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U.S. DEPARTMENT OF AGRICULTURE

Southwest Region Coronado National Forest

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Biennial Monitoring Evaluation Report for the Coronado National Forest

Fiscal years 2021-2023



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Why Monitoring Matters

There is no single correct approach to managing a forest or grassland. Each decision maker must weigh the ecological complexity of the ecosystems, the social and economic contributions, the changing environmental conditions, the many different viewpoints of the public, and uncertainty about long-term consequences.

Data from monitoring can therefore be extremely useful. A robust, transparent, and meaningful monitoring program can provide information on specific resources, management impacts, and overall trends in condition – in other words, feedback on whether we are meeting our management objectives.

Every national forest or grassland has a land management plan that balances tradeoffs among recreation, timber, water, wilderness, wildlife habitat, and other uses. The plan describes a set of desired conditions – a science-based vision for the state of the forest or grassland once the goals of the plan are met. The land management plan includes a monitoring plan, organized around a set of monitoring questions and indicators that are designed to track progress toward achieving the desired conditions. Monitoring of certain resources is required by law, regulation, or policy (see box below for required monitoring topics). Other monitoring occurs depending on specific needs of the national forest or grassland. Under the current planning rule, monitoring questions developed for the monitoring plan must be “within the financial and technical capability” of the Forest Service, meaning that we must have the money and ability, including support from partners, to actually carry out the strategic monitoring outlined in the monitoring plan.

Every 2 years, each forest or grassland compiles and evaluates monitoring results and drafts a biennial monitoring evaluation report (BMER) like this one. If the monitoring report reveals that we are not quite meeting the mark, then there might be a need to change the land management plan, the management activities, the monitoring plan, or to reassess current conditions and trends—this is adaptively managing. Monitoring results allow us to learn through management and adjust our strategies based on what we learned. Monitoring also helps us be accountable and transparent to interested and affected parties and colleagues. BMERs are critical to adaptive management because they tell us and the public whether the land management plan is working. Although we don’t make any decisions in BMERs, they are a great opportunity to document and share monitoring results.

Our 2018 land and resource management plan (referred to throughout this report as Land Management Plan) is available on our website (https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd583208.pdf). The monitoring plan, Chapter 6, begins on page 175.

Monitoring questions must address the following topics (per 36 CFR sec 219.12 - Monitoring and Forest Service Manual 1909.12 sec. 32.13 - Content of the Plan Monitoring Program):

1. Status of select watershed conditions.
2. Status of select ecological conditions including key characteristics of terrestrial and aquatic ecosystems.
3. Status of focal species to assess the ecological conditions.
4. Status of a select set of the ecological conditions to contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern.
5. Status of visitor use, visitor satisfaction, and progress toward meeting recreation objectives.
6. Measurable changes on the plan area related to climate change and other stressors that might be affecting the plan area.
7. Progress toward meeting the desired conditions and objectives in the plan, including for providing multiple use opportunities.
8. Effects of each management system to determine that they do not substantially and permanently impair the productivity of the land.
9. Social, economic, and cultural sustainability must also be addressed in the monitoring plan because sustainability is an inherent part of several of the required monitoring items.

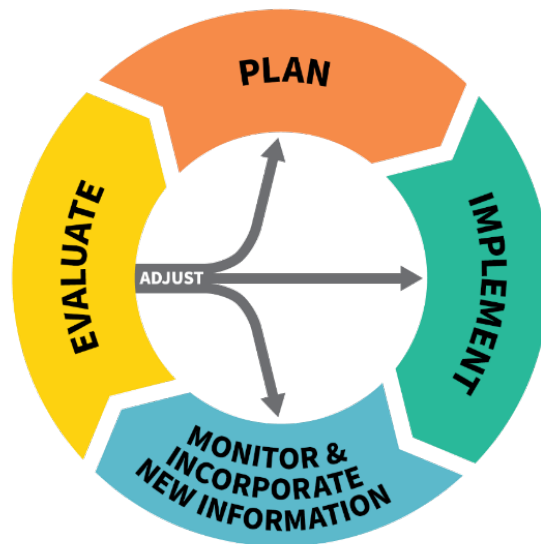


Figure 1. Adaptive Management Cycle

Partnerships and Data Sources

To accomplish our mission, the Forest Service partners with land management agencies across all levels of government, with nonprofit and for-profit entities, universities, and communities large and small. The diversity of our partners parallels the breadth of Forest Service work that includes: managing the nation's 193 million acres of National Forest System lands to sustain healthy terrestrial and aquatic ecosystems; conducting collaborative research that connects the agency to hundreds of partners around the world; supporting States, Tribes, communities, and nonindustrial private landowners through technical and financial assistance; protecting communities and the global environment from catastrophic wildland fires, climate change and invasive species; and inspiring life-long connections to nature for every American.

Monitoring can be expensive, time-consuming, and labor-intensive, so we rely on the help of our partners and work collaboratively with them to accomplish monitoring objectives. Some of the entities that we partner with include the University of Arizona, National Forest Foundation, White Mountain Apache Tribe, San Carlos Apache Tribe, Tucson Audubon Society, Borderlands Restoration Network, Watershed Management Group, The Desert Museum, Sky Island Alliance, Arizona Department of Forestry and Fire Management, Arizona Game and Fish Department, and many, many more.

We also rely on existing data sources such as national and regional inventory, monitoring, and research programs; Federal, State, or local government agencies; scientists, partners, and members of the public; and information from Tribal communities and Alaska Native Corporations.

Report Summary

This 2024 biennial monitoring evaluation report (BMER) for the Coronado National Forest (CNF, referred to throughout this document as Coronado) documents monitoring activities that occurred during fiscal years 2021 through 2023. Resource specialists answered 12 of the 22 monitoring questions to determine if current activities described in the Coronado Land Management Plan are moving the forest toward or maintaining the desired conditions or objectives.

The detailed resource data and specialist reports that were used to build this monitoring report are available on request by contacting us at (520) 388-8300 or sara.amiot@usda.gov. Each new monitoring report builds upon the evaluations and recommendations that precede it. This monitoring and evaluation report and previous reports are available at <https://www.fs.usda.gov/detail/coronado/landmanagement/planning/?cid=fseprd582615> where you can review previous recommendations made to move our forest toward the desired conditions and objectives in our land management plan.

Not all monitoring questions outlined in the Land Management Plan were answered in this report. For some questions, this was due to the frequency of reporting being on a 5-to-10-year cycle. For others, there was insufficient data, at this time. We will address the status of these monitoring questions in the next monitoring report.

Of the 12 monitoring questions examined, we are meeting plan objectives or progressing toward our desired conditions in all 12 monitoring questions. To keep the Coronado National Forest on track to reaching desired condition for vegetation and habitat, we need to continue concentrating herbicide treatments on the Santa Catalina Ranger District (SCRD) to meet minimum 200 acres treated in Pusch Ridge and other impacted areas, as well as increase efforts to survey and treat high priority invasive species in other districts. We also need to keep incorporating design features into ground disturbing activities to prevent the spread of invasive grass species. The Coronado also needs to maintain its upland vegetation monitoring program, including non-native invasive grass species spread. The Coronado plans to maintain regular prescribed burning where appropriate to return natural fire regimes and low intensity wildfire back to the landscape, reduce fuel loads, and facilitate ecosystem resilience. Additionally, monitoring plans could be expanded for focal species, including the implementation of stratified sampling across different ecological sites of varying quality. Additional coordination with partner agencies and groups is recommended to collaborate data collection efforts.

Table 1 – Recommended Changes

The following table tallies our recommended changes based on evaluation of the monitoring questions addressed in this report. At a glance, it provides the overall totals for how many monitoring questions or indicators are meeting the land management plan direction, or whether changes to the land management plan, management activities, monitoring plan, or new assessment should be considered. See **Table 3** at the end of this report for a more detailed summary of the monitoring questions, results, and recommendations.

Table 1. Adaptive management recommendations for all monitoring questions addressed in this report.

Recommendations	Yes	No	Uncertain
Land Management plan direction met	12	0	0
Change to land management plan	0	12	0
Change to management activities	0	12	0
Change to monitoring plan	0	12	0
Assessment	1	9	2

Forest Supervisor's Certification

This report documents the results of monitoring activities that occurred from fiscal year 2021 through fiscal year 2023 on the Coronado National Forest.

I have evaluated the monitoring and evaluation results presented in this report. I have examined the monitoring recommendations and found that there are no recommended changes to the 2018 Land Management Plan at this time. I therefore consider the 2018 Land Management Plan sufficient to continue to guide land and resource management of the Coronado National Forest.

FOREST SUPERVISOR NAME

Status of Select Watershed Conditions

Streams recharge groundwater aquifers, provide habitat for aquatic and riparian dependent species, and supply water for a variety of human uses. In southeast Arizona, the sources of many headwater streams are on the Coronado.

On the forest, we are managing for habitat connectivity, vegetation conditions that enhance water quality and quantity, water quality that meets state standards, floodplains that are functioning properly, habitat and ecological conditions capable of supporting native riparian-dependent plant and animal species, and streambanks that are stable and protected from erosion by vegetation and rock material. We are working to help accomplish our goals by implementing projects that will improve and maintain natural waters on the landscape as well as connect habitat that is associated with water. Projects and activities on forest lands can impact soil, water quantity and quality, and air resources. Monitoring for impacts from these actions helps the forest determine overall water resource health.



Figure 2. Danelle Scott, a hydrologist on the Coronado NF, taking water flow measurements.

Monitoring Questions and Key Results

MQ 1: Are springs and streams showing a decrease in water availability due to increases in air temperature, an increase in extreme weather events, and increased drought?

Statewide, temperatures have risen 2.5 degrees Fahrenheit since the beginning of the 20th century. Additionally, the entire state of Arizona is experiencing over a 20 year long drought. Data from the two US Geological Survey (USGS) gauges on the Coronado (Ramsey Canyon and Sabino Creek) were pulled and analyzed for statistically significant downward trends.

Both gauges had decades of volumetric flow data (in cubic feet per second, CFS) being continuously collected every 15 minutes from 1987 to 2024. Additionally, both gauges continue to actively collect data. For both gauges, a statistically significant downward

Annual precipitation averages were calculated for the entire available period of record. The analysis results for Ramsey Canyon and Sabino Creek suggest that there is a statistically significant downward trend in average annual CFS for both gauges.

MQ 2: How many stream or spring restoration projects have been completed for the benefit of forest planning species?

Projects that enhance streams or springs for forest planning species include invasive plant removal, native vegetation planting, structures to reduce erosion issues, livestock exclusion fencing, bullfrog removal, and native species restoration.

Specifically, the Highwater Cienega project focused on restoring the high-elevation Emerald Spring. Instream structures have been put in place to aggrade sediment and restore the now incised Cienega. Emerald Spring is also Critical Habitat for the endangered Mt. Graham red squirrel.

On the Coronado National Forest, 32 projects were completed between fiscal year 2021 and the end of the 2023 fiscal year.



Figure 3. Log Mattress structure installed in Ash Creek to prevent further incision and catch sediment as part of the Highwater Cienega project.

MQ 3: What projects have been implemented to improve watershed conditions?

Projects with the potential to improve watershed conditions include thinning woody vegetation to reduce fuel loads so wildfires burn with less severity and less soil resource damage, placing erosion control structures in small drainages of damaged watersheds to reduce erosive flows and sediment runoff, and controlling invasive plant communities.

Stream restoration projects using instream structures constructed from native materials were also implemented in FY 2023 to retain and fill sediment back into Ash Creek to reconnect it to its natural floodplain.

In FY 2021, 30 watershed projects were completed for a total of 11,217 watershed acres treated. Approximately 8,000 of these treated acres were from the YLE prescribed burn. In FY 2022, 29 projects were implemented to improve watershed conditions. In FY 2023, 26 projects were implemented or partially implemented (Table 2). The accomplishment acres for FY 2022 were largely influenced by several prescribed fire burns, the largest being the 10,850-acre Redfield burn.

Additionally, the Highwater Cienega stream restoration project began implementation. Approximately half of the proposed structures have been installed. Structures in place catch sediment, prevent further downcutting, and restore the channel’s stream morphology to natural conditions. Cross-sectional plots will be installed to monitor the success of these instream structures in the spring of FY24 and will be continuously monitored on an annual basis.

Fiscal Year	Number of Projects Completed or Partially Completed	Total acres treated	Total miles of stream habitat enhanced
2021	30	11,217	13.23
2022	29	18,460	9.30
2023	26	5,898	9.60

Table 2. Number of Watershed Projects, Acres, and Miles Completed or Partially Completed 2021-2023.

MQ 4: Are there bat escape ramps on elevated artificial water sources?

Elevated, artificial water sources, such as open top storage tanks and water troughs, provide an important source of water and refugia for a multitude of wildlife species and livestock. They also provide environments that encourage the reproduction of native aquatic organisms. However, they can pose a threat for bats, lizards, snakes, and other small mammals. Without a means of escape, these species can accidentally fall into the water source and drown. An appropriately designed ramp providing access to

the rim of the tank or trough can provide a life-saving exit in the event of an entrapment, as well as prevent future pollution for other organisms who need the water.

All grazing permits issued on the Coronado NF require permit holders to install and maintain wildlife escape ramps in such watering facilities. The presence and function of the ramps are determined during various field inspections, such as range allotment inspections, water rights validation inspections and other impromptu visits by Forest personnel. If a watering facility is found to be lacking a ramp or the ramp is inadequate, the grazing permittee will be notified. Once notified, either the permittee or Forest staff will install, repair, or replace the ramp to ensure prevention of unnecessary deaths and clean, safe drinking water for livestock and wildlife.



Figure 4. Example of a wildlife escape ramp installed in a stock tank.

Recommendations

No changes are needed at this time. More projects were completed throughout FY21-FY23 relative to the previously observed monitoring period.

For the Highwater Cienega project and other future projects, cross sections will be installed and continuously measured to observe changes in stream morphology and success of implemented stream restoration projects. Additionally, riparian monitoring using the National Riparian Core protocol will begin taking place in spring on 2024 in select locations throughout the Coronado.

Monitoring question (MQ)	Progress Toward Land Management Plan Desired Conditions and Objectives	Recommended Actions/Next Steps
MQ1	The Coronado instream flow monitoring program is continuing to measure water availability and secure USFS owned water rights.	No changes recommended.
MQ2	32 projects were completed between FY 2021 and 2023.	No changes recommended.
MQ3	85 projects have been implemented to improve watershed conditions between FY 2021 and 2023.	No changes recommended.
MQ4	Wildlife (bat) escape ramps are installed on all elevated artificial water sources; any damaged or missing ramps are remedied by USFS staff or permittees.	No changes recommended.

Status of Focal Species

The Coronado is an ecologically distinct landscape ranging from desert and grasslands to high-elevation forests. The Sky Island Mountain ranges are among the world's most diverse ecosystems due to their unique location and microclimates. This environment supports rich biodiversity and provides ecological corridors for wildlife. Notably, the Coronado manages habitat for more than 20 federally listed species of wildlife and rare plants. Resource management practices outlined in the Land Management Plan for the Coronado (Appendix B.) aim to either progress or maintain suitable habitat conditions for wildlife within associated vegetation communities. Consistent with the Coronado monitoring program, we evaluate landscape quality by studying wildlife interactions with their habitats, monitoring focal species' behavior and patterns across time and space. Focal species are selected based on their affinity for specific habitat types, which may be vulnerable to reduced resource quality and the impacts of climate change. This approach provides valuable insights into ecological system conditions and the effects of management practices.

For example, the Mexican spotted owl is a focal species for both wet and dry mixed conifer communities due to its unique characteristics and role in the ecosystem. As a resident territorial bird, it can live up to approximately 15 years in the wild. This owl is a habitat specialist, particularly in mixed conifer communities, where it thrives as a top predator. Its adaptation for hunting elusive nocturnal prey underscores its ecological importance in maintaining ecosystem balance. The presence of Mexican spotted owl signifies a natural habitat structure and thriving food web, both of which are essential components of a sustainable ecosystem. The



Figure 5. Mexican Spotted Owl family perched together.

Coronado collaborates with the US Fish and Wildlife Service to monitor and conserve the habitat of this listed species. Based on projections of future climate change for the region, mixed-conifer forest ecosystems are susceptible to decreases in plant productivity from water limitations and increased heat, increases in frequency, intensity and severity of insect attacks, colonization by invasive species, longer and more severe fires seasons, and altered frequency, severity, timing, and spatial extent of disturbance events (such as droughts, flash floods, landslides, windstorms, and ice storms). Extended drought from delayed monsoons or earlier onset of spring conditions could lead to increased tree mortality, resulting in increasing risk of intense wildfire.

The acorn woodpecker is a commonly observed species in the Coronado, depending on acorn availability throughout the year. Based on projections of future climate change for the region, Madrean pine-oak woodland ecosystems are susceptible to decreases in plant productivity. Due to increasingly warmer climatic conditions, there are years when the acorn crop is insufficient to support acorn woodpecker territories, leading to migrations into Mexico. Within the forest, this species has shown atypical social and migratory behavior, such as forming temporary reproductive partnership during winter migration or remaining resident in communal groups. Monitoring the abundance of acorn woodpeckers throughout the year enables us to track shifts in woodpecker populations associated with habitat quality. This

monitoring can serve as an indicator of how our management actions impact the landscape and influence woodpecker distribution.

The Sonoran mud turtle is a freshwater species found throughout lower elevations of the Coronado. The species inhabits a variety of aquatic environments, including stock tanks, ponds, and streams. Known for their longevity and sedentary behavior, mud turtles are a crucial indicator species that reflect the health of aquatic systems. Based on projections of future climate change for the region, constructed water sources are susceptible to increased evaporation from warmer temperatures and altered frequency and severity of both droughts and flash floods. Water resources are also at risk due to increased drawdown of aquifers and competing demands for multiple uses. These conditions place additional stress on native animal species that depend on surface water as a habitat source. Monitoring the populations of Sonoran mud turtles provides valuable insights into the status of sporadic freshwater habitats within desert environments and their resilience to environmental changes, including those driven by climate change.

Monitoring Questions and Key Results

MQ 5: The Mexican spotted owl (MSO) is identified as a focal species in these vegetation communities. Are post-treatment conditions and plan components guiding fuels reduction and forest restoration activities consistent with and moving toward desired ecological conditions within mixed conifer, ponderosa pine-evergreen shrub (oak), and madrean pine-oak woodland habitats that contribute to stable or increasing MSO populations? How have populations and distributions of MSO changed?

The Coronado's management activities align with U.S. Fish and Wildlife recommendations for Mexican spotted owl critical habitat. These activities include regulated treatment and long-term fire risk mitigation, which enhance the resilience of ecosystems adapted to disturbance. Fuels treatments and prescribed burning activities promote the natural composition and structure of tree stands adapted to low-intensity fire intervals, supporting suitable breeding habitat and forage availability for MSO in mixed conifer and pine-oak ecosystems. Forest fuel reduction and restoration initiatives are progressing ecosystems toward desired conditions. Between 2019 and 2023, fuel treatments were completed on 5,076 acres of mixed conifer, 3,252 acres of ponderosa pine, and 37,605 acres of madrean pine oak woodland. Additionally, the Coronado has followed management approaches to mitigate disturbances in mixed conifer systems, including burns and insect outbreaks, by implementing anti-aggression pheromone deployment to retain large conifers. Since 2018, the Coronado has deployed deterrent pheromones on 1,700 acres within mixed-conifer systems following outbreaks and burn response. Based on this rate, the Coronado is on track to accomplishing our 10-year acreage treatments targets.

More information in the form of additional years of data collection are needed to determine population status of MSO on the Coronado. However, monitoring data from 2018 to 2023 indicates a stable distribution of MSO across territories on the Coronado, designated as protected activity areas (PACs). Survey detections of solitary owls, mating pairs, and offspring within these areas have remained consistent. Owl dispersal into new areas, an indicator of species resilience, has been observed as well. These findings suggest that the ecological conditions within relevant habitat are being sustained, facilitating stable owl populations. The exception of sustained data includes the Santa Catalina Ecological Management Area (EMA). Survey efforts for MSO were paused in the Santa Catalina mountains after 120,000 acres burned during the Bighorn fire in the summer of 2020. Surveys continued in limited areas in 2021. MSO populations within the mountain range have since shown signs of recovery, but face challenges with reduced habitat.

MQ 6: The acorn woodpecker is identified as a focal species in the madrean pine-oak woodland. Are post-treatment conditions and plan components guiding fuels reduction and forest restoration activities consistent with and moving toward ecological conditions within madrean encinal and madrean pine-oak woodlands, and ponderosa pine-evergreen shrub (oak) habitats that contribute to stable or increasing acorn woodpecker populations? How have populations and distribution of acorn woodpeckers changed?

Management initiatives are meeting desired conditions for project plans while improving acorn woodpecker habitat on the Coronado. Vegetation treatments and monitoring are conducted in accordance with project guidelines, reducing high-density fuel while maintaining clusters of trees, shrubs, and snags to enhance breeding, feeding, and shelter opportunities. An uneven-aged forest management approach is emphasized to increase successional diversity and provide additional resources for woodpecker populations. Current treatments on 37,605 acres in madrean pine-oak woodland, 108,804 acres in madrean encinal woodland, and 3,272 acres of ponderosa pine-evergreen oak demonstrate progress towards 10-year goals for associated habitat. These management practices are designed to enhance habitat suitability for woodpeckers in response to climate change, facilitated by the presence of low-severity, high frequency fires, while allowing for natural regeneration of disturbed areas.



Figure 6. Acorn woodpecker searching a tree.

Current data, based on a 5-year trend, suggest stable acorn woodpecker populations, with signs of gradual increase up to six percent in associated vegetation communities throughout southern portions of the Forest. Furthermore, recent trends suggest stable distribution, with an increased abundance in the Chiricahua EMA. This information indicates there are adequate resources for woodpecker to reside in the Coronado throughout the year. These trends indicate that management practices have maintained and are actively improving habitat quality, which is likely to benefit acorn woodpeckers.

MQ 7: The Sonoran mud turtle is identified as a focal species in natural and constructed water sources and can be found in the grasslands, madrean encinal woodlands, and madrean pine-oak woodlands vegetation communities. Are post-treatment conditions and plan components guiding management activities consistent with and moving toward ecological conditions within natural and constructed waters found in grassland, madrean encinal woodland, and madrean pine-oak woodland habitats that contribute to stable or increasing Sonora mud turtle populations? How have populations and distribution of Sonora mud turtles changed?

The Coronado is actively improving mud turtle habitat and following Land Management Plan goals by installing in-stream flow monitoring systems for future water rights and constructing developed springs. Three of the ten planned in-stream flow monitors have been installed in the past year, and five developed springs have been constructed within the past five years. In 2020, the forest constructed two stock tanks on the Sierra Vista District to provide for aquatic species habitat and sources for fire suppression. Additionally, the forest is also implementing the Mariposa Canyon watershed restoration project, improving Sonoran mud turtle habitat. These stream and spring restoration efforts are currently meeting the outlined objectives in the Land Management Plan for constructed and natural water

sources. These treatments aim to improve water quality, soil function, and aquatic species habitat. Management guidelines prioritize minimizing soil moisture impacts, reducing fuel buildup around natural water sources, and avoiding road construction near springs and seeps, allowing natural instream movement of aquatic species, including mud turtles, unless barriers are necessary to prevent the movement of non-native species. To manage for forest-wide aquatic systems and associated native species, the Coronado collaborates with partner groups to ensure viability through monitoring, water developments, and removal of invasive species.

The current data on population and distribution trends of Sonoran mud turtles on the Coronado is unclear, requiring more information to determine significant trends. To address this, the Coronado intends to coordinate with other agencies to acquire more data and develop monitoring efforts to detect mud turtle presence more frequently. This initiative may include monitoring additional stream habitats and integrating detections into leopard frog surveys. Furthermore, ongoing watershed improvement projects are underway to enhance aquatic habitats, which could benefit mud turtle populations. These efforts will be reassessed in five years to evaluate notable trends.

Recommendations

Based on our results, we are not considering any changes to the current Land Management Plan. The Coronado is meeting objectives and management approaches to progress desired conditions for focal species’ vegetation communities.

It is recommended that monitoring plans be expanded for focal species, including the implementation of stratified sampling across different ecological sites of varying quality. This approach can provide a better understanding of habitat influence on species distribution and abundance across the landscape.

Additionally, there is a need to develop monitoring efforts for focal species by fostering coordination with partner agencies and nonprofit groups. Collaborative efforts can lead to the development of comprehensive monitoring plans that incorporate a broader range of expertise and resources. Ensuring transparency and sharing trend analysis and monitoring data is crucial for fostering trust and facilitating effective decision making towards habitat and species management.

Monitoring question (MQ)	Progress Toward Land Management Plan Desired Conditions and Objectives	Recommended Actions/Next Steps
MQ5	Between 2019 and 2023, fuel treatments were completed on 5,076 acres of mixed conifer, 3,252 acres of Ponderosa pine, and 37,605 acres of madrean pine oak woodland. Since 2018, the Coronado has deployed deterrent pheromones on 1,700 on acres of mixed conifer.	Monitoring plans could be expanded for focal species, including the implementation of stratified sampling across different ecological sites of varying quality. Additional coordination with partner agencies and groups recommended to collaborate data collection efforts.

MQ6	Between 2019 and 2023, fuels treatments were completed on 37,605 acres in Madrean Pine-oak Woodland, 108,804 acres in madrean encinal woodland, and 3,272 acres of ponderosa pine-evergreen oak.	See above
MQ7	3 instream flow monitors have been installed, 5 developed springs have been constructed in the past 5 years, along with ongoing watershed restoration projects.	See above

Climate Change and Other Stressors

In the last decade, the United States has experienced new records for extreme temperature, drought, storms, and fire. These events affect millions of Americans and pose a growing threat to the resilience of communities, as well as the services that flow from the nation's forests and grasslands. The Forest Service is working to mitigate the effects of climate change using the best available science and information. Our goal is to ensure we continue to deliver the products and services that the public values and work to sustain ecological conditions on our national forests and grasslands.

Similar to the rest of the United States, on the Coronado and across the Southwest Region, we are experiencing extreme drought, extreme heat, reduction in late-season snowpack, intensified weather events, more frequent and severe fire, invasive species spread, and greater human demands. Scientists project increases in temperature and drought severity into the future (Frankson et al 2022).

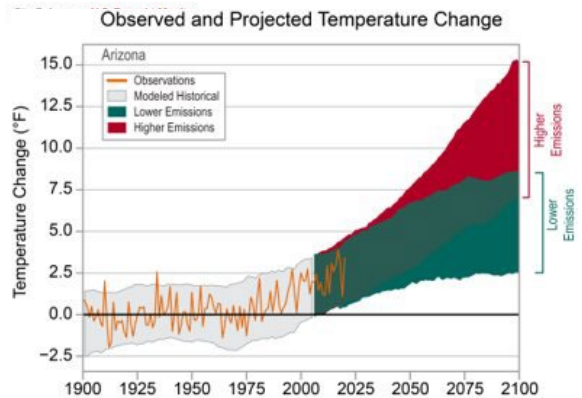
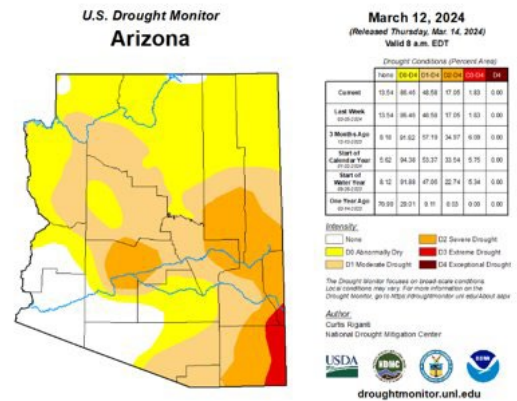
Although many of the effects of future changes are negative, strategic natural resource management can help mitigate impacts. Responses informed by the best available science will enable our resource specialists to better protect the land, resources, and the region's forests and grasslands into the future.

Monitoring Questions and Key Results

MQ 8: How has the distribution of non-native invasive grasses changed? Have changes in climate affected the spread of invasive grasses to new niches?

Invasive plant species threaten natural ecosystems of the Coronado by altering ecosystem structure and function, out-competing native plants, dominating habitat areas, decreasing biodiversity, and altering fire regimes. Once an invasive species gains traction in an area, the invasive species' success creates a significant cascading effect. For example, the invasive species can spread fire of higher intensity and frequency, creating a disturbed post-fire environment where the invasive species thrives as an early colonizer. Effective management strategies, such as herbicide treatments, prevention, and careful restoration can all facilitate the integrity of ecosystems on the Coronado.

Drought Monitor - Arizona



The Coronado's invasive management program has primarily been focused on the Santa Catalina Ranger District (SCRD). This is due to increased fire risks from the spread of buffelgrass, threatening both the wilderness-urban interface (WUI) around Tucson and the non-fire adapted ecosystem saguaro habitat within the Sonoran Desert. The Coronado has partnered with the National Forest Foundation (NFF) to tackle treating buffelgrass and other invasive species in the Santa Catalina Mountains (SCM) to reduce wildfire risk and prevent the conversion of the species-rich Sonoran Desert habitat into a monoculture grassland. Most of these efforts are concentrated within the Santa Catalina Foothills in sensitive riparian habitat, such as Sabino Canyon, Bear Canyon, Pusch Ridge, and around the Wildland Urban Interface (WUI). Between 2018 and 2023, over 9000 acres have been treated in the Santa Catalina district alone; these treatments are meeting acreage objectives in the Land Management Plan.

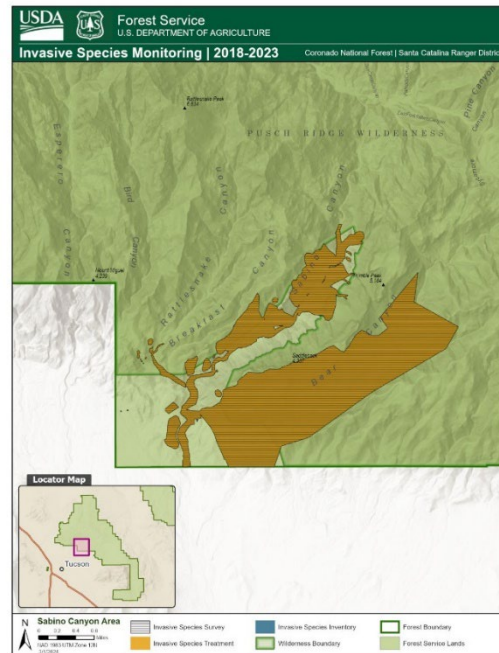


Figure 7. Example of herbicide treatments for buffelgrass on the SCM.

A photo point monitoring program supported by the University of Arizona (U of A) captured general trends regarding the distribution of non-native invasive grasses and their response to disturbances such as wildfire. 116 photo point locations were captured across the Coronado, spanning a total of 14 Ecological Response Units (ERU); ERUs represent ecosystem types, and the ERUs selected for the photo point study were roughly proportional to the extent they occur on the Coronado. Photos of the Mojave-Sonoran scrub ERUs revealed an increase in saguaros, buffelgrass, fountain grass, and Lehmann lovegrass (all three of these grass species being non-native and invasive). The Semi-Desert Grassland and Madrean Encinal ERU photo points also showed an increase in Lehmann lovegrass. In another U of A study analyzing upland vegetation monitoring data from 2000 to



Figure 8. A botanist spraying herbicide on buffelgrass on the SCM.

2021, an observed increase in Lehmann lovegrass was seen on the Safford Ranger District. Overall, warmer and drier conditions throughout the Coronado have led to additional stress for species at the lower elevations of their range. Oak and grass dominated ecosystems are vulnerable to invasive grass spread, where invasive species can displace natives and become vectors for more wildfire. Additionally, and perhaps counter intuitively, fire-adapted communities such as semi-desert grassland may begin to push systems such as Mohave-Sonoran Desert scrub downslope, a historic condition based on early 1900s photo point matches.

Monitoring invasive species comes with many challenges, and monitoring consistency has been a significant hurdle for the Coronado. Due to personnel shortages and changing funding availability for invasive species work, efforts towards monitoring have been variable over the years making it difficult to

accurately track the spread of invasives. In addition, the challenging nature of accurately surveying and managing invasive species data adds to the difficulty. Although numerous pressures influence the spread of invasive species, climate change impacts are an undeniable element in the success of non-native species invasion. Increased temperatures, growing season lengths, and high intensity wildfire all can contribute to the widened window of opportunity for invasive species to establish.



Figure 9. Sonoran Desert landscape peppered with invasive buffelgrass (yellow-brown grass).

However, quantifying changes in climate relative to invasive species spread on a Forest level scale would be difficult. The invasives species dataset we pull from to answer this question spans just 5 years, whereas assessing effects from climate change often requires a much longer dataset. It would be difficult to attribute the movement of an invasive species into new niches to climate change, and not just stochastic events, within such a short time scale. Measuring ecological effects from climate change is also difficult on a geographic scale as small as the Forest level. Broad scale vegetation patterns, such as movement of invasive species, are more easily assessed and linked to climate change on larger regional scales since climate patterns, as opposed

to weather, emerge more readily from larger geographic areas.

MQ 9: How has the scale and severity of disturbance (such as wildfires, insects, and disease) and vegetative response to these disturbances demonstrated changes in wildland ecosystems due to climate change across the Coronado?

Maintaining ecosystems under past fast regimes has become increasingly difficult due to climate change, which is a fundamental driver of increasing annual area burned (Kitzberger et al. 2017; Abatzoglou et al. 2017), and drought stress, which leaves ecosystems especially vulnerable to fire (van Mantgem et al. 2013, 2018), maintaining ecosystems as they have existed in the past has become increasingly more difficult. The long-term suppression of natural wildfire has left many forests uncharacteristically dense. These high fuel loads, when ignited, can lead to high severity fire.



Figure 10. Bighorn fire burn scar on Mt. Lemmon.

The U of A conducted a case study in the Santa Catalina Mountains (SCM) to analyze the impacts of three fires on forest resilience over time. The first two fires included the 2002 Bullock and 2003 Aspen fires; with minimal spatial overlap and close in time, the fires were combined for analysis purposes at 115,311 acres total. The second fire, the 2020 Bighorn fire, left a burn scar of over 119,986 acres. The Bighorn fire left the SCM with a complex mosaic of mostly low to moderate severity fire. Some areas burned in the Bullock and Aspen fires 17 years prior were reburned in the Bighorn fire, allowing for an examination of forest response to multiple fire exposures. Researchers examined the response of two

ERUs: ponderosa pine evergreen oak and mixed conifer, with dominant species including ponderosa pine, Southwestern white pine, and Douglas fir. What they saw was the beginnings of a complex recovery process; conifer recruitment was seen in the majority of burned plots, consisting mostly of ponderosa pine. Some mixed conifer species rely on specific climatic conditions to successfully regenerate or sprout new seedlings, so may require many more years to see full recovery. High severity plots were not seen converting entirely to an oak-dominated ecosystem, but instead in varying stages of recovery with some instances of oak and fern understory and aspen emergence. These transient states in species composition were observed over time across disturbances, suggesting they may follow expected successional tendencies and return to a previous, or similar, vegetative state. These observations support the continued introduction and support of low-mixed severity fires to moderate fuel loads, enhance biodiversity, and reduce competition for overall forest health (Kolb et al 2007, Laughlin & Fule 2008, Korb et al 2020)

The researchers also concluded that while some changes in species composition over time may seem undesirable, patches of oak or shrub are not inherently negative outcomes. These native species bring with them their own favorable characteristics, such as higher drought and fire resistance and unique habitat and resource offerings (Barton & Poulos 2018, Guiterman et al 2018). Acceptance and trust of long-term processes which reflect overall ecosystem resilience and self-regulation is critical in the face of a changing climate.

Recommendations

The above results are considered as data to support a baseline for future trend analysis on the Coronado. The Coronado is meeting management objectives laid out in the Land Management Plan for non-native invasive species and fuels treatments. Given these reasons, currently no changes are recommended. These monitoring questions will continue to be answered in future monitoring reports, and climate impacts will be considered with the given larger temporal scale.

Monitoring question (MQ)	Progress Toward Land Management Plan Desired Conditions and Objectives	Recommended Actions/Next Steps
MQ8	On track to meeting objectives, 9000 acres treated on the SCRCD between 2018 and 2023.	Continue concentrating herbicide treatments on SCRCD to meet minimum 200 acres treated in Pusch Ridge and other impacted areas. Increase efforts to survey and treat high priority invasive species in other districts. Continue improving methods and funding efforts for accurately recording invasive species infestations and treatment areas. Continue incorporating design features into ground disturbing activities to prevent the spread of invasive grass species. Monitor

		<p>for invasive species spread through partnership surveys and annual upland monitoring; ensure monitoring includes site disturbance history and methods.</p> <p>Recommend updating the monitoring question to: <i>“What are the status and trend of areas infested by invasive plant species? What are the stressors or management actions that these trends be linked to?”</i></p>
MQ9	<p>Fireshed projects and planned prescribed burns are meeting Plan objectives for their respective vegetation types.</p>	<p>Continue fireshed project program and regular prescribed burning where appropriate to return natural fire regimes and low intensity wildfire back to the landscape.</p>

Progress Toward Meeting Desired Conditions in the Plan

We are managing toward a more contiguous landscape within Forest boundaries. The isolated, high-elevation mountain ranges of the Coronado (referred to as Sky Islands) contribute greatly to public access issues, as the forest is non-contiguous. Within Coronado boundaries are numerous scattered private inholdings. Acquiring non-federal inholdings often has far-reaching benefits for multiple resources including wildlife habitat, public access, recreation, and clean water. Inholding acquisition often prevents incompatible development. Rapid population growth in Southeastern Arizona has led to a greater demand for access to public lands and, at the same time, increased development of adjacent private lands, which results in even greater restrictions to public access.



Resolution of these access deficiencies can take several forms including fee title acquisition, easement or right of way acquisition, or construction of an alternative route across NFS lands to the desired road or trail. The Coronado works closely with a coalition of partners including the Arizona Game and Fish Department, Bureau of Land Management, The Nature Conservancy, Trust for Public Land, Arizona Land and Water Trust, local counties, and recreation users to work on potential solutions.

Monitoring Questions and Key Results

MQ 10: How many acres of non-Federal land within the property lines of the Coronado National Forest have been acquired?

Between 2018 and 2023, 325 acres within forest boundaries were acquired via the Cross F land exchange. In addition, a 4-acre interchange with the Metz Trust was completed. This was a no-net gain or loss of acres, however, the acreage acquired accomplished resource objectives.

Recommendations

Based on these results, we are not considering any changes.

Monitoring question (MQ)	Progress Toward Land Management Plan Desired Conditions and Objectives	Recommended Actions/Next Steps
MQ10	Non-federal land inholdings continue to be considered for land exchange opportunities to increase contiguity on the Coronado.	No changes recommended.

Effects of Management Activities on the Productivity of the Land

Livestock grazing is permitted on about 90 percent of the Coronado. Grazing use is administered through a grazing permit system on designated livestock grazing allotments. Livestock management and Term Grazing Permits are highly variable in the season of use and the class of livestock (cows, cows and calves, bulls, yearlings, and saddle stock) grazed. To simplify the discussion of stocking in response to resource conditions, the measure of Head Month (HM) will be used as a measure of occupancy and capacity. A HM is defined as one head of cattle grazing for one month. Grazing permits define a permitted capacity for each allotment on the forest. Every Grazing Year the permit holders work with the forest to determine the annual stocking for their allotments based on resource conditions.

Monitoring Questions and Key Results

MQ11: What number of livestock are being authorized to graze on the Coronado each year to be in balance with forage supplies?

As a forest, the actual yearly stocking is often lower than the overall permitted capacity due to management changes responding to annual changes in resource conditions. For example, in 2021, the Forest permitted capacity in HMs was 260,635. As of February 2021, 149,015 HMs were authorized to graze on the Forest for the 2021 grazing year.

Inconsistent rainfall since 2020 has led to significant fluctuation in stocking forest wide. Stocking in 2021 was approximately 37 percent below permitted capacity, and down nearly 50,000 HMs from the previous year's authorized stocking.

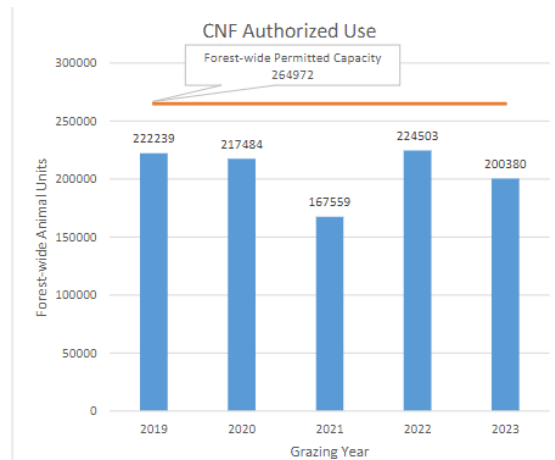
This steep decline in stocking was due to the response from the forest and permit holders to the unprecedented drought that hit the Southwest in 2020. As the forest moved forward in livestock management during the 2021 Grazing Year even greater reductions took place as permit holders responded further to the reduction in forage.

However, the monsoon season of 2022 was extremely wet, breaking records for rainfall received. The stocking rate that year reflected the abundance of forage. Finally, the summer of 2023 was the second driest monsoon ever recorded on the Coronado, so livestock reductions again took place. The stocking analysis since 2019 would suggest that the forest and its permit holders are making livestock stocking decisions based on resource conditions.

Rainfall during the 2023 winter season has provided some relief to the drought conditions residual from the summer, but there is yet to be seen if any increases from status quo may occur due to the uncertainty of the predicted monsoon strength.

Recommendations

The Coronado Range program continues to administer grazing permits in tandem with the forage capacity of the rangelands on the forest. The Range program monitors drought conditions and the impact of low moisture on forage availability for cattle. No changes are recommended for livestock



grazing based on our monitoring results in comparison to actual livestock use records and rangeland monitoring reports.

Monitoring question (MQ)	Progress Toward Land Management Plan Desired Conditions and Objectives	Recommended Actions/Next Steps
MQ11	Authorized livestock on the Coronado are in balance with forage supplies conditional on precipitation and vegetative response.	No changes recommended.

Social, Economic, and Cultural Sustainability

The Coronado supports not only diverse ecosystems, but also diverse recreational, economic, and personal experiences. To manage and regulate the various activities within its boundaries, the Coronado maintains a special use permit system. All special use permits support local and regional social, economic, and cultural sustainability in some way. The numerous outfitting and guiding permits provide a source of sustainable, tourism-based revenue for small businesses and families operating in Southern Arizona.



The administration of special use permits also ensures resource protection, public safety, economic opportunities for local communities, and access to public lands.

Monitoring Questions and Key Results

MQ 12: How many special use permits are being issued or renewed each year for events and activities on the Coronado?

All special use permits support local and regional social, economic, and cultural sustainability. The numerous outfitting and guiding permits provide a source of sustainable, tourism-based revenue for small businesses and families operating in Southern Arizona. By year, the issuance of special use permits are as follows: 129 in fiscal year 2020, 99 in 2021, 119 in 2022, and 143 in 2023. As of the end of February 2023, the Coronado was leading the Southwest region, administering 754 special use authorizations total. This is always a snapshot in time as permits are closed and issued all the time.

In the last Biennial Monitoring and Evaluation Report in 2021, the special use program was in the process of phasing out permits for isolated cabins that are not part of the recreation residence program. The legislated sale for the three isolated cabins was completed, and the associated permits terminated. The Coronado is still in the process of phasing out the remaining two isolated cabins. While there is currently no anticipated date of this being complete, the decision to remove the improvements and remediate the area around the two isolated cabins was signed in September 2023.

Recommendations

Based on these results, we are not considering any changes.

Monitoring question (MQ)	Progress Toward Land Management Plan Desired Conditions and Objectives	Recommended Actions/Next Steps
MQ12	The Coronado will continue to administer special use permits as needed.	No changes recommended.

Public Engagement

Additional information and resources can be found below:

Feel free to reach out to sara.amiot@usda.gov for any questions or feedback!

Coronado National Forest Land Management and Planning website:

<https://www.fs.usda.gov/detail/coronado/landmanagement/planning/?cid=fseprd582615>

Stinknet Awareness: Although not yet a major issue on the Coronado, stinknet, a highly flammable, noxious invasive weed has been spotted in Pima and Maricopa Counties. Also known as globe chamomile, stinknet has become widespread in some areas of those counties, pushing out native winter flowers. Stinknet has carrot-like leaves, yellow globe-shaped flower heads, and a strong turpentine odor. If you happen to spot the species anywhere on or off forest, you can track the observation online through: stinknet.org. If spotted on your property, did the plant up immediately and dispose of the entire plant to prevent future growth and reproduction. For more information on stinknet, visit:

<https://www.fws.gov/story/2021-06/pretty-looks-can-be-deceiving>;

<https://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1827-2020.pdf>



Table 3 – Summary of Results and Recommendations

Coronado National Forest monitoring questions and evaluation addressed in this report. Possible types of recommendations include changes to the land management plan or monitoring plan, changes in management activities, or recommendations for a focused assessment.

Table 3. Monitoring questions, results, and recommendations.

Monitoring question (MQ)	Progress Toward Land Management Plan Desired Conditions and Objectives	Recommended Actions/Next Steps
MQ1: Are springs and streams showing a decrease in water availability due to increases in air temperature, an increase in extreme weather events, and increased drought?	The Coronado instream flow monitoring program is continuing to measure water availability and secure USFS owned water rights.	No changes recommended.
MQ2: How many stream or spring restoration projects have been completed for the benefit of forest planning species?	32 projects were completed between FY 2021 and 2023.	No changes recommended.
MQ3: What projects have been implemented to improve watershed conditions?	85 projects have been implemented to improve watershed conditions between FY 2021 and 2023.	No changes recommended.
MQ4: Are there bat escape ramps on elevated artificial water sources?	Wildlife (bat) escape ramps are installed on all elevated artificial water sources; any damaged or missing ramps are remedied by USFS staff or permittees.	No changes recommended.
MQ5: The Mexican spotted owl (MSO) is identified as a focal species in these vegetation communities. Are post-treatment conditions and plan components guiding fuels reduction and forest restoration activities consistent with and moving toward desired ecological conditions within mixed conifer, Ponderosa pine-evergreen shrub (oak), and Madrean pine-oak woodland habitats that	Between 2019 and 2023, fuel treatments were completed on 5,076 acres of mixed conifer, 3,252 acres of Ponderosa pine, and 37,605 acres of Madrean pine oak woodland. Since 2018, the Coronado has deployed deterrent pheromones on 1,700 acres of mixed conifer.	Monitoring plans could be expanded for focal species, including the implementation of stratified sampling across different ecological sites of varying quality. Additional coordination with partner agencies and groups recommended to collaborate data collection efforts.

<p>contribute to stable or increasing MSO populations? How have populations and distributions of MSO changed?</p>		
<p>MQ6: The acorn woodpecker is identified as a focal species in the Madrean pine-oak woodland. Are post-treatment conditions and plan components guiding fuels reduction and forest restoration activities consistent with and moving toward ecological conditions within Madrean encinal and Madrean pine-oak woodlands, and Ponderosa pine-evergreen shrub (oak) habitats that contribute to stable or increasing acorn woodpecker populations? How have populations and distribution of acorn woodpeckers changed?</p>	<p>Between 2019 and 2023, fuels treatments were completed on 37,605 acres in Madrean Pine-oak Woodland, 108,804 acres in Madrean Encinal Woodland, and 3,272 acres of Ponderosa Pine-Evergreen Oak.</p>	<p>Monitoring plans could be expanded for focal species, including the implementation of stratified sampling across different ecological sites of varying quality. Additional coordination with partner agencies and groups recommended to collaborate data collection efforts.</p>
<p>MQ7: The Sonoran mud turtle is identified as a focal species in natural and constructed water sources and can be found in the grasslands, Madrean encinal woodlands, and Madrean pine-oak woodlands vegetation communities. Are post-treatment conditions and plan components guiding management activities consistent with and moving toward ecological conditions within natural and constructed waters found in grassland, Madrean encinal woodland, and Madrean pine-oak woodland habitats that contribute to stable or</p>	<p>3 instream flow monitors have been installed, 5 developed springs have been constructed in the past 5 years, along with ongoing watershed restoration projects.</p>	<p>Monitoring plans could be expanded for focal species, including the implementation of stratified sampling across different ecological sites of varying quality. Additional coordination with partner agencies and groups recommended to collaborate data collection efforts.</p>

increasing Sonora mud turtle populations? How have populations and distribution of Sonora mud turtles changed?		
MQ8: How has the distribution of non-native invasive grasses changed? Have changes in climate affected the spread of invasive grasses to new niches?	On track to meeting objectives, 9000 acres treated on the SCR D between 2018 and 2023.	Continue concentrating herbicide treatments on SCR D to meet minimum 200 acres treated in Pusch Ridge and other impacted areas. Increase efforts to survey and treat high priority invasive species in other districts. Continue improving methods and funding efforts for accurately recording invasive species infestations and treatment areas. Continue incorporating design features into ground disturbing activities to prevent the spread of invasive grass species. Monitor for invasive species spread through partnership surveys and annual upland monitoring; ensure monitoring includes site disturbance history and methods.
MQ9: How has the scale and severity of disturbance (such as wildfires, insects, and disease) and vegetative response to these disturbances demonstrated changes in wildland ecosystems due to climate change across the Coronado?	Fireshed projects and planned prescribed burns are meeting Plan objectives for their respective vegetation types.	Continue fireshed project program and regular prescribed burning where appropriate to return natural fire regimes and low intensity wildfire back to the landscape.
MQ10: How many acres of non-Federal land within the property lines of the Coronado National Forest have been acquired?	Non-federal land inholdings continue to be considered for land exchange opportunities to increase contiguity on the Coronado.	No changes recommended.
MQ11: What number of livestock are being authorized to graze on the Coronado each	Authorized livestock on the Coronado are in balance with forage supplies conditional on	No changes recommended.

year to be in balance with forage supplies?	precipitation and vegetative response.	
MQ12	The Coronado will continue to administer special use permits as needed.	No changes recommended.

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