospermophilus beecheyi*), black-tailed jackrabbits (*Lepus californicus*), and cottontail rabbits (*Sylvilagus* spp). Historic local accounts in southern

California usually describe squirrels as the main prey item for nesting eagles and then rabbits (Dixon 1937). Hoechlin (1976) noted squirrels were the most common and then cottontails, and Hanna (1930) also suggested "ground squirrel is the chief food and rabbits second". Sumner (1929) also described ground squirrels as frequent prey items at a nest in eastern Los Angeles County, California. However, the surrounding habitat likely plays a role. For example, further north in the Coast Range, jackrabbits were the main prey item in nests that were surrounded by open and wide ridge tops and fields, while ground squirrels were the main prey item in nests in more rugged wooded areas (Carnie 1954). In addition, golden eagles are generalists and will consume a wide variety of other prey items, including various birds, mule deer fawns, and more, as well as being opportunistic scavengers of carrion (Olendorff 1976; Bedrosian et al. 2017).

California ground squirrels are therefore important prey for eagles in San Diego County but are also considered a pest species. Ground squirrels create networks of burrows underground which can damage structures and can be destructive to crops, prompting considerable efforts to control them (Quinn and Baldwin 2018). They appear to be very flexible with their habitat requirements, but outside of anthropogenic habitats are generally found in more open landscapes such as grasslands (Smith et al. 2016). However, native grasslands have been replaced by exotic annual grasses throughout California (D'Antonio et al. 2007), and ground squirrels are found less often in tall non-native grass cover that can build up thatch as well as limit sightlines used for spotting predators (Hennessy et al. 2016). Rangelands with grazed grasslands can support ground squirrels for eagles (Hunt et al. 1995), although it depends in part on past and present pest management (Lenihan 2007). Ground squirrels consume herbaceous vegetation during breeding in the spring, and otherwise will eat a variety of seeds and plant parts (Smith et al. 2016). They have large litters and increase in density (Smith et al. 2016), although their population can decline due to drought (Prugh et al. 2018). Historical observations recorded high densities over widespread areas (Grinnell and Dixon 1918), but their current distribution and abundance is likely currently more variable.

Jackrabbits and cottontails are also important prey for golden eagles, but there is evidence of a decline over the last several decades in California (Brown et al. 2018). Both can sometimes be found in the same general habitats as ground squirrels, such as open landscapes with scattered patches of shrubs (Smith et al. 2018), however jackrabbits and cottontails appear to tolerate more arid environments than ground squirrels and their distribution includes the Colorado Desert (Best 1996; Smith et al. 2018). Jackrabbits are not generally found in areas with tall grass (Best 1996), but it has also been suggested that overgrazed rangelands may not support jackrabbits (Simes et al. 2015; Hansen et al. 2017b). Cottontails prefer habitat with a higher density of shrub cover than jackrabbits to avoid predators, while jackrabbits rely more on speed and can run up to 64 km/h when evading predators (Smith et al. 2018). Diet of leporids consists of grasses and forbs, as well as shrub bark, leaves and buds, and cacti (Hansen et al. 2017b; Smith et al. 2018). Jackrabbits can breed nearly year round in the southwest and are capable of producing many

offspring (Best 1996), while cottontails have a shorter breeding season and fewer young per litter (Smith et al. 2018). Increased rainfall can lead to higher densities (Hart et al. 2015), however, population fluctuations can occur from changes in the mortality rate, such as from disease, fire, and drought (Smith et al. 2018).

3. Potential Management Strategies for Specific Threats and Stressors

Golden eagles are impacted by 11 of 13 general categories of MSP threats/stressors in western San Diego County (SDMMP and TNC 2017). The working group identified 18 associated specific threats/stressors potentially affecting golden eagles in San Diego County, and developed potential regional and preserve-level management strategies focused on improving nesting (i.e. mating success/nest productivity, nest and roost site availability), foraging (i.e. prey availability, amount and quality of habitat available), and survival (i.e. mortality of adults and young, recruitment, health and body condition, stress levels; Table 1). Below is a brief summary, compiled by the USGS, of the 18 specific threats/stressors identified by the working group that are potentially impacting golden eagles in San Diego County and the associated potential regional and preserve-level management strategies. Some of the specific threats are grouped together, and both direct and indirect effects of threats and stressors are summarized below.

Table 1. Threats/stressors impacting golden eagle populations in San Diego County as identified by the working group and ordered by Risk Level. See SDMMP and TNC (2017) for more information on MSP threat/stressor categories.

	Management Focus

Specific Threat/Stressor	MSP Threat/Stressor Category	Risk Level**	Mating success/Nest Productivity	Nest and/or roost site availability	Prey availability	Amount of habitat available	Quality of habitat available	Mortality of adults and young/Recruitment	Health/Body condition/Stress levels
			N*	N	F	F	F	S	S
Drought, Heatwaves, Rainfall Variability	Climate Change	High	x	x	x	x	x	x	x
Wildfire	Altered Fire Regime	High	x	x	x	x	x	x	x
Hunting / Illegal Shooting	Hunting / Illegal Shooting	High	x			x		x	x
Recreation	Human Activity	High	x	x	x	x	x	x	x
Invasive Plants	Invasive Plants	High	x		x		x		
Rodenticides	Poison/Pesticides/Contaminants	High	x		x			x	x
Nest Damage / Vulnerable Nest	Habitat Loss	High	x	x			x		x
Habitat Loss	Habitat Loss	High	x	x	x	x	x		x
Urban, Rural, and Energy Development	Habitat Loss	High	x	x	x	x	x	x	x
Lack of Information	Lack of Information**	High	x	x	x	x	x	x	x
Border Activity/Military Activity	Human Activity	Med	x	x	x	x	x		x
Roads / Highways	Roads / Highways	Med	x			x	x	x	x
Transboundary Movement	Transboundary**	Med	x	x	x	x	x	x	x
Interspecific Competitors	Interspecific Competitors	Med	x	x	x	x	x	x	x
Disease / Parasitism	Disease / Parasitism	Med	x		x			x	x
Electrocution / Collision	Infrastructure**	Med	x			x	x	x	
Lead Poisoning	Poison/Pesticides/Contaminants	Low	x					x	x
Other Contaminants	Poison/Pesticides/Contaminants	Low	x					x	x

* Management Focus: N = Nesting; F = Foraging; S = Survival

** Threat/stressor categories that were added by the working group and are not included as an MSP Threat/Stressor

3.1 Climate Change: Drought, Heatwaves, Precipitation Variability

Threat/Stressor Category: Climate Change

Risk Level: High

San Diego County is within a larger regional climate change 'hotspot' (Diffenbaugh et al. 2008), and these climatic changes can be an amplifier for all other threats to golden eagles (Blois

et al. 2013). Among the expected changes include rising temperatures and more frequent heat waves (Jennings et al. 2018), as well as changes to precipitation including both more frequent and intense drought, as well as extreme rainfall events (Diffenbaugh et al. 2015; Swain et al. 2018). There has been an increase in hot droughts (King et al. 2024; Soulé and Knapp 2024), which could potentially lead to physiological issues from dehydration in golden eagles (Albright et al. 2017). Golden eagles may increasingly seek water sources for drinking during the hottest parts of the summer (Finlayson 2021). Nestlings can be particularly vulnerable to the hot sun and can easily die (Beecham and Kochert 1975; Kochert et al. 2019; Steenhof et al. 1997). Human disturbance can then potentially have more severe consequences, even for short periods of time (see Section 3.6 Human Activity). Heat stress may also exacerbate effects of contaminants (Hooper et al. 2013), and noise (Blackburn et al. 2024), and impact cognition (Soravia et al. 2021).

Drought can reduce the abundance of key prey species like ground squirrels and jackrabbits (Hernández et al. 2011; Prugh et al. 2018), which can lead to reduced breeding success (Wiens et al. 2018; Smith et al. 2020). Golden eagles often do not lay eggs or attempt to breed when conditions are poor (Steenhof et al. 1997; Watson 2010). Home range sizes expand during extreme drought as eagles must travel further to find resources (Thomsen et al. 2025). Rising temperatures and decreased rain could lead to increasing prevalence of some diseases (Rogers et al. 2016). Conversely, heavy rainfall during vulnerable nesting stages such as incubation or young nestlings can also be fatal (Anctil et al. 2014). Drought can also contribute to nest tree mortality (Fettig et al. 2019), which can also be exacerbated by invasive insects such as the goldspotted oak borer (GSOB), which has contributed to massive die-offs of oak trees in the County (Coleman et al. 2011).

Regional Level Management Strategies

- Develop a nest and roost restoration strategy for each priority GEMA.

Preserve Level Management Strategies

- Enhance and restore foraging habitat to maintain healthy prey populations by controlling nonnative invasive annual grasses.
- Add supplemental water around nest trees and restore perennial grasslands around nesting locations (Fettig et al. 2019).
- Add carcasses for short term food availability (Gonzales et al. 2006)
- Add wildlife water developments (“water guzzlers”) for prey animals and for eagles (Rich et al. 2019).
- Restore/increase nest and roost ledges and trees following the regional strategy.
- Add shade structures over nests with harsh sun exposure or increase protection from adverse weather to enhance nestling survival (Kochert et al. 2019; Corregidor-Castro et al. 2023).

3.2 Disease / Parasitism

Threat/Stressor Category: Disease / Parasitism
Risk Level: Medium

Golden eagles are affected by several diseases and parasites. Recently, a highly pathogenic avian influenza (HPAI) virus, H5N1, has been circulating amongst wild birds worldwide and was first documented in San Diego County in 2022 (APHIS 2024). This panzootic is highly unusual for avian flu, although thus far it appears to not have impacted golden eagles as much as other wild birds. West Nile virus (WNV) is commonly transmitted by mosquitoes possibly including from the newly invasive *Aedes* sp to San Diego (Rochlin et al. 2019, California Department of Public Health 2024), and can cause neurological issues and death (Wünschmann et al. 2014). Trichomonosis is caused by a parasitic protozoan and can cause oral lesions that can contribute to starvation and suffocation, particularly in nestlings (Dudek et al. 2018). Some ectoparasites like poultry bugs can decrease nest success as nestlings suffer from bites (Dudek et al. 2021). Other possible diseases could include a fungal disease, aspergillosis, and avian cholera (Katzner et al. 2020), although the prevalence of these diseases and parasites are unknown.

Other diseases impact golden eagle prey species in important ways. Rabbit Hemorrhagic Disease (RHDV2) has recently reached the leporid population in California and Mexico (Asin et al. 2022; Lorenzo et al. 2024; Ringenberg et al. 2024), and it along with other diseases like Tularemia (rabbit fever) can rapidly decrease their population (Smith et al. 2018). Ground squirrels are also susceptible to plague which can cause die-offs (Smith et al. 2016). An increase in rock pigeon (*Columba livia*) as a prey item when mammalian prey is scarce can increase Trichomonosis and can decrease nestling survival (Dudek et al. 2018). Rock pigeons and other potential avian prey species like waterfowl could also expose golden eagles to avian flu, as could scavenging on infected carrion as H5N1 increasingly impacts mammal species (Plaza et al. 2024; Eisfeld et al. 2024).

Regional Level Management Strategies

- Utilize local and regional expertise for outreach to pet rabbit owners about RHDV2 and vaccines (Shapiro et al. 2022).
- Utilize local and regional expertise in raptor rehabilitation techniques for golden eagles and conduct disease surveillance (Hagen et al. 2024; Hall et al. 2024).

Preserve Level Management Strategies

- Report suspected cases of RHDV2 to CDFW.
- Improve foraging habitat quality to increase prey availability by controlling invasive nonnative annual grasses and restoring open shrub habitats.
- Add carcasses to increase short term food availability.

- Treat nests found to have poultry bugs (Driscoll 2010).

3.3 Infrastructure: Electrocution / Collision

Threat/Stressor Category: Infrastructure
Risk Level: Medium

Trauma from collisions and electrocutions remain common sources of mortality in the western states (Russell and Franson 2014; Millsap et al. 2022). Collisions are the most common source of mortality for raptors in urban habitats (Dwyer et al. 2018), so this threat is likely to increase with increasing urbanization. Vehicle strikes can happen when eagles scavenge roadkill (Slater et al. 2022), but collisions with wind turbines and wires are also common (Katzner et al. 2020). Powerlines and guy wires for towers may not be obvious to eagles focused on chasing down prey (Olendorff and Lehman 1986; Bernardino et al. 2018). Distribution and transmission powerlines may attract some individuals for perching (Marques et al. 2022), which is an issue for both electrocution and shooting (Thomasen et al. 2023a). The surrounding habitat can influence which locations have an increased risk of electrocution (Dwyer et al. 2014), as well as pole configuration and type of powerlines (APLIC 2006). Subadults and juveniles are more frequently killed by electrocutions than adults (Mojica et al. 2018).

Regional Level Management Strategies

- Work with regional partners to site wind farms outside and away from eagle habitat and use eagle-safe equipment.
- Work with utility providers to continue to retrofit electric poles to prevent electrocutions in priority GEMAs.

Preserve Level Management Strategies

- Follow USFWS guidelines for siting new communication towers and removal of guy wires and abandoned communication towers in priority GEMAs (USFWS 2013).

3.4 Habitat Loss: Nest Damage / Vulnerable Nest

Threat/Stressor Category: Habitat Loss
Risk Level: High

Nests in trees such as coast live oak (*Quercus agrifolia*) or canyon live oak (*Quercus chrysolepis*) are less common than cliff nests overall (Scott 1985) but are vulnerable to multiple

threats. Repeated wildfire, tree disease, invasive beetles, drought and other threats may reduce the distribution of suitable nest trees and threaten existing tree nests (Steinberg 2002; Fettig et al. 2019). Notably in San Diego County, the goldspotted oak borer (GSOB) is an invasive insect that has contributed to massive die-offs of oak trees over the last ~20 years and contributes to drought stress (Coleman et al. 2011). The intense heat from wildfire can also damage the integrity of rock ledges where nests are located (Hunsicker 1972). In addition, with heat waves and hot droughts increasingly common due to climate change (King et al. 2024), nests that have a southern aspect and little protection from the intense sunlight are likely at increased risk of mortality of nestlings or eggs (Kochert et al. 2019; Corregidor-Castro et al. 2023).

Regional Level Management Strategies

- Consider a regional golden eagle rehabilitation program, and potentially a hacking program if low recruitment impacts the persistence of the eagle population in the MSPA (Negro et al. 2007).
- Develop a nest and roost restoration strategy for each priority GEMA.

Preserve Level Management Strategies

- Place shade structures on nests that face south with little shade (Kochert et al. 2019), and/or other methods to increase protection from adverse weather
- Install artificial nest platforms on cliffs to increase availability of alternative nest sites
- Add supplemental water around nest trees and in stands to promote seedling survival and restore perennial grasslands in nesting areas (Fettig et al. 2019).
- Plant oaks in areas impacted by fire and GSOB for future nest sites. Select areas where oaks can be resilient to climate change, especially drought.

3.5 Habitat Loss: Urban, Rural, and Energy Development

Threat/Stressor Category: Habitat Loss
Risk Level: High

Habitat loss, fragmentation, and degradation can occur from multiple causes and be a limiting factor for golden eagles, although urbanization has been cited as one of the biggest drivers in San Diego County (Scott 1985). Indeed, golden eagles strongly avoid urban areas in the region and the probability of habitat use drops substantially within 1.3km to the urban edge (Tracey et al. 2018; Tracey et al. 2020a). Coastal southwestern California is the location of both the San Diego-Tijuana cross border metro as well as the Los Angeles ‘megacity’ (Folberth et al. 2015; SANDAG 2021). The human population is expected to grow throughout the region, leading to continued urban and exurban growth (SANDAG 2021; Figure 4). As housing costs rise in urban centers, the wildland-urban interface (WUI) increases (Greenberg et al. 2024). Even a small, developed area can potentially be detrimental to golden eagles if it leads to human

disturbance (Hansen et al. 2005), and the expanding WUI also contributes to increased wildfire risk (Radeloff et al. 2018). Fire and drought (both also discussed in Section 3.1 and 3.14) can cause both changes to habitat that impacts their prey base as well as damage to nesting trees or cliffs. Habitat loss can occur from other sources as well. Energy development (oil and gas, wind and solar) can result in habitat loss (Katzner et al. 2020), as well as agricultural development such as plantation woodlands and orchards (Dixon 1937). Land use changes like urbanization, agriculture and energy development are generally irreversible (Ojeda-Revah et al. 2008), and therefore contribute to habitat loss and fragmentation. Private lands are at risk for those types of development, and rangelands especially (Liffmann et al. 2000).

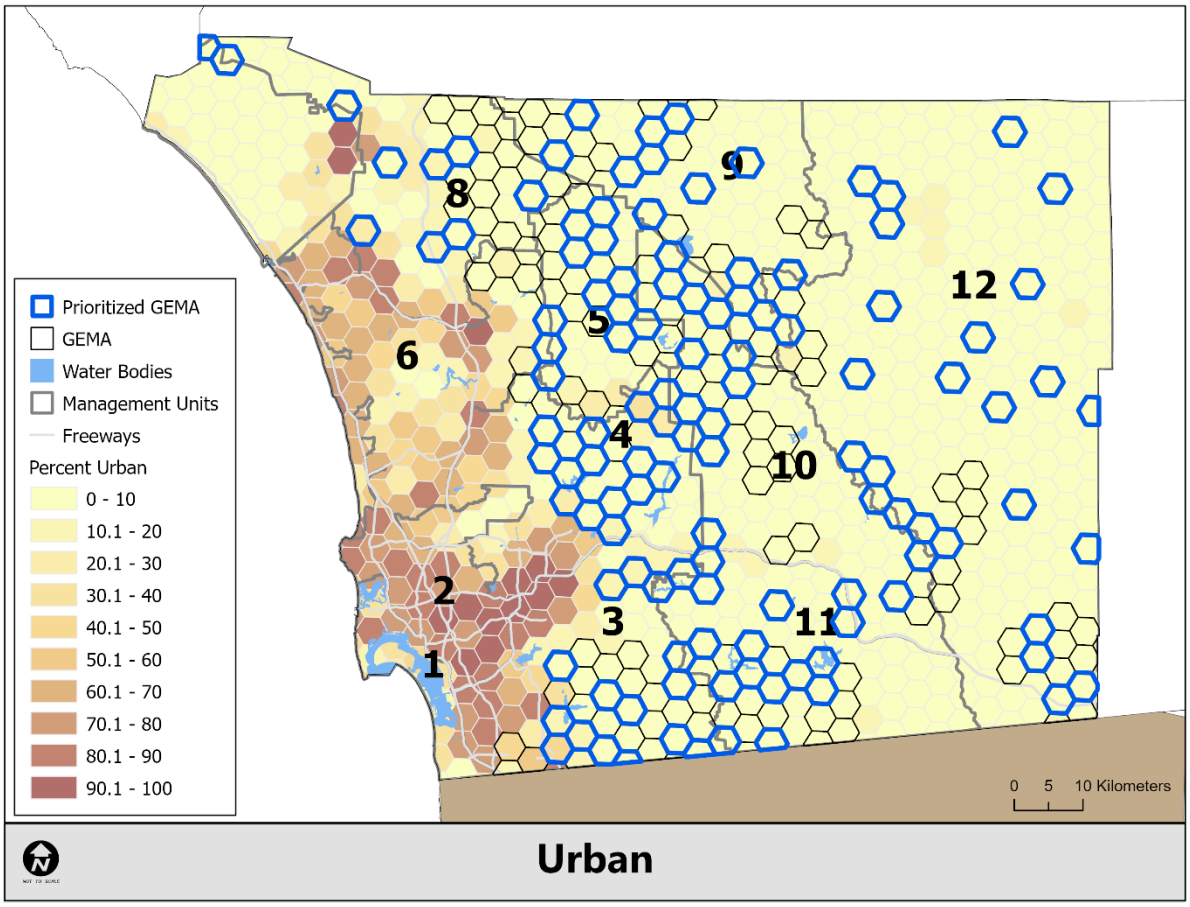

Figure 4. Map of San Diego County showing the percent of urbanized land cover calculated in each hexagon as well as the Golden Eagle Management Areas (GEMAs). Urban land cover data from SANDAG 2019.

Regional Level Management Strategies

- Work with regional partners to purchase/conserve land surrounding high priority GEMAs and foraging habitat
- Facilitate development of additional strategies to protect habitat in areas outside of conserved lands, including more protective zoning for backcountry/undeveloped areas.

Preserve Level Management Strategies

- Work with landowners and managers to site structures to minimize impacts to high priority GEMAs.

3.6 Human Activity: Recreation, Border Activity, Military Activity, Construction, other

Threat/Stressor Category: Human Disturbance
Risk Level: High

Golden eagles are known to be sensitive to human activity of various types, including different kinds of recreation, border activity and military activities, as well as construction activities, use of drones, and more. Proximity to human development, such as nearby housing density, is associated with increased recreational use of reserves (Larson et al. 2018; Figure 5). For all types of disturbance, physiological stress can occur even if no behavioral changes are observed in golden eagles (Gill et al. 2001). Behavioral changes such as flushing from a nest or flying off in response to human activity can be particularly detrimental to a breeding attempt. The sudden movement or prolonged absence may leave a nest with eggs or nestlings vulnerable to overheating, chilling, and accidental ejection from the nest (Fyfe and Olendorff 1976), or even predation in rare cases (Morton and Pereyrabut 2008). Overheating is particularly a concern with nests that have a southerly aspect and with little shade (Corregidor-Castro et al. 2023). Human disturbance can also amplify the effects of competitors like ravens, who can steal prey items from the nest (Brambilla et al. 2004). These impacts can lead to reduced nest success (Boeker and Ray 1971; Steenhof et al. 2014). Human disturbance can also lead to reduced occupancy (Spaul and Heath 2016; Kaisanlahti-Jokimäki et al. 2008), and reduced probability of egg laying (Spaul and Heath 2016). Foraging can also be impacted, and home ranges might increase in size from the disturbance when they move to other areas (Bautista et al. 2004; Perona et al. 2019). Rock climbing, construction activities, and military training might have similar impacts as hiking (Hansen et al. 2017a). Paragliding and recreational drones may have negative effects (Tobajas et al. 2022). People getting out of stopped vehicles was associated with worse impacts than OHV use alone (Spaul and Heath 2016). Human activity along the USA/Mexico border includes both legal and illegal human activities that can be increased near the border within eagle territories (WRI 2010; Wang 2019), including development of unauthorized trail networks used by people on foot and OHV usage (McIntyre and Weeks 2002; Baker and Leberg 2018), both of which can impact golden eagles (Spaul and Heath 2016).

The USFWS Migratory Bird Program recommends a 1-mile (1.61 km) buffer of no disturbance from most types of ground-based disturbance to a golden eagle nest in California,

and 2 miles (3.2 km) for disturbing noises (USFWS 2021). However, these recommendations do not consider either accumulative disturbance or synergistic habitat loss in an urbanizing landscape.

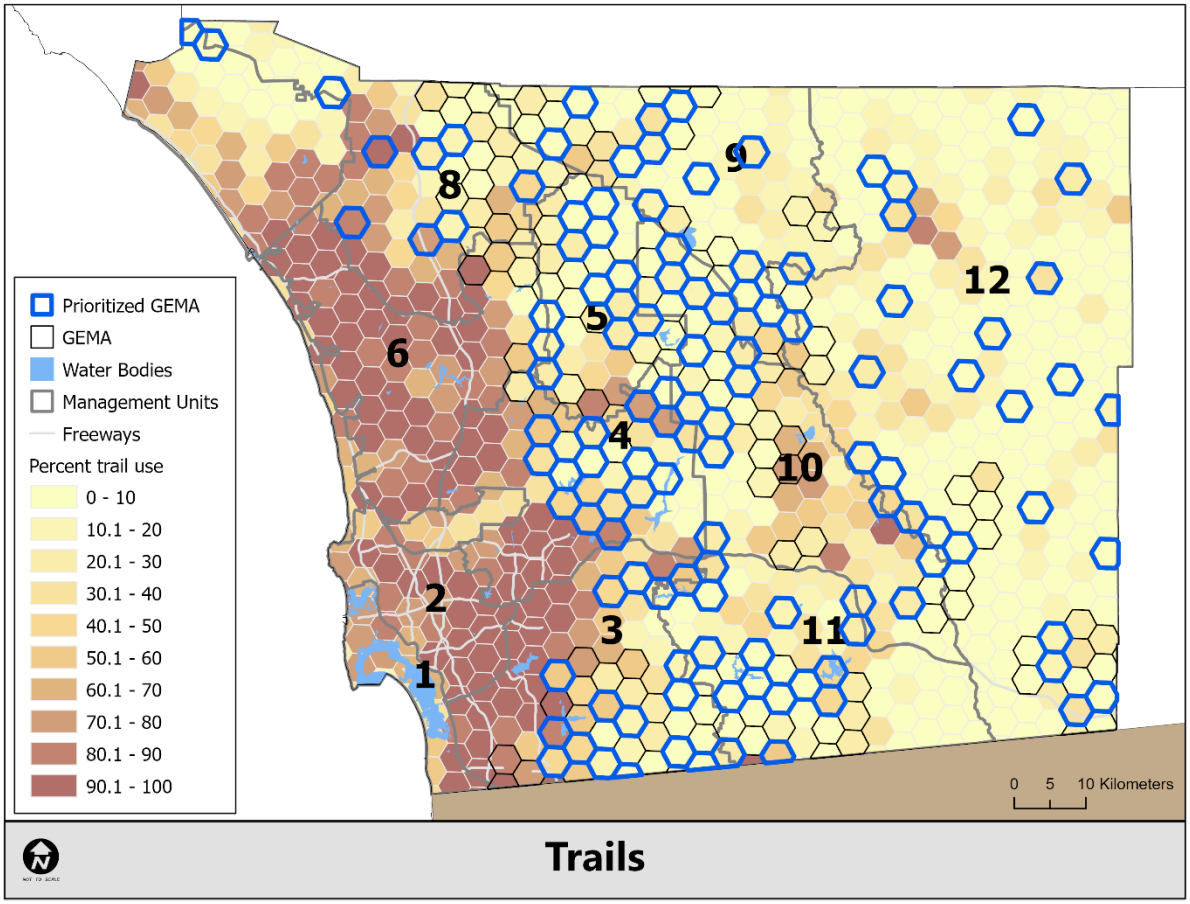

Figure 5. Map of San Diego County showing density of human activity within hexagons as measured by the Strava app (Strava 2024). The proportion of area within each hexagon that is covered by all trails of varying use levels is shown.

Regional Level Management Strategies

- Develop a regional level educational outreach program to reduce human activities near occupied nests.
- Coordinate with land managers regarding recreational trail closures or realignments near nests and foraging habitat.
- Consider further research on regional specific guidelines for buffer zones for various activities in the presence of multiple synergistic threats.
- Consider further research on efficacy of potential enforcement methods around trail closures at preserves (Greer et al. 2017; Schwartz et al. 2018).

- Collaborate with the rock climbing/paragliding communities for potential development of a rock climbing and paragliding management task force, including outreach about seasonal or year-round closures of climbing areas important to golden eagles (Access Fund 2021; Hendrick et al. 2023).

Preserve Level Management Strategies

- When designing trails, consider re-routing them away from priority GEMAs during the nesting season.
- Close trails at priority GEMAs during the nesting season.
- Develop and implement preserve level educational outreach programs.

3.7 Hunting / Illegal Shooting

Threat/Stressor Category: Hunting/ Illegal Shooting
Risk Level: High

Persecution through hunting and shooting at golden eagles remains a common cause of mortality, despite being illegal (Millsap et al. 2022). Many deaths along powerlines may actually be the result of shooting rather than electrocution (Thomason et al. 2023a) and may be either intentional or opportunistic (Thomason et al. 2024). Scott (1985) reported the most common cause of mortality for juveniles was shooting. Roads located along powerlines might lead to areas with more shooting (Thomason et al. 2024).

Regional Level Management Strategies

- Develop a regional level educational outreach program or establish a task force with stakeholders to address the issue (Thomason et al. 2023b).
- Consider a regional golden eagle rehabilitation program.
- Coordinate with transportation agencies, utility providers, law enforcement and the public to report eagle fatalities and their locations and/or establish drop off locations for dead eagles (https://www.fws.gov/program/migratory-bird-permit/living-around-birds#Dropoff)

Preserve Level Management Strategies

- When designing trails, consider re-routing away from priority GEMAs during the nesting season.
- Close trails at priority GEMAs during the nesting season.
- Develop and implement preserve level educational outreach programs.

3.8 Interspecific Competitors

Threat/Stressor Category: Interspecific Competitors
Risk Level: Medium

Despite their large size, golden eagles may compete for prey and nesting sites with other raptors and corvids. Both the peregrine falcon (*Falco peregrinus*) and bald eagle (*Haliaeetus leucocephalus*) populations have increased in California (Latta 2012; Zimmerman et al. 2022). Falcons also nest in cliffs and can be aggressive towards golden eagles (Hays 1987). For the most part, bald eagles have different nesting requirements than golden eagles, but their frequent kleptoparasitism might be an issue (Katzner et al. 2020). Ravens (*Corvus corax*) might also steal food and harass adult eagles (Simes at al. 2017). Although nest predation is very rarely documented by ravens (Morton and Pereyrabut 2008), ravens can visit nests while nestlings are young and steal prey items (Simes et al. 2017).

Regional Level Management Strategies

- Track interspecific competitor populations if found to impact nesting golden eagles in priority GEMAs.
- Develop a nest and roost restoration strategy for each priority GEMA.

Preserve Level Management Strategies

- Improve foraging habitat quality to increase prey availability by controlling invasive nonnative annual grasses and restoring open shrub habitats.
- Add carcasses to increase short term food availability.
- Restore/increase nest ledges and nest trees following the regional strategy.

3.9 Invasive Plants

Threat/Stressor Category: Invasive Plants
Risk Level: High

Invasive non-native annual grasses (such as *Avena* spp and *Bromus* spp) can contribute to an altered fire regime in a feedback loop where habitat can be converted to more invasive grasses (Keeley and Brennan 2012; also discussed below). When invasive grasses are tall and develop a layer of thatch, the habitat becomes less suitable for ground squirrels (Hennessy et al. 2016). Jackrabbits are also less common in habitats with little shrub cover and taller grass (Best 1996).

Regional Level Management Strategies

- Consider a regional nonnative invasive annual grass management program to improve grassland and open shrubland foraging habitat in priority eagle use areas.

Preserve Level Management Strategies

- Improve foraging habitat quality to increase prey availability by controlling nonnative invasive annual grasses and restoring open shrub habitats.
- Add carcasses for short term food availability.

3.10 Lack of Information

Threat/Stressor Category: Lack of information
Risk Level: High

Lack of information, whether too infrequent monitoring or a specific knowledge gap, is a threat to golden eagles. Without adequate knowledge, it can be difficult to accurately assess the impact of threats or prioritize conservation actions effectively (Nicol et al. 2019). Specific knowledge gaps are listed in Section 6 below.

Regional Level Management Strategies

- Work with regional partners to facilitate communication and continued regular working group meetings.
- Coordinate research to address key information gaps.
- Consider a long-term monitoring program to assess population trends and refine conservation strategies.

Preserve Level Management Strategies

- Keep track of specific knowledge gaps and discuss with other stakeholders within and beyond the working group to help develop and coordinate research.

3.11 Poison/Pesticides/Contaminants: Rodenticides, Lead Poisoning, Other Contaminants

Threat/Stressor Category: Poison/Pesticides/Contaminants
Risk Level: High (Rodenticides)
Low (Lead Poisoning and Other Contaminants)

Golden eagles may be impacted by both poisoning and contaminants. Lead poisoning in California may have decreased since a ban on some lead ammunition was implemented (Kelly et al. 2011) but remains a threat to individuals that disperse elsewhere and those that feed on carrion species that the ban doesn't apply to (Herring et al. 2017; Katzner et al. 2024). In California, as of 2019, lead ammunition was banned for all wildlife species except for pellet guns (CDFW 2024). The California ground squirrel is considered an important pest species and is targeted with first- and second-generation anticoagulant rodenticides, such as brodifacoum (Quinn and Baldwin 2018). Exposure can occur from scavenging dead squirrels that die above ground (Whisson and Salmon 2009), or before a slower acting rodenticide causes death (Vyas et al. 2017). Some limitations on rodenticides were implemented in 2020 (California Ecosystems

Protection Act of 2019; Assembly Bill 1788), but it is not clear how enforcement has been applied (Saggese et al. 2024). Lethal and sublethal effects of contaminants can interact with other threats such as causing immunosuppression (Mete et al. 2014). Neurological issues from contaminants could result in vulnerability to trauma from collisions (Herring et al. 2017), or other behavioral changes (Ecke et al. 2017; Grunst et al. 2023). There is also the potential for negative effects from emerging contaminants of concern such as per- and polyfluoroalkyl substances (PFAS; Wu et al. 2020), microplastics (Leviner and Perrine 2023), and some pharmaceuticals (Blanco et al. 2017; Herrero-Villar et al. 2024).

Regional Level Management Strategies

- Consider further research on rodenticides, lead and other contaminants and their impact on golden eagles and their prey.
- Consider a regional golden eagle rehabilitation program.

Preserve Level Management Strategies

- Consider the use of alternative pest control methods that protect nontarget species.
- Improve foraging habitat quality to increase prey availability by controlling invasive nonnative annual grasses and restoring open shrub habitats.
- Add carcasses to increase short term food availability.

3.12 Roads / Highways

Threat/Stressor Category: Roads /Highways
Risk Level: Medium

Roads can be sources of collision risk and mortality for golden eagles scavenging on roadkill (Slater et al. 2022). Roads along powerlines might also increase the risk of shooting (Thomason et al. 2024). Eagles may avoid some roads on days with increased traffic (Bautista et al. 2004). Roads may therefore facilitate human disturbance and development into sensitive areas, contribute to habitat fragmentation, and spread of invasive species (Forman and Alexander 1998).

Regional Level Management Strategies

- Work with regional partners to consider siting roads and highways outside of priority GEMAs.

Preserve Level Management Strategies

- Move roadkill further off sides of roads.
- Close unnecessary roads.

- Reduce speed limits on roads and add educational signage in priority GEMAs.

3.13 Transboundary Movement

Threat/Stressor Category: International and State boundaries
Risk Level: Medium

Golden eagles can fly from San Diego County across multiple state boundaries and into Mexico and back again (Tracey et al. 2017; Tracey et al. 2020b). This results in eagles moving through multiple locations that can have different laws and regulations regarding a variety of threats than in California. This connectivity also goes both ways, as some migratory populations that breed elsewhere could also move through the county. Golden eagle territories along both sides of the U.S.-Mexico border may be particularly vulnerable to potential differences and disturbance related to human activity along the border (De León-Girón et al. 2016). Golden eagles are listed as threatened at the national level in Mexico (SEMARNAT 2019). Many of the same threats to golden eagles also exist in Mexico, including land use change, contaminants and poisoning, shooting, electrocution, and low recruitment (SEMARNAT and CONANP 2008). This has led to increasing concern for golden eagles in Mexico, as there is relatively little protected habitat in Baja for golden eagles (D'Addario et al. 2019). Increasing aridity is likely to reduce suitable habitat over the next few decades in Mexico (Gama-Rodríguez et al. 2024).

Regional Level Management Strategies

- Work with stakeholders and partners to develop binational cooperation on eagle management and monitoring.
- Cooperate on data collection protocols if projects are developed on eagles in northwestern Baja California.

Preserve Level Management Strategies

- Keep track of specific threats that are unique to eagle territories along the U.S.-Mexico border and discuss with other stakeholders within and beyond the working group.

3.14 Wildfire

Threat/Stressor Category: Altered Fire Regime
Risk Level: High

Wildfires in southern California are a complex issue and can impact golden eagles both directly by mortality (Millsap et al. 2022), and indirectly by influencing habitat and prey availability (Figure 6). Fires could also destroy nest trees (Franklin et al. 2006) or weaken cliff ledges that support nests which can collapse (Hunsicker 1972). Fires have become more frequent

and larger in California (Syphard et al. 2018). In southern California, the month of March has become increasingly dry (Swain et al. 2018), and the summer dry season has been lasting longer until November, which contributes to extending the fire season (Luković et al. 2021). This results in fire season overlapping more with the Santa Ana winds that can drive extreme fires that grow quickly (Swain 2021).

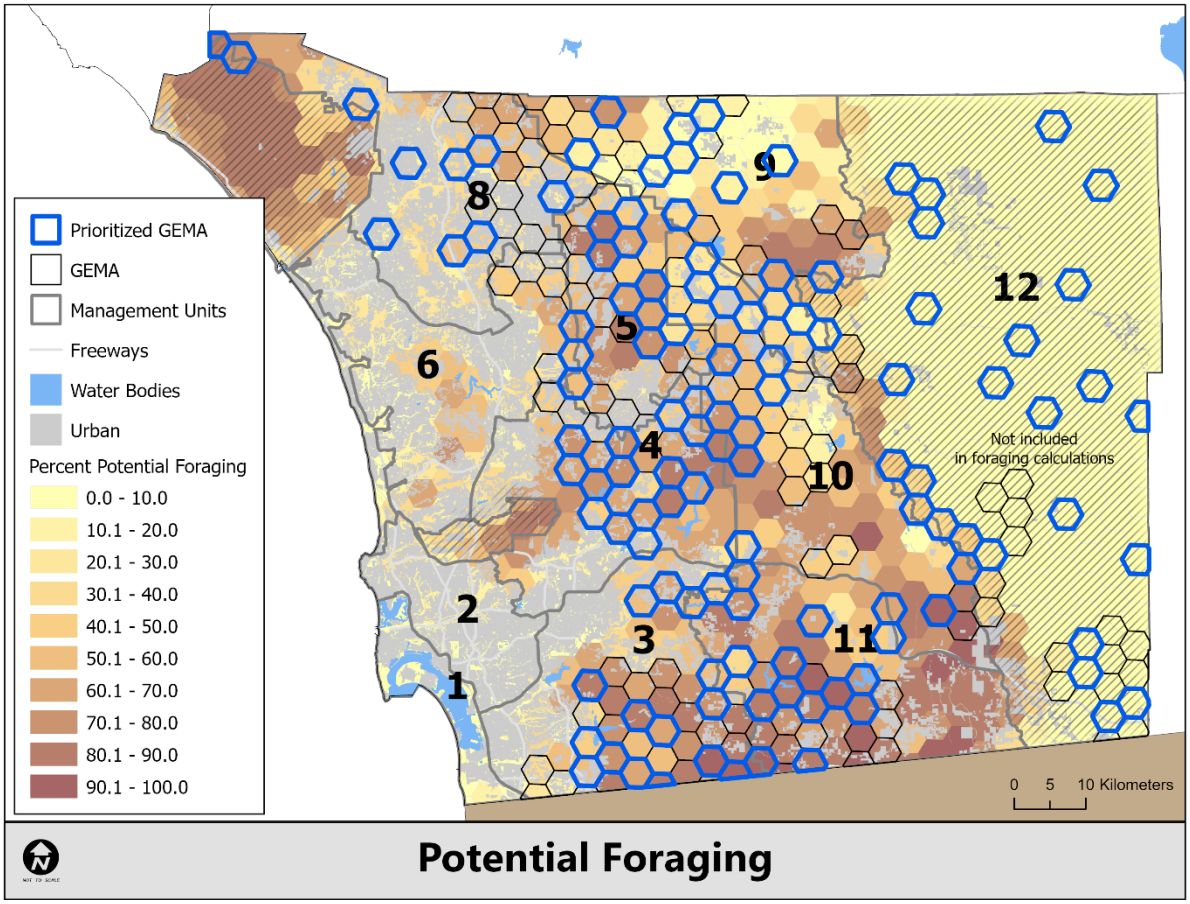

Figure 6. Map of San Diego County and the proportion of potential foraging habitat for golden eagles withing hexagons. Potential foraging habitat was defined as shrub- or herbaceous-dominated vegetation types that had less than 50% shrub or tree cover as determined with LIDAR (FRAP 2016; Perkins and Kus 2022).

Fires can quickly burn habitat across several eagle territories (Watson et al. 2020), and many of the prioritized GEMAs have burned at least once over a 30-year period (Figure 7). Increased frequency and severity of drought can lead to vegetation dieback that possibly contributes to fire severity (Keeley et al. 2022). The resulting mortality of shrub and tree cover from high severity fires can result in type conversion from shrub dominated vegetation to non-native grasses (Syphard et al. 2022), and non-native grass can result in more frequent fire in a positive feedback loop (Keeley and Brennan 2012). Tall non-native grass cover might not support ground squirrels or jackrabbits (Best 1996; Hennessy et al. 2016). A wildfire that destroyed jackrabbit habitat in Idaho led to some territory abandonment and decreased nest

success that did not improve for a decade (Kochert et al. 1999). The decrease in mammalian prey can lead to an increase in avian prey that can be disease vectors and lead to reduced nest success (Heath et al. 2021). Human related ignitions start most fires in San Diego County (Syphard et al. 2007), therefore reducing those ignitions particularly during bad fire weather could help reduce impacts to golden eagle habitat (Keeley et al. 2021).

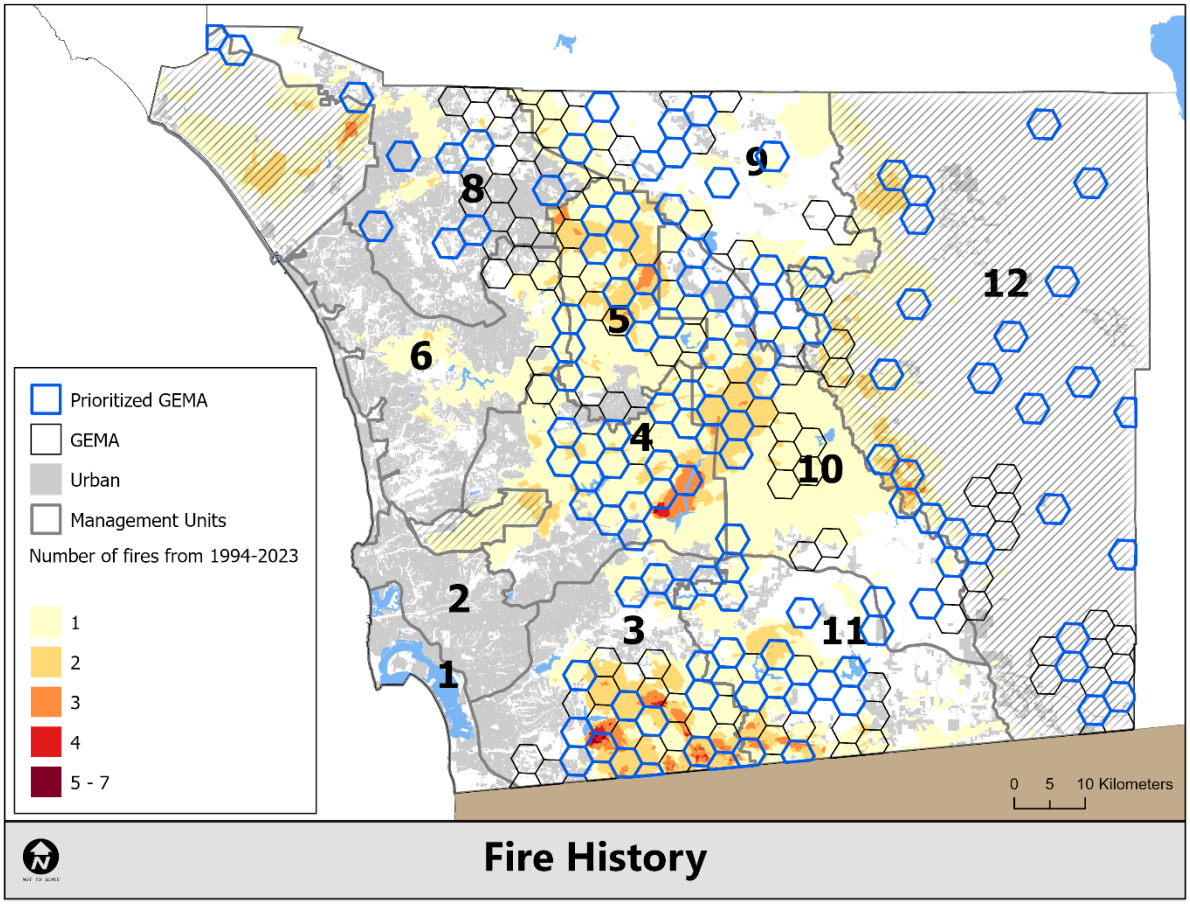

Figure 7. Map of San Diego County and the number of fires over a 30-year period (1994-2023). Data from CalFire (2022).

Regional Level Management Strategies

- Work with utility providers to reduce fire risk potential at priority GEMAs (such as steel poles, underground lines, and covered conductors).
- Reduce fire ignition risk in GEMAs by hardening roads, restricting use of power equipment during high fire risk conditions, and strategic use of fuel management zones.
- Develop a nest and roost restoration strategy for each priority GEMAs.

- Consider a regional golden eagle rehabilitation program, and potentially a hacking program if low recruitment impacts the persistence of the eagle population in the MSPA (Negro et al. 2007).
- Consider a regional invasive nonnative annual grass management program to reduce fire risk from flashy fuels.
- Share locations such as cliffs and ridges where nests might be located as places to avoid dumping aerial retardant.

Preserve Level Management Strategies

- Establish nest site protective zones to prevent inadvertent fire starts by equipment.
- Improve foraging habitat quality to increase prey availability and reduce flashy fuels by controlling nonnative invasive annual grasses and restoring open shrub habitats.
- Add carcasses to increase short term food availability.
- Restore/increase nest and roost ledges and trees in GEMAs affected by wildfire.
- Add wildlife water developments or “water guzzlers” for prey animals (Rich et al. 2019).

4. Threats to Prioritized Golden Eagle Management Areas

Summary of Areas Identified for Management

The golden eagle was historically found in all 12 MUs. Currently, golden eagles are considered extirpated from territories along the San Diego County coast in MUs 1, 2, 6 and 7. We identified 56 GEMAs which represent prioritized golden eagle nesting and foraging resources to be managed. Prioritized GEMAs were selected primarily based on evidence of recent historical or current use based on available evidence given gaps in monitoring and differences in methodology among golden eagle stakeholders. The GEMA approach is intended to be comprehensive yet flexible, despite being a non-random sample, so that selection of a prioritized GEMA can change at any time with better information and could be updated with subsequent revisions of this document. The longstanding use of territory names for identification, usually loosely based on general geographic place names instead of precise locations can lead to confusion among golden eagle stakeholders, which is exacerbated by alternative nests, shifting territory boundaries, and insufficient monitoring. The hexagon system is intended in part to overcome those challenges (also see Wiens et al. 2017).

Each prioritized GEMA typically encompasses at least one nest location and potential alternative nests. However, hexagons are only 13.9 km^2 in area, which is about a quarter of the average core home range of 59.3 km^2 calculated with AKDE (Thomsen et al. 2025). Therefore, although a representative hexagon (HexID) is selected for a GEMA, adjacent hexagons are also just as important as they likely have important potential foraging habitat as well as possible alternative nest sites. Alternative nests are sometimes located near a boundary between neighboring hexagons, so a cluster of hexagons may be part of the same underlying golden eagle territory whether it is displayed on the maps below or not. Portions of historically occupied territories can still hold important resources to remaining eagles (Marzluff et al. 1997; Kochert and Steenhof 2012; Watson et al. 2014), either for foraging, perching or access to predictable updrafts that reduce reliance on energetically expensive flapping flight (Katzner et al. 2020). Alternative nests can be re-occupied sometimes decades after the last previous documented use (Kochert and Steenhof 2012). We also have added a few additional GEMAs based on seven years of golden eagle GPS tracking data (Tracey et al. 2016; Tracey et al. 2017; Tracey et al. 2020; Thomsen et al. 2025). To identify these areas to include as a GEMA, the Optimized Hot Spot Analysis tool in ArcGIS Pro v3.2 was used identify statistically significant areas of clustering (high use areas) based on the Getis-Ord Gi* statistic with the GPS tracking data.

For each MU described below, we include a map that displays the prioritized GEMAs in blue along with the corresponding HexID number, as well as the adjacent hexagons outlined in black that may have additional important habitat. Where possible in the threat matrix

descriptions below, it was noted if a location in the GEMA has been documented to be associated with nesting eagles for nearly 100 years or more. Names of historic territories are included when available for convenience and posterity, but the HexID is the official designation of a GEMA to avoid confusion. To help navigate the maps, note that the HexID number increases by one from left to right from the apex on the right side of a hexagon. The list of threats within each GEMA below was generated from participants in the working group using a semi-structured expert elicitation process (Yamada et al. 2003), in combination with the GIS-based decision support tool described in Section 1.

As mentioned in Section 1.3, the steps below can be used as a guide to identify potential management strategies for golden eagles in San Diego County.

1. After reviewing the list of threats and potential management strategies above in Section 3, locate the prioritized Golden Eagle Management Area and review the list of threats/stressors.
2. Determine which threats/stressors were identified at the location and the rankings of those threats/stressors. In general, managing higher priority threats first may be more effective for long-term resilience.

4.1 Management Unit 3

MU3 General Characterization

MU3 covers 215,567 acres and is one of four MUs that border Mexico (Figures 1 and 7). This MU has the Sweetwater and Lower Otay Reservoirs and watersheds of the Sweetwater, Otay, and Tijuana River. MU3 has more urban and rural development to the east and north but also has some larger areas of undeveloped landscapes to the southeast. Habitat within conserved lands consists of coastal sage scrub (43%), chaparral (35%), and grasslands (11%; SDMMP and TNC 2017).

Important preserves and landowners in the MU include:

- Bureau of Land Management lands, BLM (25,255 acres)
- San Diego National Wildlife Refuge, USFWS (11,347 acres)
- Hollenbeck Canyon Wildlife Area, CDFW (6,112 acres)
- Rancho Jamul Ecological Reserve, CDFW (5,724 acres)

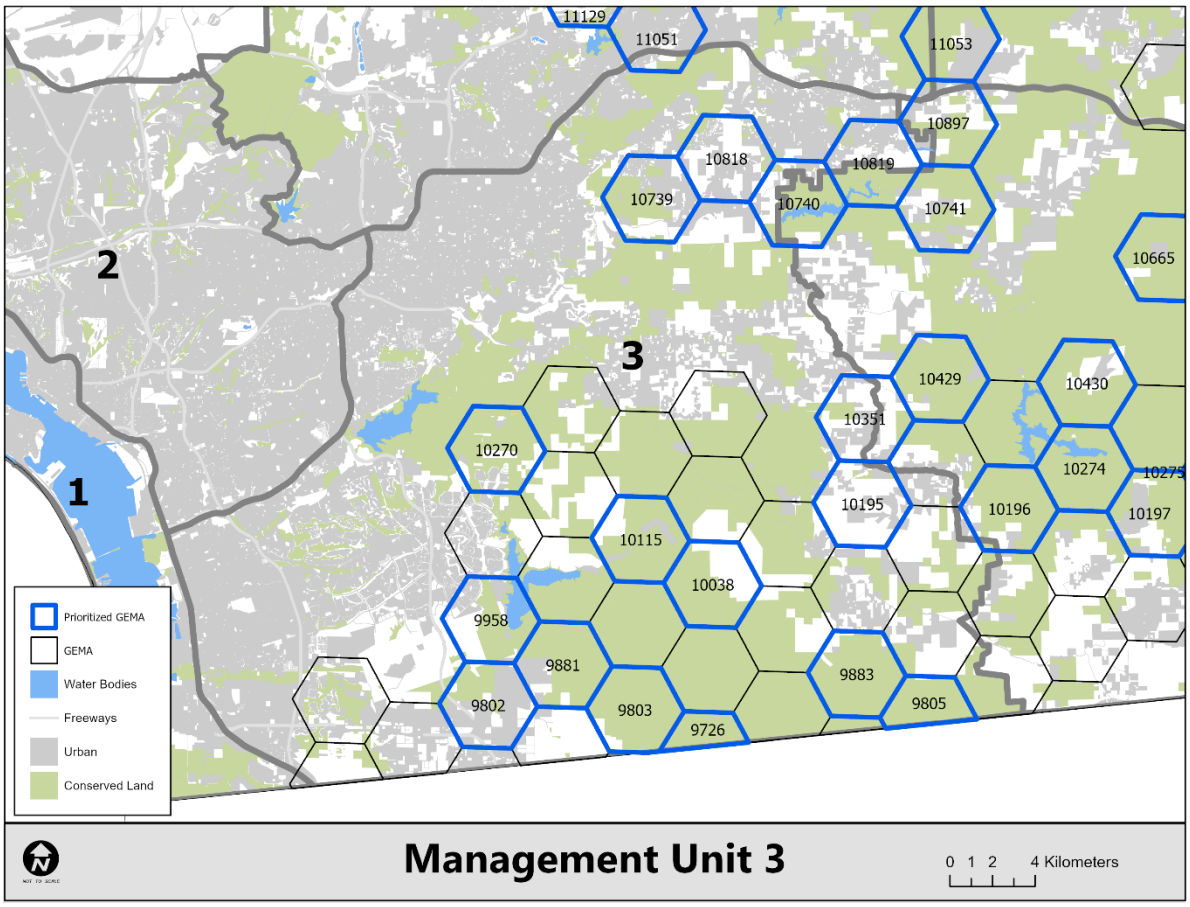

Figure 8. Golden Eagle Management Areas in Management Unit 3. Data from SDMMP 2024, County of San Diego 2000, and SANDAG 2019.

MU3 Golden Eagle Management Areas

MU3 Cedar Canyon HexID: 10038

This GEMA has cliff sites. Important potential foraging areas could include the lower northwest slopes of Otay Mountain Wilderness Area and BLM lands.

Known and potential threats present include:

Threat Level: High

- **Wildfire** – fires are a concern as all of the surrounding habitat has burned 1 to 3 times
- **Invasive plants** – large areas of non-native grass on slopes facing Otay Lakes and Otay Lakes Road
- **Recreation** – there are high use hiking trails in the area
- **Habitat loss / urban development** – development of Otay Ranch Village

Threat Level: Medium

- **Human Activity** – this area is potentially highly impacted along the USA/Mexico border
- **Transboundary –** eagle activity in this GEMA extends into Mexico

MU3 Copper Canyon HexID: 9726

This GEMA overlaps the US-Mexican border but multiple cliff sites are within San Diego County some of which have had documented historic use as far back as 1925. Potential foraging in South Otay Mountain, Mexico BLM lands

Known and potential threats present include:

Threat Level: High

- **Wildfire** – nearly all of the surrounding area has burned, some areas 2 or more times
- **Nest damage / Vulnerable nest** – nest sites burned in the 2003 fire

Threat Level: Medium

- **Human Activity** – this area is potentially highly impacted by activity along the USA/Mexico border
- **Transboundary –** eagle activity in this GEMA extends into Mexico

MU3 Lyon's Peak HexID: 10351

This GEMA has cliff nest sites and has had documented use since 1898. Foraging areas might be Hollenbeck Canyon Wildlife Area, Rancho Jamul Ecological Reserve, and private lands.

Known and potential threats present include:

Threat Level: High

- **Habitat loss / urban development** – roads and rural development on all sides of Lyon's Peak and more development planned. Private lands surround a small conserved area
- **Wildfire** – most of the habitat nearby the nesting area has burned
- **Invasive plants –** non-native grass cover is present in potential foraging areas

Threat Level: Medium

- **Roads –** roads surrounding all sides of Lyon's Peak
- **Infrastructure –** there are distribution powerlines in the area

MU3 Marron Valley (N2) HexID: 9884

This GEMA has cliff sites for nests. Potential foraging might be in Marron Valley, BLM land, and private lands.

Known and potential threats present include:

Threat Level: High

- **Wildfire** – nearly all of the habitat nearby has burned at least 2 times or more.
- **Invasive plants –** high cover of invasive nonnative annual grasses nearby

Threat Level: Medium

- **Human Activity** – this area is potentially highly impacted by activity along the USA/Mexico border.
- **Transboundary –** eagle activity in this GEMA extends into Mexico.
- **Competitors** – peregrine falcons have recently used a nest site in this GEMA

MU3 O'Neal Canyon (N2) HexID: 9881

This GEMA has cliff nest sites and possible foraging locations on Otay Mountain and Southwest Otay Mountain.

Known and potential threats present include:

Threat Level: High

- **Recreation** – there are relatively high use hiking trails in the area; and rock climbing
- **Invasive plants** – high abundance of invasive nonnative grass cover
- **Wildfire** – nearly all of the habitat near the nesting area burned at least 2 times.
- **Hunting / shooting** – there is a target practice nearby
- **Nest damage / Vulnerable nest** – small and/or unstable nest cliffs
- **Habitat loss / urban development** – recent industrial development, including roads linking new port of entry. Proposed quarry as well as a proposed landfill.

Threat Level: Medium

- **Human Activity** – this area is potentially highly impacted by activity along the USA/Mexico border.
- **Transboundary –** eagle activity in this GEMA probably extends into Mexico

MU3 San Miguel Mountain1 (002) HexID: 10270

This GEMA has cliff sites that have had documented historical use since the 1900s. San Miguel Mountain, San Diego National Wildlife Refuge and San Diego National Wildlife Refuge and in Proctor Valley.

Known and potential threats present include:

Threat Level: High

- **Recreation** – there are relatively high use recreation trails in the area (dirt bikes)
- **Invasive plants** – high abundance of invasive nonnative grass cover
- **Wildfire** – nearly all of the habitat near the nesting area burned 2 or more times
- **Hunting / shooting** – there may be hunting in the area
- **Nest damage / Vulnerable nest** – nest sites were affected by previous fires and destroyed. Artificial nest platforms were added at this site but their placement could be reassessed
- **Habitat loss / urban development** – there is quite a lot of development in the wider area

Threat Level: Medium

- **Human Activity** – this area is potentially highly impacted by activity along the USA/Mexico border.
- **Roads** – a number of roads in the area
- **Infrastructure** – both transmission and distribution lines are present nearby

MU3 Tecate Peak HexID: 9885

This GEMA has cliff ledge sites and documented use since 1970. Potential foraging areas include Tecate Peak and Southwest and Northeast of Tecate Peak, Tecate Peak north across Potrero Creek and east to Tecate Road.

Known and potential threats present include:

Threat Level: High

- **Recreation –** high levels of human recreational trail use
- **Wildfire –** nearly all of the habitat nearby nesting area has burned and some twice

Threat Level: Medium

- **Human Activity** – this area is potentially highly impacted by activity along the USA/Mexico border
- **Transboundary –** eagle activity in this GEMA probably extends into Mexico
- **Competitors** – ravens and other raptors are present in this area

4.2 Management Unit 4

MU4 General Characterization

MU4 is 188,199 acres in size (Figure 8). This MU has the San Diego River and five reservoirs, the San Vicente, El Capitan, Murray, Miramar, and Lake Powell. MU4 is characterized by urban and rural development towards the west and gets more undeveloped to the east. Habitat within conserved lands consists of coastal sage scrub (28%), chaparral (57%), grassland (4%), and oak woodland (2.2%; SDMMP and TNC 2017).

Important preserves and landowners in the MU include:

- Cleveland National Forest (CNF), USFS (12,414 acres)
- Canada de San Vicente, CDFW (4,731 acres)
- El Capitan Reservoir Open Space, City of San Diego (6,001 acres)
- Mission Trails Regional Park/Cowles Mountain, City of San Diego (3,581 acres)

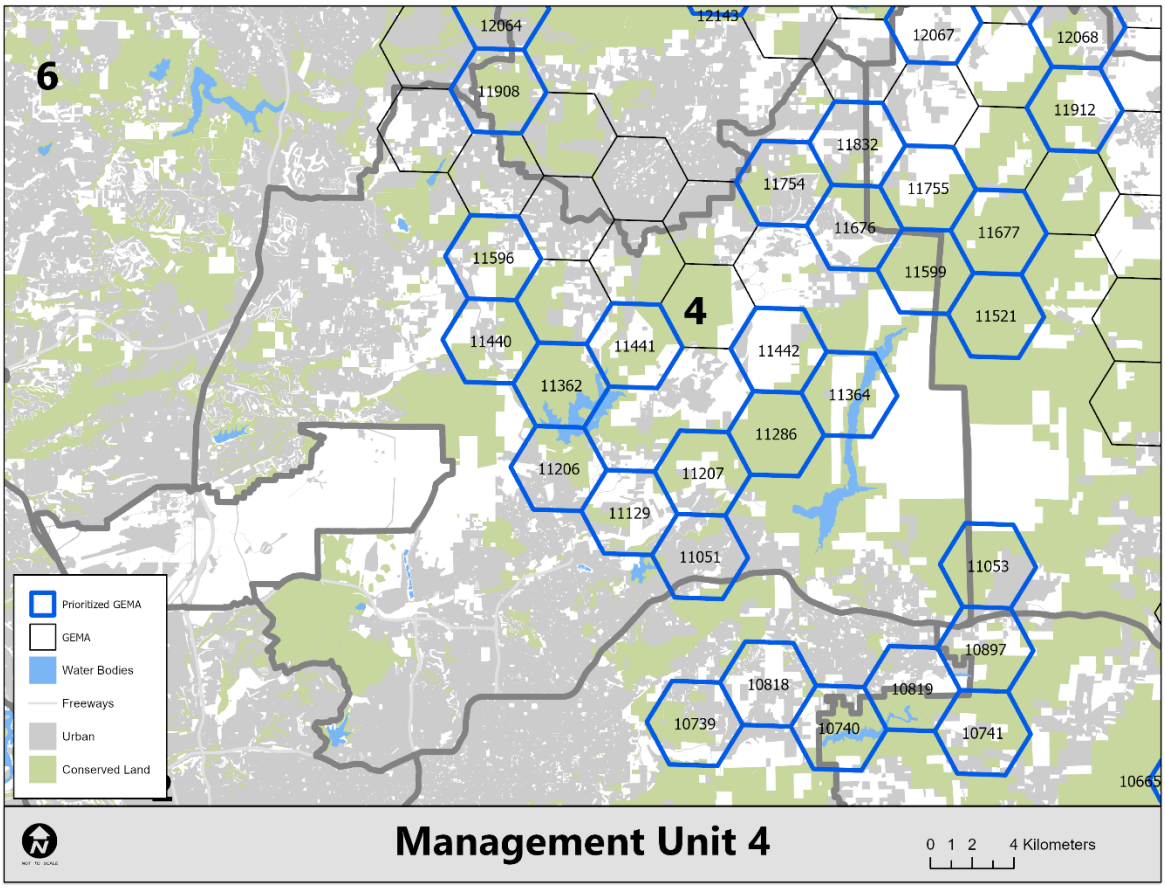

Figure 9. Golden Eagle Management Areas in Management Unit 4. Data from SDMMP 2024, County of San Diego 2000, and SANDAG 2019.

MU4 Golden Eagle Management Areas

MU4: El Cajon Mountain HexID: 11286

This GEMA contains multiple cliff nest sites and has documented historic use since 1918. Foraging habitat could include El Cajon Mountain Preserve, and potentially west of San Diego River Gorge including El Capitan Preserve and El Capitan Reservoir Open Space.

Known and potential threats include:

Threat level: High

- **Recreation** – popular hiking trails are nearby. Paragliders coming from the south, soaring over nest site. Rock climbing on El Cajon Mountain - users accessing through San Diego River Park, City of San Diego and USFS properties.
- **Wildfire** – most of area surrounding nest has burned at least once

- **Habitat loss/Urban development** – rural development to the south of territory, north of San Diego River. There is urban development below nests sites on ridges across from nests and in El Monte Valley that could have edge effects with previous plans for golf course development.
- **Hunting –** hunting may occur in the area although it is not allowed on El Capitan Preserve County of San Diego Department of Parks and Recreation
- **Invasive plants –** areas with high cover of invasive grasses, particularly fountain grass covering south facing slopes above El Monte Valley.

Threat Level: Medium

- **Competitors** – peregrine falcons have been observed to the east

MU4 Gower Mountain HexID: 11676

This GEMA has cliff nests and perhaps had a tree nest. Potential foraging habitat may be in the CNF and adjacent private open space.

Known and potential threats include:

Threat Level: High

- **Recreation –** hiking trails are present on Mt. Gower Preserve. Paragliders; impacts to nest documented. Rock climbing nearby.
- **Habitat loss/Urban development –** adjacent to San Diego Estates

Threat Level: Medium

- **Competitors** – interspecific competitors have been observed

MU4 Iron Mountain HexID: 11596

This GEMA has limited cliff nests and potential tree nesting sites and has had documented historic use since 1906. Potential foraging habitat may be located on Iron Mountain, Boulder Oaks Preserve, and San Vicente Highlands Open Space.

Known and potential threats include:

Threat Level: High

- **Recreation –** very popular hiking trails located nearby. Rock climbing very close to nesting cliffs.
- **Wildfire** – most of the surrounding area has burned once or twice, including the 2003 Cedar Fire.
- **Invasive plants** – some invasive non-native grass cover
- **Habitat loss/ urban development** – Housing development is within 2km

Threat Level: Medium

- **Competitors** – interspecific competitors have been observed
- **Infrastructure** – Powerlines nearby are risks for electrocution and collision

MU4 Kimball Valley HexID: 11597

This GEMA has cliff ledges, access to nearby water sources and potential foraging areas in Canada San Vincente, Barrett Ranch Preserve and Luelf Pond / Holly Oaks Preserve. There is also a water resource to the north on private lands.

Known and potential threats include:

Threat Level: High

- **Recreation** – Hiking trails near foraging areas
- **Hunting** – hunting on nearby CDFW lands
- **Invasive plants** – tall invasive grasses in Barrett Ranch

Threat Level: Medium

- **Infrastructure** – Powerlines are present in this GEMA

MU4 Rock Mountain HexID: 11364

This GEMA has cliff ledge sites and has potential foraging habitat in El Capitan Reservoir Open Space, Cleveland National Forest west of SD River Gorge and north of Rock Mountain.

Known and potential threats include:

Threat Level: High

- **Wildfire –** much of the surrounding area has burned three times
- **Habitat loss / urban development –** private land and development is encroaching northwest of nest

MU4 San Vicente HexID: 11441

This GEMA has cliff ledge sites and potential tree nest sites and has documented historic use since the 1920s. Potential foraging habitat includes along edges of San Vicente Reservoir and to the northeast at Canada de San Vicente and Barnett Ranch Preserve.

Known and potential threats include:

Threat Level: High

- **Wildfire** – nearly all of the area nearby has burned once
- **Habitat loss / urban development –** some urban development nearby
- **Invasive plants –** some large areas of potential foraging habitat have high invasive nonnative annual grass cover
- **Recreation** – waterskiing and wakeboarding below nest sites
- **Nest damage / Vulnerable nest** – tree nest is vulnerable to fire and other threats

Threat Level: Medium

- **Infrastructure** – powerlines are present in this GEMA

MU4 Viejas Mountain HexID: 11053

This GEMA has cliff ledge sites clustered together and potential foraging habitat located in Viejas Mountain on Cleveland National Forest lands.

Known and potential threats include:

Threat Level: High

- **Wildfire –** all of the surrounding area nearby has burned once
- **Habitat loss/urban development** – residential development nearby
- **Recreation –** unauthorized popular hiking trail nearby

4.3 Management Unit 5

MU5 General Characterization

MU5 is 117,274 acres in size (Figure 9). This MU includes the Sutherland Reservoir and the headwaters of Guejito Creek as well as the San Dieguito and the San Luis Rey Rivers. Much of MU5 is relatively undeveloped. Habitat within conserved lands include small amounts of coastal sage scrub (1%), grassland (7.5%), and oak woodland (4%), but is mostly chaparral (69%; SDMMP and TNC 2017).

Important preserves and landowners in the MU include:

- Cleveland National Forest, USFS (18,744 acres)
- Hellhole Canyon Preserve, County of San Diego (5,112 acres)
- Pamo Valley, City of San Diego (3,889 acres)
- Ramona Grasslands Preserve, County of San Diego (3,491 acres)

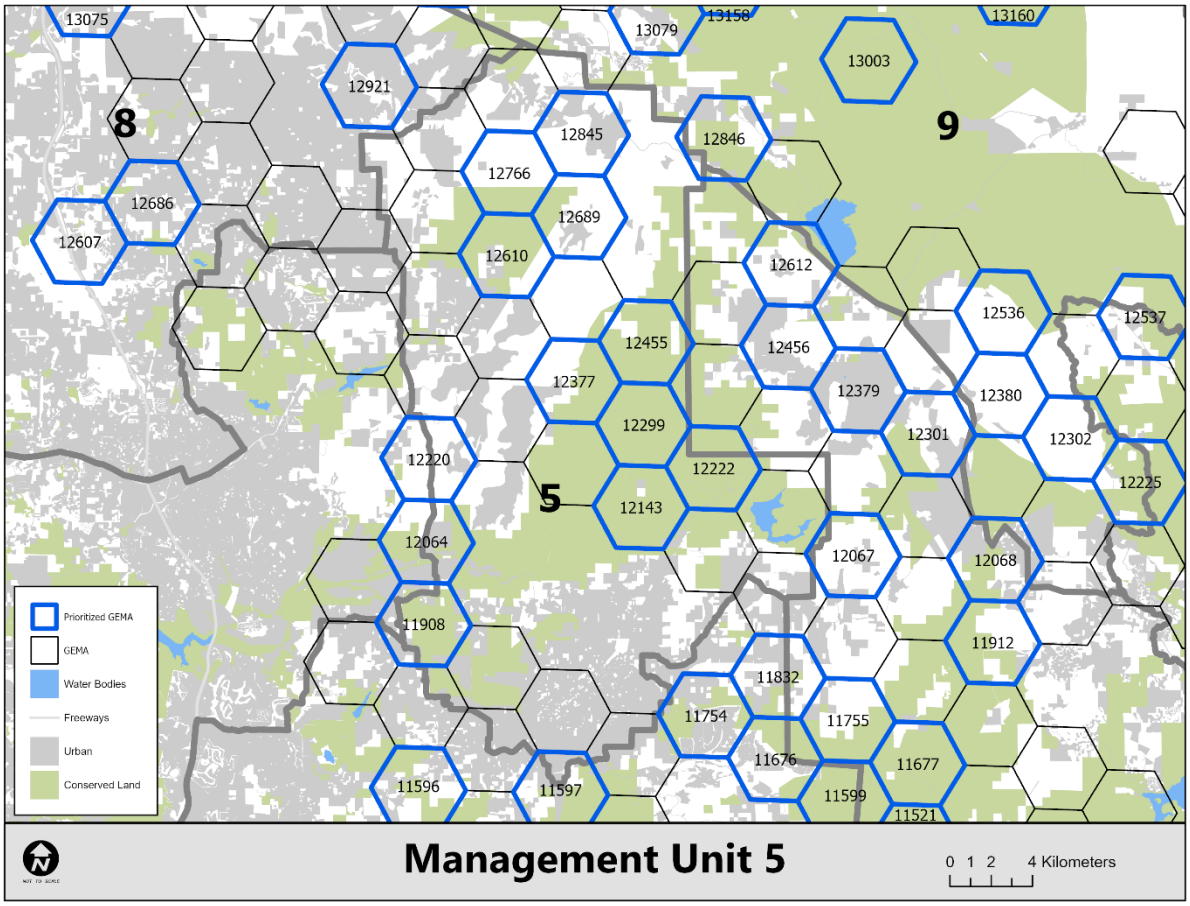

Figure 10. Golden Eagle Management Areas in Management Unit 5. Data from SDMMP 2024, County of San Diego 2000, and SANDAG 2019.

MU5 Golden Eagle Management Areas

MU5 Bandy Canyon HexID: 11908

This GEMA has cliff ledge nest sites and potential tree nests in a historic site with documented use since 1895. Known foraging areas include the Ramona Grasslands Preserve which is grazed and has ground squirrels.

Known and potential threats include:

Threat Level: High

- **Recreation** – Active hiking trail system in small portion of foraging area is open to public and other recreational trails seasonally open very close to nest sites. Rock climbing activity near nests on private lands.
- **Wildfire** – all of the area nearby has burned several times. Last fire in 2007 burned all historical nests.
- **Habitat loss** – nests are located on private lands with residential development nearby
- **Invasive plants** – high levels of non-native grass, although grazing maintains habitat for ground squirrels

- **Rodenticides –** rodenticide use is suspected in the area

Threat Level: Medium

- **Competitors** – bald eagles are present

MU5 Intake (San Luis Rey River) HexID: 12845

This GEMA has cliff ledge sites and has documented history of use since the 1920s. Potential foraging habitat on San Luis Rey River Gorge, Cuca Ranch, La Jolla Reservation and Hellhole Canyon Preserve and Cleveland National Forest.

Known and potential threats include:

Threat Level: High

- **Wildfire –** nearly all of the surrounding area nearby has burned once and some of it twice
- **Habitat loss / urban development –** rural development at Cuca Ranch. Nest sites are on private lands.
- **Nest damage / Vulnerable nest –** limited space in cliff cave for nesting materials

MU5 Lower Gorge (San Luis Rey River) HexID: 12766

This GEMA has cliff ledge sites and has documented history of use since the 1920s. Potential foraging habitat is on Rincon Reservation and private lands to the west and in the river gorge, as well as Hellhole Canyon Open Space to the south.

Known and potential threats include:

Threat Level: High

- **Wildfire –** much of the area nearby has burned once or twice. Last fire occurred in 2007
- **Habitat loss / urban development –** Nest area is on tribal lands and there is housing close by to the west. This GEMA has very little conserved lands within it.
- **Hunting –** recreational shooting occurring on adjacent federal and tribal lands
- **Recreation –** unauthorized off-road motorized vehicles driving along the southern border of Hellhole Canyon Preserve
- **Invasive plants** – observed in Hellhole Canyon Preserve properties

MU5 Pamo Gap/Black Canyon HexID: 12222

This GEMA has cliff nest sites and potential tree nests. Potential foraging habitat may include southern Pamo Valley and Black Canyon in City of San Diego and Cleveland National Forest. Foraging habitat in Pamo Valley includes grazed areas that support ground squirrels.

Known and potential threats include:

Threat Level: High

- **Wildfire –** much of the surrounding area has burned a few times
- **Recreation –** popular hiking trail nearby nest area
- **Nest damage / Vulnerable nest –** nest materials fell off a recently used site and could have additional supports added. Tree nests have been used in the past and are vulnerable to fire.

MU5 Pamo North HexID: 12455

This GEMA contains nest sites in trees. Potential foraging areas include northern Pamo Valley in City of San Diego, Pamo Valley on City of San Diego Public Utilities District and Cleveland National Forest.

Known and potential threats include:

Threat Level: High

- **Wildfire –** most of the surrounding area has burned at least twice
- **Habitat loss / urban development –** ranch house located not far from nest area
- **Rodenticides –** rodenticide use is suspected
- **Nest damage / Vulnerable nest** – tree nests are vulnerable to fire and other threats

MU5 Rockwood Canyon HexID: 12220

This GEMA has cliff ledge nest sites and potential tree nest sites and has been documented history of use as far back as the 1910s. Potential foraging habitat includes private lands, Safari Park, and Guejito Ranch. Foraging habitat on privately owned Guejito Ranch is grazed with low thatch and likely supports ground squirrel population.

Known and potential threats include:

Threat Level: High

- **Wildfire –** most of the surrounding area has burned at least twice
- **Habitat loss / urban development** – nesting and foraging habitat on private lands that could be developed further. A road was recently built on Guejito Ranch nearby nest sites.
- **Nest damage / Vulnerable nest –** the 2007 fire burned all the previously known (historical) nests.
- **Rodenticides** – rodenticide use is suspected

MU5 Rodriguez Mountain HexID: 12610

This GEMA has cliff ledge sites. Potential foraging habitat includes grazed grassland on Guejito Ranch and Hellhole Canyon Preserve.

Known and potential threats include:

Threat Level: High

- **Wildfire –** most of the surrounding area has burned once or twice. Last fire occurred in 2007.
- **Invasive plants** – non-native grass observed in Hellhole Canyon Preserve properties
- **Recreation** – Unauthorized off-road motorized vehicles driving along the southern border of Hellhole Canyon Preserve. Also popular area for climbing.
- **Hunting –** recreational shooting occurring on adjacent federal and tribal lands

4.4 Management Unit 8

MU8 General Characterization

MU8 is 211,717 acres in area and borders Marine Corps Base Camp Pendleton as well as Orange and Riverside Counties (Figure 10). MU8 includes both the Santa Margarita River and the San Luis Rey River. Most of the land in MU8 is fragmented by agriculture and urbanization, except in the northwestern section which contains the largest area of undeveloped land. Habitat in conserved lands includes coastal sage scrub (16%) and chaparral (65%), as well as some grassland (4%) and oak woodland (2.7%; SDMMP and TNC 2017).

Important preserves and landowners in the MU include:

- Cleveland National Forest, USFS (11,731 acres)
- Bureau of Land Management, BLM (2,466 acres)
- Santa Margarita River Park, Fallbrook Land Conservancy (1,378 acres)
- Margarita Peak, Fallbrook Land Conservancy (1,164 acres)

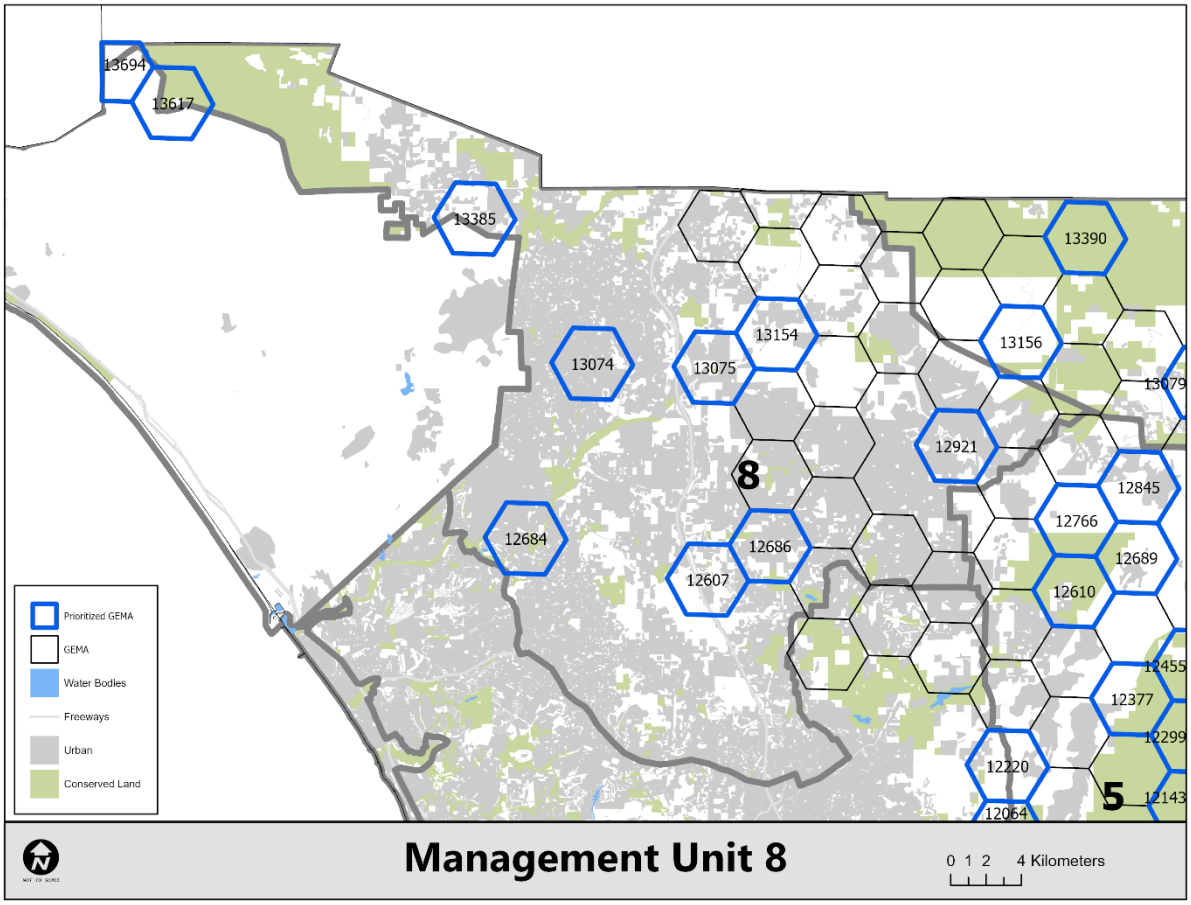

Figure 11. Golden Eagle Management Areas in Management Unit 8. Data from SDMMP 2024, County of San Diego 2000, and SANDAG 2019.

MU8 Golden Eagle Management Areas

MU8 Gregory Mountain/Pala HexID: 13154

This GEMA has cliff nest sites. Potential foraging and important sites include Gregory Mountain, Pala Reservation, Rice Canyon, Montserate Mountain Preserve, and Wilderness Gardens Preserve.

Known and potential threats include:

Threat Level: High

- **Wildfire –** Mesa Fire in 2021 burnt close to nest cliff
- **Habitat Loss / Urban development** – surrounded by rural and urban development with more developments in progress and proposed. Not a lot of foraging habitat remaining.

Threat Level: Medium

- **Infrastructure –** guy wires used for abandoned antennas caused a known fatality. Transmission powerlines and distribution line in foraging area in Rice Canyon

MU8 San Mateo Canyon HexID: 13617

This GEMA has tree nest sites. Potential foraging areas include San Mateo and Devil Canyons and Margarita Peak in Cleveland National Forest and Elsinore and Santa Margarita Mountains within the Marine Corps Base Camp Pendleton.

Known and potential threats include:

Threat Level: High

- **Nest damage / Vulnerable nest –** tree nests are vulnerable to fire and other threats
- **Invasive plants** – large amounts of non-native grass in Marine Corps Base Camp Pendleton
- **Lack of information** – access restricted by ground, aerial no-fly zone

Threat Level: Medium

- **Military activity –** nest area is adjacent to Marine Corps Base Camp Pendleton

4.5 Management Unit 9

MU9 General Characterization

MU9 is 229,778 acres in size (Figure 11). MU9 includes Lake Henshaw as well as parts of the Santa Margarita and San Luis Rey River watersheds. MU9 consist of mostly undeveloped land in the rugged terrain of Palomar Mountain, Hot Springs Mountain, and the Volcan Mountains. Habitat within conserved lands includes mostly chaparral (70%), as well as some grassland (11%), and oak woodland (4.7%; SDMMP and TNC 2017).

Important preserves and landowners in the MU include:

- Cleveland National Forest, USFS (63,420 acres)
- Vista Irrigation District, VID (31,746 acres)
- Bureau of Land Management, BLM (22,745 acres)

- Anza Borrego State Park, California State Parks (10,801 acres)
- Santa Ysabel East Open Space, County of San Diego (5,000 acres)
- San Felipe Valley Wildlife Area, CDFW (3,163 acres)

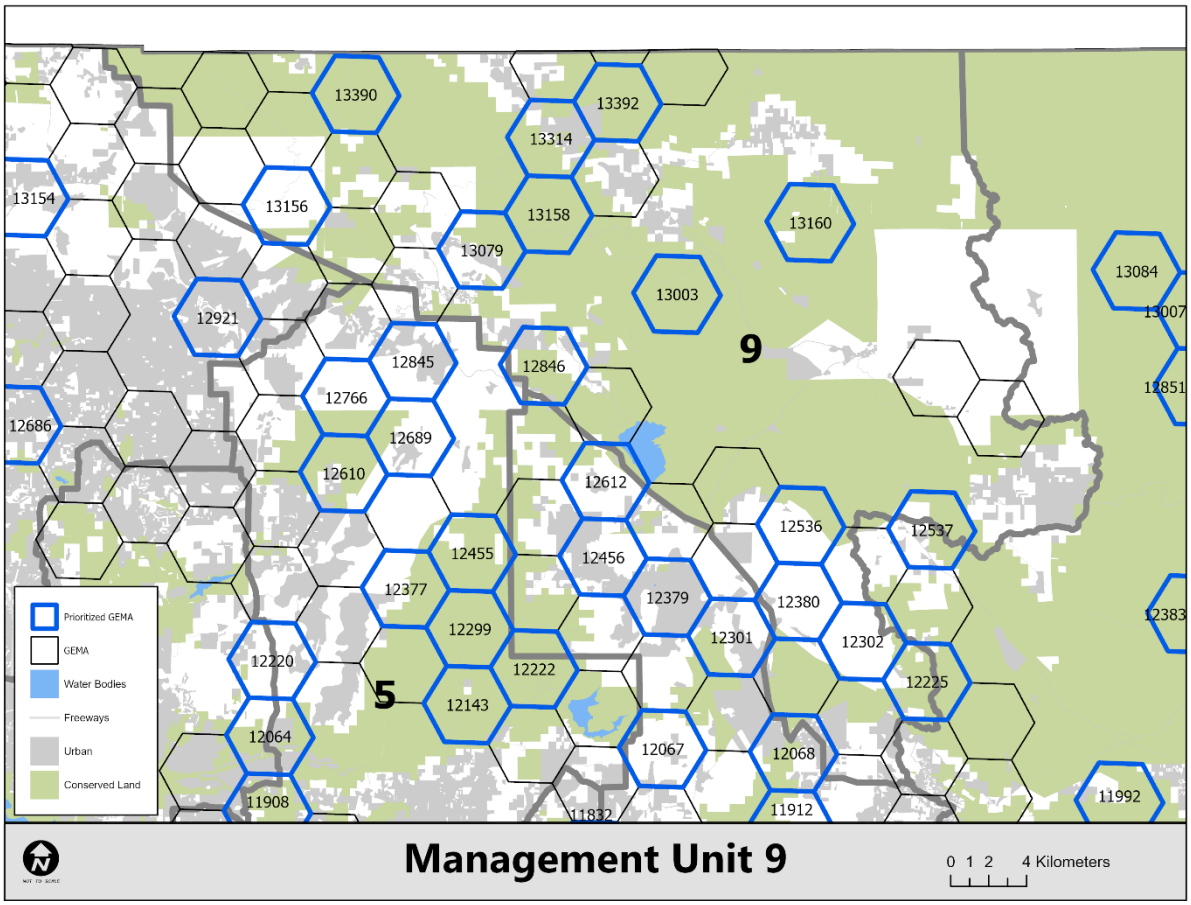

Figure 12. Golden Eagle Management Areas in Management Unit 9. Data from SDMMP 2024, County of San Diego 2000, and SANDAG 2019.

MU9 Golden Eagle Management Areas

MU9 Boucher Hill HexID: 13156

This GEMA has nest sites in trees. Potential foraging habitat on south facing slopes above Pauma Valley in CNF and Doane Valley in Palomar Mountain State Park.

Known and potential threats include:

Threat Level: High

- **Wildfire** – much of the surrounding area nearby has burned once.
- **Rodenticides** – suspected rodenticide use in agricultural lands
- **Recreation** – high levels of recreational activity nearby
- **Habitat loss / urban development –** private inholding in CNF lands could be developed
- **Nest damage / Vulnerable nest** – tree nest is vulnerable to fire and other threats
- **Lack of Information** – inadequate monitoring

MU9 Honor Camp HexID: 13003 or 12924

This GEMA may have tree nest sites but a cliff site has been recently discovered. Potential foraging habitat may be located in the CNF and the Vista Irrigation District.
Known and potential threats include:
Threat Level: High

- **Hunting** – there may be hunting activity in this area
- **Nest damage / Vulnerable nest** – tree nest is vulnerable to fire and other threats

Threat Level: Medium

- **Competitors** – bald eagles are present on nearby Lake Henshaw
- **Military Activity** – helicopter training and ground based training in the area

MU9 Long Canyon (Palomar Mountain) HexID: 13390

This GEMA has cliff nest sites although some are located nearby in Riverside County. Potential foraging habitat includes Agua Tibia Mountain on Cleveland National Forest and Aguanga Valley, private lands in Chihuahua Valley and lower southern slopes of Beauty Mountain on CNF.
Known and potential threats include:
Threat Level: High

- **Habitat loss / Urban development** – Aguanga Valley to east getting built up with residential development

MU9 Mendenhall HexID: 13079

This GEMA has tree nesting sites. Foraging habitat is potentially on privately owned and National Forest System grazed grasslands in Mendenhall Valley, Colb Valley as well as Barker Valley and Fry Creek in CNF.
Known and potential threats include:
Threat Level: High

- **Nest damage / Vulnerable nest** – No recent fire but tree nests are vulnerable
- **Habitat loss / urban development** – private land in Mendenhall Valley. Small amount of rural development nearby
- **Lack of Information** – inadequate monitoring

MU9 Morretti Ranch HexID: 12536

This GEMA has tree nests. Potential foraging habitat on Warner Basin on Vista Irrigation District lands, Volcan Mountain and Santa Ysabel Reservation.
Known and potential threats include:
Threat Level: High

- **Nest damage / Vulnerable nest** – No recent fire but tree nests are vulnerable
- **Habitat loss / urban development** – private lands

- **Lack of information –** unclear if No Name nest on Vista Irrigation Lands is another territory

MU9 Oak Crest HexID: 13158

This GEMA has both cliff and tree nest sites. Potential foraging habitat in small CSS patches on slopes on CNF and in grasslands on private lands in Dodge Valley.

Known and potential threats include:

Threat Level: High

- **Nest damage / Vulnerable nest –** No recent fire but tree nests are vulnerable
- **Habitat loss / urban development** – private lands
- **Recreation** – close to dirt roads with above average human recreation activity recorded very close to a nesting area, OHV Use (BLM, No gate)
- **Hunting** – hunting may occur in this area
- **Rodenticide** – suspected rodenticide use in agricultural lands
- **Lack of information –** inadequate monitoring

MU9 Oak Grove/Chihuahua Valley HexID: 13392

This GEMA possibly has tree and cliff nest sites. Potential foraging habitat could be located on Beauty Mountain on BLM lands, Dodge Valley and northeast Palomar Mountain on Cleveland National Forest, Chihuahua Valley (private lands and CDFW) and slopes of Aguanga Valley.

Known and potential threats include:

Threat Level: High

- **Habitat loss / urban development** – rural residential development
- **Nest damage / Vulnerable nest –**tree nests are vulnerable to fire and other threats
- **Invasive plants –** cheat grass has been observed in this area
- **Rodenticides** – rodenticide use suspected in Chihuahua Valley in agriculture and/or illegal marijuana grows
- **Wildfire** – recent 2024 wildfire nearby

Threat Level: Medium

- **Military Activity** – US Navy Remote Training Site, Warner Springs

MU9 Pine Hills HexID: 12846

This GEMA has a tree nest. Nearby potential foraging areas could include Dyche Valley and Parayne Hill on private lands and Jeff Valley and Pine Hills in CNF.

Known and potential threats include:

Threat Level: High

- **Wildfire –** much of the habitat nearby has burned once or twice
- **Nest damage / Vulnerable nest** – tree nest is vulnerable to fire and other threats
- **Habitat loss / urban development** – private lands nearby

- **Recreation –** above average human recreation activity nearby a nest
- **Lack of information** – limited ground survey access for finding alternative nest sites

Threat Level: Medium

- **Roads** – a road is nearby nest area

MU9 San Felipe 1 HexID: 12537

This GEMA may have tree nest locations. Foraging habitat is likely in San Felipe Canyon Wildlife Area on CDFW lands and private lands near San Felipe Creek.

Known and potential threats include:

Threat Level: High

- **Wildfire –** most of surrounding habitat has burned once
- **Nest damage / Vulnerable nest –**tree nests are vulnerable to fire and other threats
- **Lack of information** – inadequate monitoring
- **Habitat loss / urban development** – private lands and rural development nearby
- **Recreation** – hiking trails nearby

Threat Level: Medium

- **Roads** – there are roads nearby

MU9 San Felipe 2 HexID: 12225

This GEMA could have tree nest sites. Foraging habitat could be located in on Volcan Mountain and San Felipe Valley on CDFW and Volcan Mountain Preserve lands.

Known and potential threats include:

Threat Level: High

- **Wildfire –** most of GEMA has burned at least once
- **Nest damage / Vulnerable nest –**tree nests are vulnerable to fire and other threats
- **Lack of information** – inadequate monitoring

Threat Level: Medium

- **Infrastructure** – distribution powerlines in this GEMA

4.6 Management Unit 10

MU10 General Characterization

MU10 is 242,560 acres and includes the San Dieguito, San Diego, Sweetwater, and Tijuana River watersheds (Figure 12). There is a lot of undeveloped land in this MU of which large patches are separated by mountain highways. Vegetation types within conserved lands are coastal sage scrub (7.6%), chaparral (68%), as well as some montane hardwood forest (SDMMP and TNC 2017).

Important preserves and landowners in the MU include:

- Cleveland National Forest, USFS (102,130 acres)
- Anza Borrego State Park, California State Parks (30,712 acres)
- Santa Ysabel East Open Space, County of San Diego (1,502 acres)

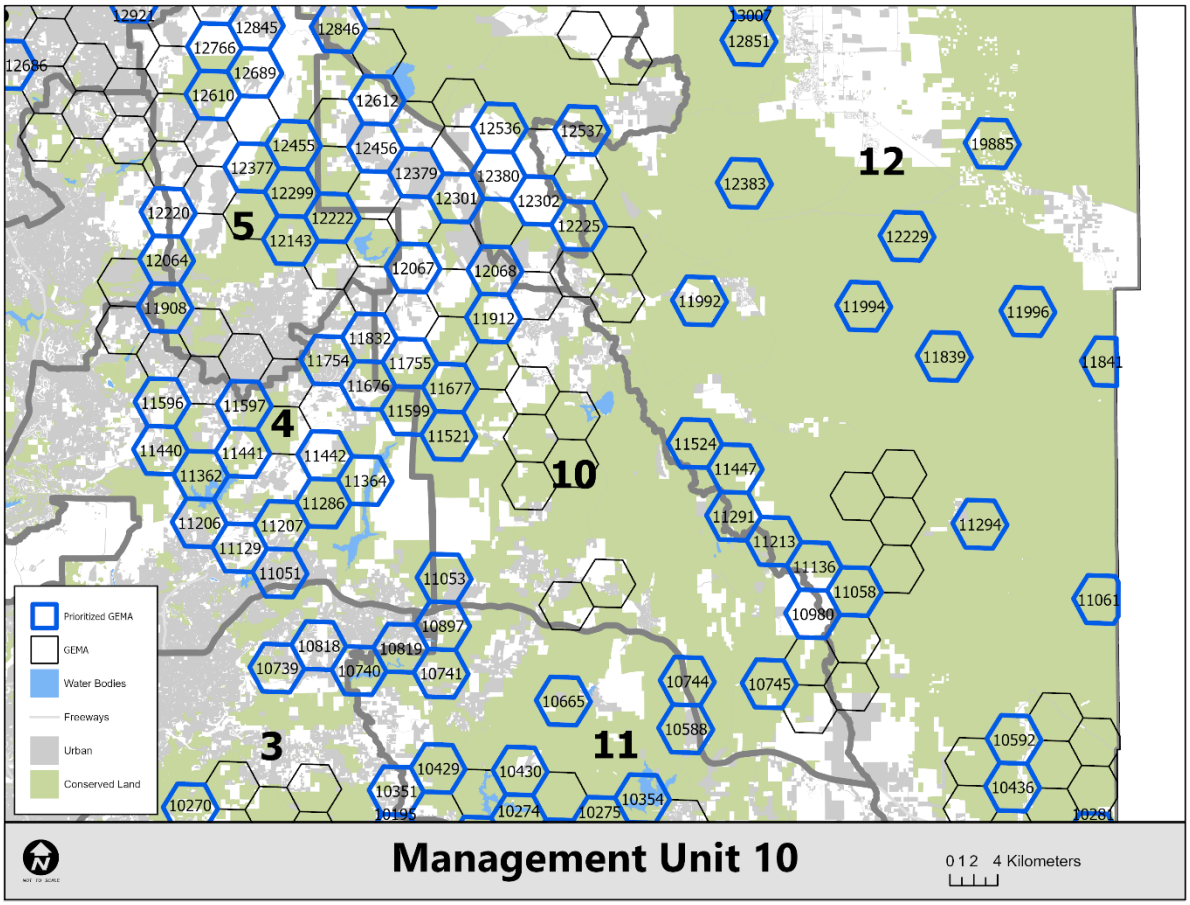

Figure 13. Golden Eagle Management Areas in Management Unit 10. Data from SDMMP 2024, County of San Diego 2000, and SANDAG 2019.

MU10 Golden Eagle Management Areas

MU10 Angel Mountain HexID: 12612

This GEMA has potential tree nests. Potential foraging areas nearby are on private lands and appears fragmented. Other potential foraging may be located on Angel Mountain and in the Vista Irrigation District and CNF.

Known and potential threats include:

Threat Level: High

- **Habitat loss / urban development** – private lands and rural development nearby
- **Recreation** – human recreational activity is above average
- **Nest damage / Vulnerable nest –**tree nests are vulnerable to fire and other threats

Threat Level: Medium

- **Competitors –** bald eagles are present nearby on Lake Henshaw and have used nest trees

- **Infrastructure** – electrical transmission lines are nearby

MU10 Ballena/Witch Creek HexID: 12067

This GEMA has cliff sites. Possible foraging habitat may be located on private lands nearby and possibly be in the CNF, San Dieguito River Park, and Santa Ysabel Open Space.
Known and potential threats include:
Threat Level: High

- **Habitat loss / urban development** – rural and residential development nearby and recently very close to nest sites
- **Wildfire** – all of the surrounding area has burned at least once
- **Recreation** – potential hiking trail planned that would be close to nest sites

Threat Level: Medium

- **Roads** – there are roads nearby
- **Infrastructure** – distribution and transmission powerlines are not far

MU10 Black Mountain HexID:12456

This GEMA may have a tree nest. Potential foraging habitat is fragmented but may include grassland foraging habitat on private and tribal lands. Santa Ysabel West Preserve has grazed grasslands.
Threat Level: High

- **Habitat loss / Urban development –** surrounding lands are not part of conserved lands
- **Recreation** – there are recreational trails near by
- **Invasive plants** – lots of invasive annual grasses on hills
- **Nest damage / Vulnerable nest** – tree nest is vulnerable to fire and other threats
- **Lack of information –** inadequate monitoring

MU10 Buckman Springs/Cottonwood Valley HexID: 10588

This GEMA has a cliff nest site overlooking I-8. Foraging habitat is likely in the CNF lands and private lands nearby on either side of the interstate.
Known and potential threats include:
Threat Level: High

- **Nest damage / Vulnerable nest** – south facing nest with little shade
- **Habitat loss / Urban development** – a facility was developed near an alternative nest site and more potential residential development nearby
- **Recreation** – popular hiking trail nearby

Threat Level: Medium

- **Roads** – highway traffic on I-8

MU10 Canebrake HexID: 10980 or 11058

This GEMA potentially has multiple nest sites. Potential foraging areas are on private land, BLM land or CNF.
Known and potential threats include:
Threat Level: High

- **Recreation** – hiking trails and an OHV park are nearby
- **Nest damage / Vulnerable nest –** possibly south facing nests
- **Habitat loss / urban development** – surrounded by private lands

MU10 Eagle Peak HexID: 11521 or 11599

This GEMA has multiple nest sites. Possible foraging habitat is located in CNF, Eagle Peak Preserve, and El Capitan Reservoir Open Space.
Known and potential threats include:
Threat Level: High

- **Recreation –** rock climbing and hiking nearby at the nest site
- **Lack of information –** possible tree nest

Threat Level: Medium

- **Competitors** – peregrine falcons have been observed

MU10 Inaja HexID: 12068 or

This GEMA has cliff nest sites and had a tree nest site. Potential foraging habitat nearby is on private land, as well as the CNF, Eagle Peak Preserve, and Santa Ysabel Open Space.
Known and potential threats include:
Threat Level: High

- **Wildfire –** surrounding areas have burned at least once
- **Recreation –** hiking trail use and rock climbing
- **Nest damage / Vulnerable nest –** tree nest fell down

Threat Level: Medium

- **Competitors –** peregrine falcons have been observed
- **Infrastructure –** transmission and distribution powerlines nearby

MU10 Mesa Grande HexID:12379

This GEMA may have a tree nest. Potential foraging habitat may be on grasslands on private and tribal lands. Santa Ysabel West Preserve has grazed grasslands.
Threat Level: High

- **Habitat loss / Urban development** – this area has a mix of private lands
- **Recreation** – there are recreational trails near by
- **Hunting** – there may be hunting activity nearby
- **Nest damage / Vulnerable nest –** tree nest fell down
- **Lack of information** – inadequate monitoring and restricted access

MU10 San Diego River Valley/Mildred Falls HexID: 11677

This GEMA has cliff nests. Possible foraging habitat may be nearby in the CNF and San Diego River Park/ Eagle Peak Preserve.

Known and potential threats include:
Threat Level: High

- **Wildfire –** surrounding areas have burned at least once. CalFire practices water drops nearby
- **Recreation –** rock climbing and hiking nearby
- **Habitat loss / urban development –** private lands nearby

Threat Level: Medium

- **Competitors –** peregrine falcons have been observed

MU10 Monument Peak / Stephenson Peak HexID: 11213

This GEMA has cliff nest sites. Potential foraging is located nearby on BLM land and the CNF, and in Anza-Borrego State Park.
Known and potential threats include:
Threat Level: High

- **Wildfire –** surrounding area has burned once
- **Recreation –** hiking trails nearby
- **Nest damage / Vulnerable nest –** potential south facing nest sites
- **Lack of information** – inadequate monitoring

Threat Level: Medium

- **Infrastructure** – communication towers nearby
- **Competitors –** red-tailed hawks have been observed using a nest site

MU10 Thing Valley HexID: 10745

This GEMA has cliff nest sites. Potential foraging habitat is in the CNF and BLM land.
Known and potential threats include:
Threat Level: High

- **Recreation –** recreational trails are nearby
- **Nest damage / Vulnerable nest –** cliff nest site collapsed about 10 years ago

Threat Level: Medium

- **Infrastructure –** transmission powerlines are very close

MU10 HexID: 12301

This GEMA and nearby areas may have a nest that has yet to be reliably documented, but it appears as a hotspot of relative abundance (Fink et al. 2023; Figure 2).
Threat Level: High

- **Habitat loss / Urban development** – this area has a mix of conserved and private lands
- **Lack of information** – it is unclear what resources are in this hotspot

Threat Level: Medium

- **Infrastructure** – electrical transmission lines are in this area

4.7 Management Unit 11

MU11 General Characterization

MU11 is 214,140 acres in area and is along the U.S.-Mexico border (Figure 13). The three reservoirs in the MU: Loveland Reservoir, Morena Reservoir, and Barrett Reservoir. There is substantial undeveloped land in MU11 and 115,085 acres are conserved. Vegetation types within conserved lands in MU11 consist of coastal sage scrub (13.6%) and chaparral (79%; SDMMP and TNC 2017).

Important preserves and landowners in the MU include:

- Cleveland National Forest, USFS (75.618 acres)
- Bureau of Land Management lands, BLM (25,156 acres)
- Barrett Reservoir Open Space, City of San Diego Public Utilities District (4,477 acres)
- Morena Reservoir, County of San Diego (3,198 acres)

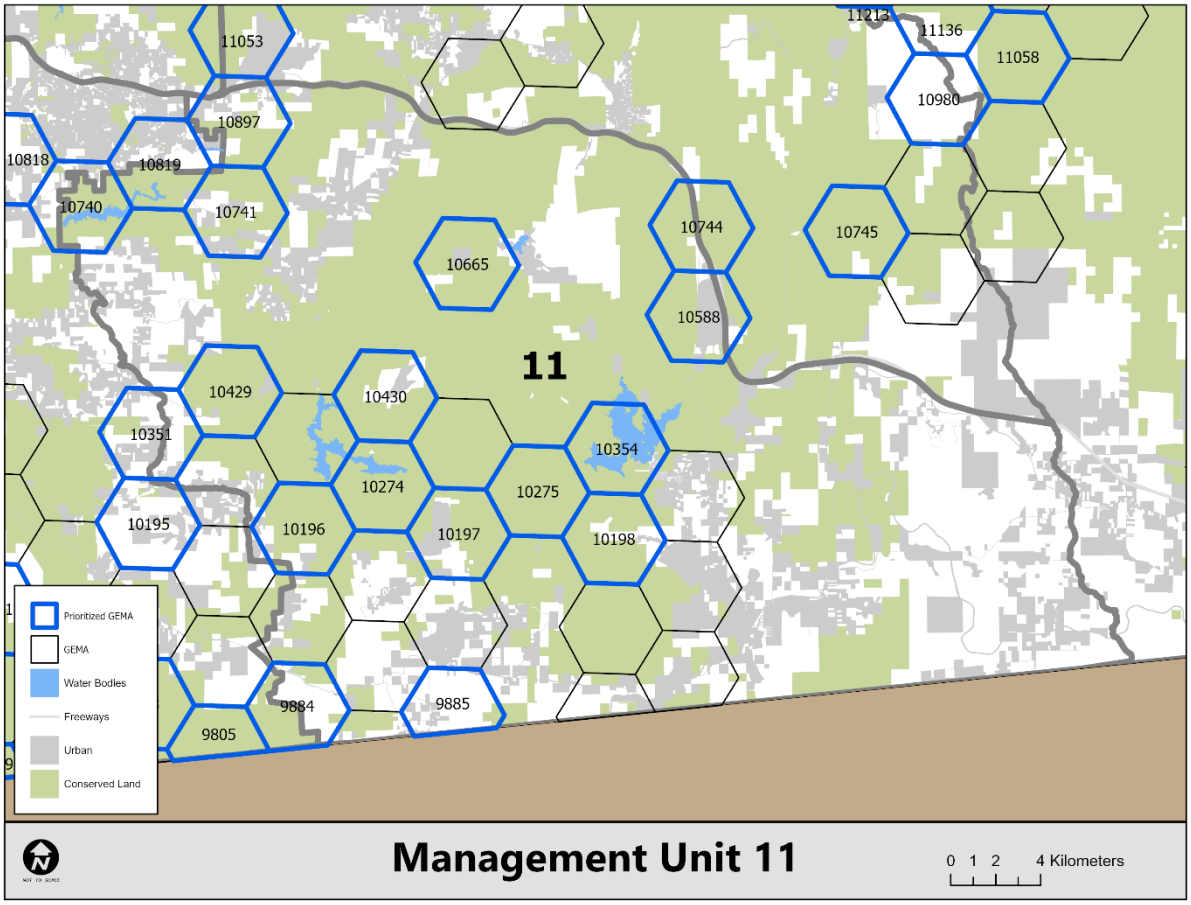

Figure 14. Golden Eagle Management Areas in Management Unit 11. Data from SDMMP 2024, County of San Diego 2000, and SANDAG 2019.

MU11 Golden Eagle Management Areas

MU11 Barrett/Echo Mountain HexID: 10196

This GEMA has cliff nest sites. Possible foraging habitat is located in the CNF, BLM land, Barrett Reservoir Open Space and on private lands.

Known and potential threats include:

Threat Level: High

- **Wildfire –** surrounding area burned
- **Habitat loss / urban development –** private lands nearby

Threat Level: Medium

- **Infrastructure** – transmission and distribution lines nearby
- **Human Activity** – this area is potentially impacted by human activity near the USA/Mexico border.

MU11 Bell Bluff HexID: 10897

This GEMA has cliff nest sites. Potential foraging habitat is located in the CNF, SDGE Sunrise Powerlink Parcels, Loveland Reservoir, and private lands nearby.

Known and potential threats include:

Threat Level: High

- **Wildfire –** surrounding area burned once
- **Habitat loss / urban development –** residential areas nearby
- **Infrastructure –** transmission and distribution lines nearby as well as power substation
- **Hunting** – hunting may be occurring in the area

MU11 Corte Madera Mountain HexID: 10665

This GEMA has cliff nest sites and had documented historical use as long ago as the 1920s. Potential foraging habitat is in the CNF and in private lands to the east.

Known and potential threats include:

Threat Level: High

- **Recreation –** rock climbing routes very close as well as hiking
- **Hunting –** hunting may be occurring in the area
- **Infrastructure –** communication tower nearby
- **Lack of Information** – inadequate monitoring

Threat Level: Medium

- **Competitors –** bald eagles have been observed

MU11 Hauser Canyon West HexID: 10274

This GEMA has cliff nest sites. Most potential foraging habitat nearby is in the CNF although there is some private land to the south.

Known and potential threats include:

Threat Level: High

- **Wildfire –** much of surrounding area has burned, including recently. Fire retardant was recently dropped here on rocks.
- **Nest damage / Vulnerable nest –** one cliff site might have been lost to rockfall
- **Lack of Information** – inadequate monitoring

MU11 Lawson Peak HexID: 10429

This GEMA has cliff sites. Potential foraging habitat is in the CNF and on private lands nearby.

Known and potential threats include:

Threat Level: High

- **Wildfire –** some habitat nearby has recently burned in 2020
- **Recreation –** hiking trail located right on Lawson Peak; rock climbing
- **Habitat loss / urban development –** residential development nearby

Threat Level: Medium

- **Infrastructure –** Transmission and distribution powerlines nearby

MU11 Loveland Reservoir HexID: 10819

This GEMA has cliff nest sites. Potential foraging habitat is located around the reservoir, on BLM land, and CNF.

Known and potential threats include:

Threat Level: High

- **Wildfire –** habitat nearby has burned at least once
- **Habitat loss / urban development –** residential development nearby and more being added

Threat Level: Medium

- **Roads** – road are located nearby
- **Infrastructure** – transmission and distribution powerlines nearby

MU11 Morena Butte HexID: 10275

This GEMA has cliff sites and documented use since the 1920s. Potential foraging habitat is in the CNF, BLM land and Lake Morena Regional Park.

Known and potential threats include:

Threat Level: High

- **Wildfire –** most of the surrounding area has burned once
- **Recreation –** current OHV use and a proposed campground
- **Rodenticide** – rodenticide use is suspected
- **Human activity –** recent construction very close by (work on dam)

Threat Level: Medium

- **Infrastructure –** transmission powerlines nearby

- **Human Activity** – this area is potentially highly impacted by activity along the USA/Mexico border.
- **Competitors –** both bald eagles and peregrine falcons have been observed

4.8 Management Unit 12

MU12 General Characterization

MU12 is outside of the MSPA but was added for the purpose of this document. MU12 covers 804,317 acres in the eastern portion of the County (Figure 14). The potential foraging habitat layer was not available for most of this part of the county.

Important preserves and landowners in the MU include:

- Anza Borrego Desert State Park, California State Parks (549,562 acres)
- Bureau Of Land Management, BLM (98,348 acres)
- San Felipe Valley Wildlife Area, CDFW (14,579 acres)
- Volcan Mountain Wilderness Preserve (1,483 acres)
- Jacumba Mountain, Anza Borrego Desert State Park (988 acres)
- San Dieguito River Park, San Dieguito River Park JPA (741 acres)

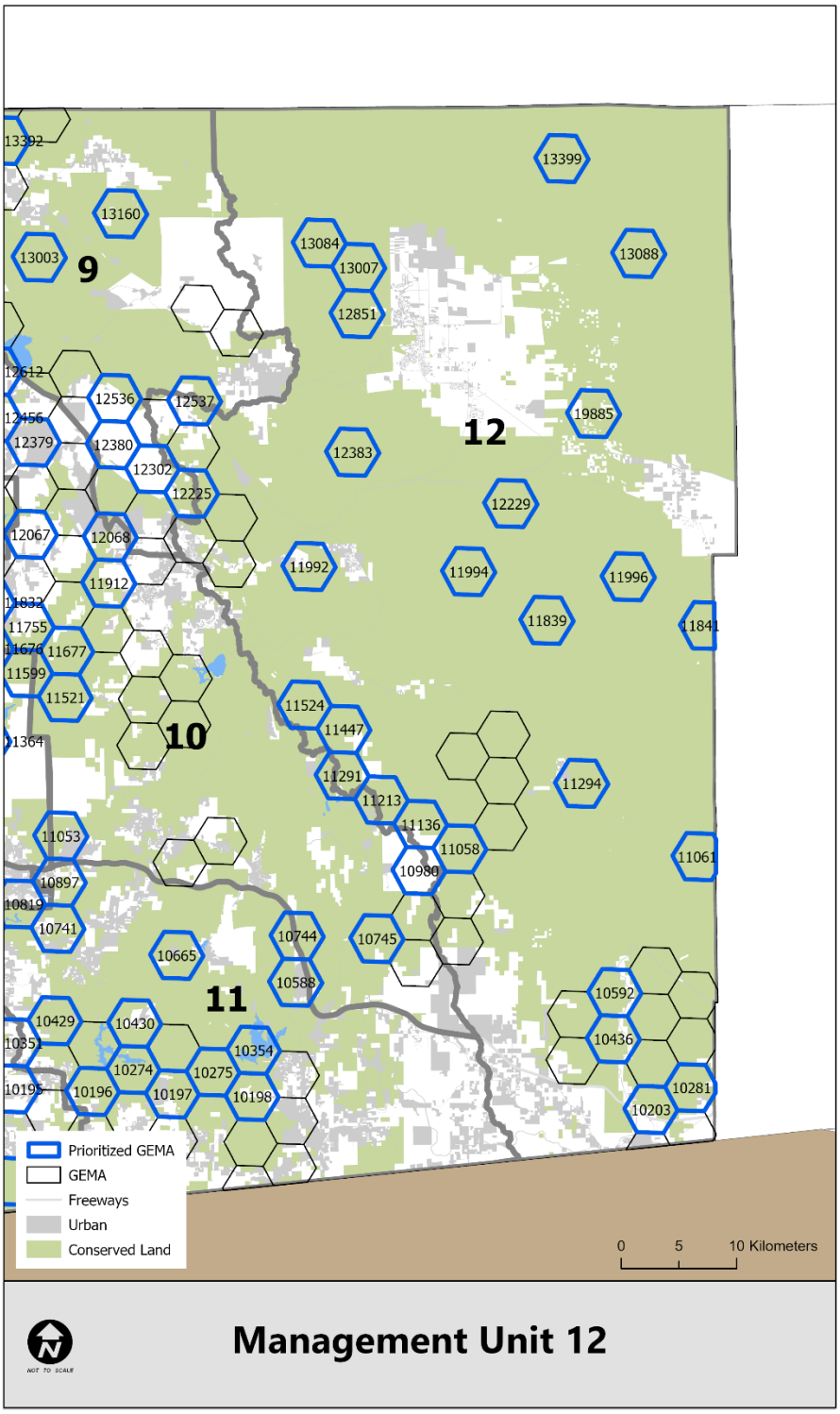

Figure 15. Golden Eagle Management Areas in Management Unit 12. Data from SDMMP 2024, County of San Diego 2000, and SANDAG 2019.

MU12 Golden Eagle Management Areas

MU12 Carrizo Gorge HexID: 10436 or 10592

This GEMA has cliff ledge sites. Potential foraging habitat may be to the east and south based on eagle GPS locations in this area.

Known and potential threats include:

Threat Level: High

- **Recreation** – popular recreational trail nearby
- **Habitat Loss / urban development** – private lands nearby

MU12 Garnett Peak HexID: 11524

This GEMA has a nest site and potential foraging may be nearby on BLM lands and Anza Borrego.

Known and potential threats include:

Threat Level: High

- **Recreation –** hiking trail nearby
- **Nest damage / Vulnerable nest –** potentially south facing nests
- **Lack of information –** inadequate monitoring

MU12 Round Mountain HexID: 10203

This GEMA has cliff ledge sites. Potential foraging habitat nearby in unknown since the data does not extend this far to the eastern part of the county.

Known and potential threats include:

Threat Level: High

- **Habitat loss / urban development –** there is a large amount of private lands nearby
- **Recreation –** high unofficial trail use nearby

Threat Level: Medium

- **Infrastructure –** there are both transmission and distribution powerlines nearby
- **Transboundary –** eagle activity in this GEMA likely extends into Mexico
- **Roads –** there is the interstate highway nearby plus other roads

MU12 Table Mountain HexID: 10281

This GEMA has cliff ledge sites. Potential foraging habitat nearby is currently unknown since the data does not extend this far to the eastern part of the county.

Known and potential threats include:

Threat Level: High

- **Recreation –** trail use nearby and illegal dumping

Threat Level: Medium

- **Human Activity** – this area is potentially impacted by activity along the USA/Mexico border
- **Competitors –** other raptors have been observed using alternative nest sites

5. Management Options for Prioritized Golden Eagle Management Areas

To assess the presence of the threats described in Section 3 across all different GEMAs, we used both quantitative and qualitative assessments in the expert elicitation process to create the lists in Section 4. Although these data have limitations, the qualitative aspect enhances our understanding by identifying risks that may not be adequately captured in the quantitative metrics alone (Bennett 2016). Land managers can check the list of threats and then refer back to Section 3 for potential management strategies for those threats. In addition, the data from the previous section can subsequently be summarized as a threat matrix to describe overall patterns in the type and variety of threats as well as the frequency of the most common high priority threats to golden eagles in San Diego County. This can help in guiding the prioritization and efficiency of management options that could address multiple threats.

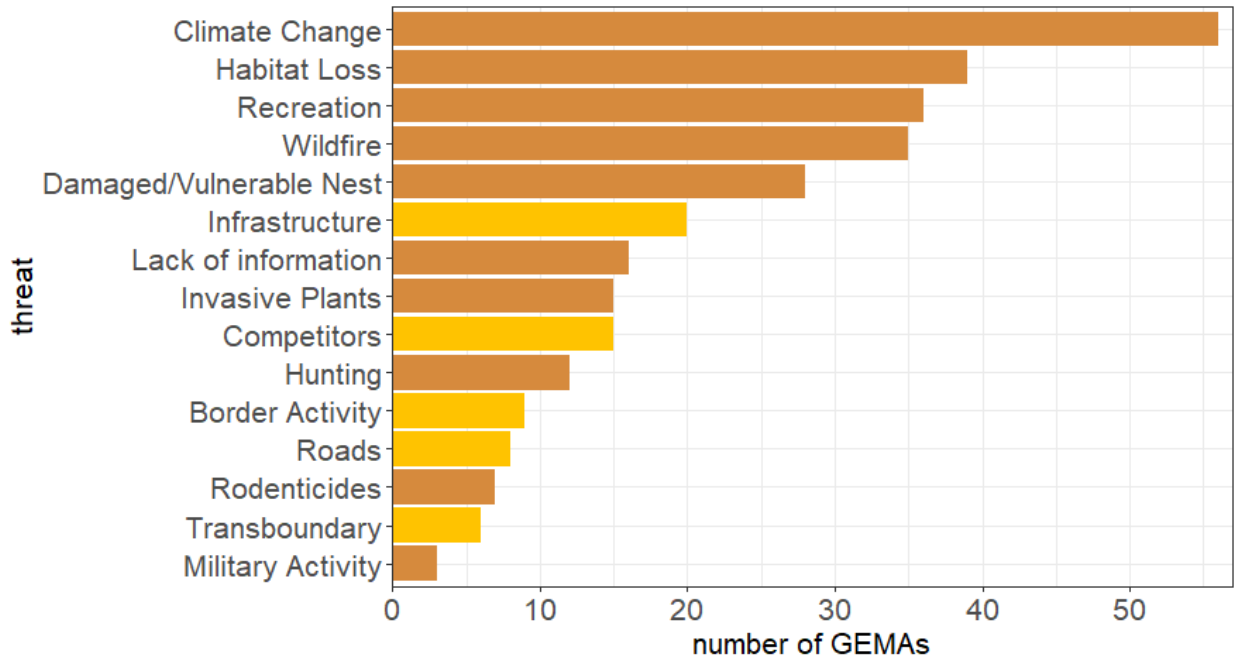

Figure 16. Frequency of occurrence of various threats identified across all prioritized GEMAs. Certain risks appear more frequently than others. Colors distinguish between threats ranked High (orange) and Medium (gold).

The most frequently occurring threats ranked as High in prioritized GEMAs included habitat loss, recreation, and wildfire (Figure 16). Climate change is a threat ranked as High and impacts the entire region (Section 3.1), as well as many aspects of golden eagle habitat, nesting, foraging and survival (Table 1). Therefore, every GEMA is impacted by climate change in some way (Figure 16). Only a small number of GEMAs had as few as one or two threats total and the GEMA with the greatest number of threats was HexID: 10270 (San Miguel Mountain) in MU3

with nine threats. Overall, GEMAs had an average of 3.2 threats ranked high, and 1.7 ranked medium, and 4.1 overall. MU3 and MU9 had the highest average number of total threats per GEMA, at 6.1 and 4.3, respectively.

In summary, the high number of unique threats ranked as High (Table 1), combined with a majority of GEMAs with multiple high ranked threats suggests a substantial complexity of issues and vulnerability to further population decline. Protecting individual eagle nest areas can lead to conservation success at a population level (Cruz et al. 2018). However, having multiple threats to address simultaneously underscores the importance of continued collaboration among stakeholders to work toward their management goals in a science-based framework. There may also be interactive and synergistic effects between different types of threats. Therefore, based upon all the information gathered on the biology and threats, the working group identified one potential overarching management strategy in each of five different categories, as well as associated options at both the regional and preserve level within each category for management consideration. The five categories are habitat, nesting, foraging, survival, and a monitoring program to assess progress.

Habitat

Strategy 1: Minimize and/or limit habitat loss and human disturbance within occupied and potentially occupied golden eagle nesting and foraging areas (reviewed in Section 3.5 and Section 3.6).

Options 1a. Identify and protect important nesting, roosting/perching and foraging habitats.

i. Work with regional partners and coordinate with other stakeholders regarding land surrounding high priority GEMAs. Further research would help to assess suitability and develop a list of priority areas.

ii. Facilitate development of strategies to protect habitat on private lands and coordinate with Tribes to protect habitat

iii. Build and maintain a GIS database of important locations, ownership, and status of protections. Refine and improve decision support tools for wider use.

Options 1b. Protect habitats from human disturbance.

i. Work with landowners, managers and energy industry to site structures to minimize impacts to golden eagles

ii. Coordinate with land managers regarding recreational trail closures or realignments, and enforcement of existing restrictions on access. Consider further research on regional specific guidelines for buffer zones for various activities in the presence of multiple synergistic threats (D'Acunto et al. 2018).

iii. Collaborate with the rock climbing/paragliding communities for potential development of a rock climbing and paragliding management task force. Such options to

explore could include closures, fee systems, timed entry and permit programs and have been implemented elsewhere for protection of sensitive cliff nesting raptors (Heller 2022; NPS 2024).

iv. Consider coordinating with the military to potentially minimize disturbing activities in areas affected by those activities.

v. Conduct public outreach to raise awareness of issues affecting golden eagles. This could include interpretive displays, trailhead ambassadors for educating recreationists about golden eagles, and spreading knowledge of citizen science projects that contribute to conservation.

Nesting

Strategy 2: Improve reproductive success via enhancement and restoration on nest and roost sites (reviewed in Section 2.2, Section 2.3 and Section 3.4, Section 3.14).

Options 2a. Identify cliffs and trees where nest restoration or artificial platforms could be added.

i. Determine priority locations for deploying artificial nest platforms such as where suitable cliff ledges are rare, or where nests were destroyed by fire (Martin and Terp 2014). Determine locations and methods where strengthening the existing nest structure is an option. Figure out optimal designs and maintenance.

ii. Plant oaks in areas impacted by fire and GSOB for future nest sites. Select areas where oaks can be resilient to climate change, especially drought.

iii. Ensure all locations selected for nest restoration have adequate protection from the sun. Add shade structures (or possibly native vegetation) to existing nests with substantial sun exposure to improve nesting success (Kochert et al. 2019; Corregidor-Castro et al. 2023).

Options 2b. Minimize the destruction of nests from wildfire by reducing fire ignitions.

i. Coordinate with utility providers to reduce fire risk potential

ii. Reduce fire ignition risk in important golden eagle areas by hardening roads, restricting use of power equipment during high fire risk conditions, and strategic use of fuel management zones.

Options 2c. Establish a potential strategy for developing a hacking program (i.e. raise and release eagle nestlings from artificial nesting sites) if deemed necessary in the future (Negro et al. 2007).

Foraging

Strategy 3. Optimize access to prey by protecting and enhancing foraging habitat (reviewed in Section 2.4 and Section 3.5).

Options 3a. Identify and protect locations with important prey species in golden eagle foraging areas.

i. Explore the potential use of conservation easements for managed grazing that provides habitat for prey (Hunt et al. 1995).

ii. Provide targeted supplementary feeding and water guzzlers for prey species, especially during drought years. Supplemental food for ground squirrels could increase their population if food is a limiting factor (Dobson and Kjelgaard 1985).

iii. Provide water guzzlers to increase access to water (Boal et al. 2023), especially during hot droughts.

iv. Map the distribution and abundance of ground squirrels, jackrabbits and cottontails in foraging habitat. Consider research on prey species and golden eagle diet.

Options 3b. Enhance or expand habitat for key prey species.

i. Identify locations where translocation or facilitated dispersal of ground squirrels would provide increased availability (Swaisgood et al. 2019).

ii. Coordinate with land managers to support habitat management for prey species including management of non-native grasses with managed grazing, mowing or prescribed fire

Options 3c. Provide supplemental feeding with carrion bait stations.

i. Develop potential ways for obtaining and providing carrion such as roadkill (Hawkwatch 2024), or sanitized bait free of contaminants, pharmaceuticals and disease (Blanco et al. 2017; Sorensen et al. 2014; Herrero-Villar et al. 2024).

ii. Identify territories with poor foraging access that would likely benefit from supplemental prey, especially during drought years (Ferrer et al. 2018).

iii. Monitor eagles to assess improvements in nesting success (Gonzalez et al. 2006), and for less movement outside protected areas (López-Peinado et al. 2023).

Survival

Strategy 4. Reducing mortality from anthropogenic sources (reviewed in Section 3.3 and Section 3.7).

Options 4a. Monitor and quantify sources of mortality.

i. Develop connections with raptor rehabilitators to collect data on locations and sources of injury and mortality, including disease surveillance (Hall et al. 2024).

ii. Coordinate with transportation agencies, utility providers including wind farms, law enforcement and the public to report eagle fatalities.

Options 4b. Implement approaches to reduce mortality.

i. Develop materials for hunter outreach and coordinate with law enforcement about the issue (Thomason et al. 2023b).

ii. Coordinate with transportation agencies to move roadkill further away from roads to reduce mortality from vehicular collisions (Slater et al. 2022).

iii. Coordinate with utility providers to minimize the take of golden eagles from powerlines by identifying priority locations for retrofitting power poles

iv. Develop and coordinate supplemental feeding techniques that would reduce mortality of juveniles and subadults due to starvation (Millsap et al. 2022).

v. Utilize local and regional expertise in raptor rehabilitation techniques for golden eagles (Hagen et al. 2024).

Monitoring Program

Strategy 5. Develop and implement a long-term monitoring program to assess population trends and refine conservation strategies (reviewed in Section 3.10).

Options 5a. Develop and follow a long-term nest and population monitoring program.

i. Develop a statistically rigorous tiered approach that combines monitoring known territories for occupancy and nesting success with surveying GEMAs of unknown status to find new nests and territories (Wiens et al. 2022; McClure and Rolek 2024).

ii. Assess logistics of ground and helicopter-based surveys in different locations and determine the appropriate partners who could conduct monitoring.

Options 5b. Standardize field procedures and data collection protocols to efficiently streamline data for analysis.

i. Standardize data definitions and field data collection procedures among various partners to facilitate efficient database entry

ii. Annual monitoring should follow established guidelines as protocols are developed (e.g. Pagel et al. 2010).

Options 5c. Develop a database and implement protocols for data management for long term collection of data.

i. Coordinate with experts on database creation, data management and data sharing agreements.

ii. Compile data from previous monitoring efforts if possible and add into database to help with refining conservation strategies sooner (Sergio et al. 2021).

6. Knowledge Gaps

- While varying levels of golden eagle nest monitoring have occurred in the past a comprehensive long term golden eagle monitoring program for the region could enable monitoring of progress towards conservation goals. The monitoring program, once developed, could include a tiered approach combining both a spatially explicit probabilistic occupancy framework (i.e. Wiens et al. 2022), as well as individual nest and territory monitoring of sentinel sites (McClure and Rolek 2024). Supplementary techniques such as bait site camera traps and genetic monitoring could also be explored.

- Habitat suitability modeling for golden eagle nest and foraging areas would help determine priority locations to add artificial nest platforms, potential locations for adding water and bait sites, and/or a gap analysis for identifying areas needing protection/acquisition.

- Assessing the impact of proximity and timing of human activity, particularly recreational activities and urban development, on eagle movements to help develop guidelines for human activity tailored to the region.

- There is a lack of recent research in southern California on golden eagle diet, foraging, and the distribution and habitat of ground squirrels, jackrabbits and cottontails. There is also a lack of quantitative information on the influence of competitors on golden eagles (e.g., consequences of increasing bald eagle presence).

- Similarly, there is a lack of recent research on contaminants exposure (rodenticides, lead, etc.), either directly or via prey populations, and the potential impacts to golden eagles in Southern California.

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