

New Mexico Bird Conservation Plan
Grace's Warbler (*Setophaga graciae*) Species Account

New Mexico Avian Conservation Partners (NMACP)

December 2019



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Recommended Citation: Darr, M. and C. Rustay. 2019. Grace's Warbler (*Setophaga graciae*) species account *in* New Mexico Bird Conservation Plan, Version 2.2. C. Rustay, S. Norris, and M. Darr, compilers. New Mexico Avian Conservation Partners, Albuquerque, New Mexico, USA.

Grace's Warbler

NMACP Level: Species Conservation Concern, Level 1 (SC1)

NMACP Assessment Score: 18 (out of 25)

New Mexico Stewardship Responsibility: Score of 3 (out of 5)

National Partners in Flight Status: "D" Yellow Watch List

New Mexico Bird Conservation Regions (BCRs): 16, 34, and 35 (for a map of BCRs see: <http://nabci-us.org/resources/bird-conservation-regions-map/>)

Primary Breeding Habitat(s): Ponderosa Pine Forest

Other Habitats Used: Mixed-Conifer Forest, Madrean Pine-Oak Woodland

Summary of Concern

Grace's Warbler is a pine specialist that, in New Mexico, occurs primarily in ponderosa pine (*Pinus ponderosa*) forest. It is patchily distributed but may be locally common. Data from the United States Geological Survey (USGS) Breeding Bird Survey (BBS) show sharp declines in New Mexico and elsewhere, and the species is thought to be less common than historically due to the loss of mature ponderosa pine forest habitat. Light forest thinning may benefit this species in the short term, but the current science strongly suggests moderate to heavy forest thinning has negative short-term impacts on Grace's Warbler populations. Long-term thinning impacts, after remaining trees grow larger, are unknown.

Associated Species

Associated species of ponderosa pine forest include: Chipping Sparrow (BC2), Dusky Flycatcher, Flammulated Owl (SC1), Hepatic Tanager, Lewis's Woodpecker (SC1), Plumbeous Vireo, Pygmy Nuthatch (SC2), Western Bluebird (SC2), Western Tanager, Western Wood Pewee, and Williamson's Sapsucker (SC2).

Conservation Status

New Mexico Species Assessment

For a description of the assessment process see: <http://avianconservationpartners-nm.org/wp-content/uploads/2017/08/Revised-NM-Species-Assessment-Methodology-1.pdf>.

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COMBINED SCORE 18

Grace's Warbler is an NMACP level one species of conservation concern in New Mexico due to a rapidly declining population, high threats, a relatively small population size and distribution, and a moderately high stewardship responsibility for New Mexico. Grace's Warbler is also a national Partners in Flight Watch List species (Rosenberg et al. 2016), a U.S. Fish and Wildlife Service National Bird of Conservation Concern (U.S. Fish and Wildlife Service 2008), and a New Mexico Department of Game and Fish Species of Greatest Conservation Need (New Mexico Department of Game and Fish 2016).

Distribution

Grace's Warbler is resident in appropriate pine habitats across much of western and central Mexico, as well as Central America. In northern Mexico and the southwestern United States, the species is considered a migrant breeder. The United States range extends from southeast California and southern Nevada east through New Mexico and far west Texas, and from southern parts of Utah and Colorado south to the Mexican border (Stacier and Guzy 2002). In New Mexico, Grace's Warbler occurs in pine habitats throughout the state, west of the plains and the far northeastern mountains, though it appears to be far less common in the isolated Chihuahuan Desert Mountains in BCR 35.

Population Size

Partners in Flight estimates the Grace's Warbler population is 3 million birds, with New Mexico holding approximately 17% of the global population, or around 510,000 birds (95% Confidence Interval [CI]: 240,000 - 870,000; Partners in Flight 2019). A recent Grace's Warbler population study estimated a statewide population of 511,657 (95% CI: 391,092 – 632,222) on national forests in New Mexico (Envirological Services, Inc. 2018). In this study, the highest estimated numbers of Grace's Warbler were found on the Santa Fe National Forest, with a population of

143,563 (95% CI: 107,476-179,650), the Gila National Forest, with a population of 115,239 (95% CI: 80,045-150,432), the Cibola National Forest, with a population of 106,963 (95% CI: 82,790-131,137), and the Carson National Forest, with a population of 96,069 (95% CI: 83,766-108,372). The Apache and Lincoln National Forests had much smaller estimated populations, with 23,236 (95% CI: 14,354-32,117) and 26,496 (95% CI: 22,607-30,384), respectively. The small portion of the Coronado National Forest in New Mexico had the smallest population, with an estimated 92 birds (95% CI: 54-130).

Population Trend

At the time of assessment, Grace's Warbler received the maximum score of five for population trend (population loss of more than 2% per year; Sauer et al. 2017). In their Landbird Conservation Plan, Partners in Flight estimated a 52% total population loss for Grace's Warbler (Rosenberg et al. 2016).

Threats

The primary threat to Grace's Warbler in New Mexico is the loss or alteration of ponderosa pine forest habitat. New Mexico's ponderosa pine forests today differ from pre-European forests due to a history of poor land management practices including heavy logging of large trees, fire suppression, and overgrazing (Reynolds et al. 2013). Because of this, in many areas, forests are now composed of small ponderosa pine in densities higher than were found historically (Reynolds et al. 2013). Additionally, these dense forests are now prone to unnatural high-intensity canopy fires, killing all, or nearly all, ponderosa pine (Reynolds et al. 2013). This combination of habitat change caused by historical land management practices, and current high-severity fire, is likely responsible for population declines, and continues to threaten population stability in the future.

Grace's Warbler is also threatened by predicted climate change effects, including increased severity and frequency of wildfires (Westerling et al. 2006), as well as tree mortality resulting from increasing drought, temperatures, and pest outbreaks (Westerling et al. 2006, Seager et al. 2007, Cayan et al. 2010, Williams et al. 2010). Additional potential threats include logging, fuelwood collection, overgrazing, development, and moderate to heavy tree thinning for fuels reduction and/or other management objectives (light thinning, however, may benefit this species; see Habitat Management section).

Ecology and Habitat Requirements

Grace's Warbler is a pine specialist. In the southwestern United States, Grace's Warbler occurs primarily in ponderosa pine forest habitat, though Chihuahuana pine (*Pinus leiophylla*) and pine-oak woodlands are also used. Breeding may sometimes extend upslope into mixed-conifer habitat (Stacier and Guzy 2002).

The Grace's Warbler arrives in New Mexico in mid- to late-April and initiates nesting in May (Stacier and Guzy 2002). Based on studies from numerous locations across its breeding range, it maintains a large breeding territory ranging from 2-6.5 ha (approximately 5-16 ac), with size dependent upon habitat quality. Within these territories, nests are typically well hidden in outer foliage of upper ponderosa pine branches ranging from 8-18 m (approximately 26-59 ft) above the ground (Stacier and Guzy 2002). Heavy cowbird parasitism (~50%) was noted in one study in Los Alamos County (Travis 1992), but the extent to which this is a problem is unknown. In general, much information regarding basic Grace's Warbler breeding ecology is lacking.

Grace's Warbler is primarily a foliage gleaner, feeding on insects and other invertebrates. It mostly forages in the middle and upper portions of conifer canopies, on small branches and needles away from the trunk (Balda 1969, Szaro and Balda 1979, Stacier and Guzy 2002). This foraging ecology suggests conifer foliage density and canopy cover influences Grace's Warbler food availability. Two studies support this assumption. Flesch (2014) found that Grace's Warbler density increased with increasing conifer canopy cover, as well as with increasing densities of canopy trees. Kalies and Rosenstock (2013) documented a weak positive Grace's Warbler occupancy response to increasing canopy cover; in this study, canopy cover ranged from 14.9% to 72.5%, with a median of 47.5%, and an average of 47.2%.

While higher levels of canopy cover appear to be important for Grace's Warbler, the contribution of large coniferous trees to the canopy also appears to be important. One study documented a strong positive Grace's Warbler occupancy response to large ponderosa pine with a diameter at breast height (DBH) greater than 45.7 cm (approximately 18 in; Kalies and Rosenstock 2013). This same study documented a weak positive Grace's Warbler occupancy response to medium-sized ponderosa pine with a DBH of 40.6-45.7 cm (approximately 16-18 in; Kalies and Rosenstock 2013). Another study found Grace's Warbler occurrence was negatively associated with small-diameter ponderosa pine with a DBH of 2.5-8 cm (approximately 1-3 in; Jentsch et al. 2008). Finally, a literature review of silvicultural treatments in the Rocky Mountains (Hejl et al. 1995) suggests Grace's Warbler is associated with old-growth forests. All of these studies suggest Grace's Warbler prefers forests with canopy cover that is composed primarily of large trees. These large trees likely provide more upper canopy foraging opportunities; Balda (1969) found that taller, older trees, with a larger diameter at the lower edge of the canopy, provided most of the foliage volume above 30 ft. In this same study, Grace's Warbler was found almost exclusively in ponderosa pine above 15 ft.

Information regarding optimum spatial arrangement of conifer trees (i.e. clumped or evenly spaced) for Grace's Warbler is limited and conflicting (Szaro and Balda 1979, Kalies and Rosenstock 2013). However, the literature as a whole suggests tree size and adequate canopy cover may be more important than spatial arrangement.

Many ponderosa pine forests throughout New Mexico contain Gambel oak (*Quercus gambelii*). Research suggests Gambel oak is used by Grace's Warbler for foraging, but to a far lesser degree than ponderosa pine (Szaro and Balda 1979, Stacier and Guzy 2008). Limited literature suggests Gambel oak may not be a critical habitat component for Grace's Warbler, but presence of oak may have a positive effect. In northern Arizona, Rosenstock (1998)

documented Grace's Warbler in nearly all ponderosa pine forest types, regardless of oak presence. Jentsch et al. (2008), however, found Grace's Warbler occurrence in Arizona and New Mexico was positively associated with increasing shrub cover (most shrubs in this study were small Gambel oak). Additionally, in northern Arizona, Kalies and Rosenstock (2013) found Grace's Warbler was positively associated with the presence of Gambel oak. Use of Gambel oak for foraging may depend upon overall forest structure; Szaro and Balda (1979) found Grace's Warbler spent more time in Gambel oak in heavily and moderately thinned forests, as opposed to denser forests. This suggests Gambel oak may be more important for Grace's Warbler in areas where thinning or fire has significantly reduced conifer canopy cover.

Altogether, research suggests two habitat variables are very important for Grace's Warbler: conifer size and conifer canopy cover. These two variables are likely inextricably linked. Large conifer trees appear to be highly preferred, but Grace's Warbler also appears to need enough conifer trees to provide adequate canopy cover and foliage density for foraging. The preferred density of conifer trees, therefore, likely depends upon how large they are, and how much each individual tree contributes to the overall canopy cover (larger trees contribute more).

Habitat Management

Thinning

Grace's Warbler response to forest thinning is dependent upon the overall prescription. Forest management that retains or promotes large conifer trees, and appropriate levels of conifer canopy cover, is expected to benefit this species. However, as shown below, moderate to heavy thinning has negative short-term impacts on Grace's Warbler populations.

In a northern Arizona study, over the course of three years, Grace's Warbler numbers varied, but were higher overall on a lightly thinned silvicultural plot than on an unthinned control plot, moderately thinned plot, and heavily thinned plot. A clear cut plot in the study lacked any Grace's Warbler detections (Szaro and Balda 1979).

The lightly thinned silvicultural plot, which had the highest overall densities of Grace's Warbler, reduced a forest stand from 294 trees per ha (119 trees per ac) to approximately 236 trees per ha (96 trees per ac). This represented an approximate 20% reduction in ponderosa pine stem density. Additionally, Gambel oak density was reduced by 10%, and the mean tree height was reduced from 14.1 m (approximately 46 ft) to 13.2 m (approximately 43 ft; see Table 1.). Tree removal in the lightly thinned silvicultural plot focused on upgrading the stand, as opposed to evenly-spaced thinning.

The unthinned plot, moderately thinned plot, and heavily thinned plot all had lower overall densities of Grace's Warbler as compared to the lightly thinned silvicultural plot. The unthinned plot had approximately 646 trees per ha (262 trees per ac) and a mean tree height of 15.5 m (approximately 51 ft). After thinning, the moderately thinned plot had approximately 181 trees per ha (73 trees per ac) and a mean tree height of 11.5 m (approximately 38 ft).

Following thinning, the heavily thinned plot had approximately 69 trees per ha (28 trees per ac) and a mean tree height of 11 m (approximately 36 ft; see Table 1.).

Table 1. Forest Metrics after Differing Levels of Tree Thinning¹

	Unthinned	Lightly Thinned ²	Moderately Thinned	Heavily Thinned
Trees per ha/ac	646 / 262	236 / 96	181 / 73	69 / 28
Average tree height in m/ft	15.5 / 51	13.2 / 43	11.5 / 38	11 / 36
¹ Szaro and Balda 1979				
² Lightly thinned plot had highest overall densities of Grace's Warbler over the course of three years (but densities varied between years across all plots)				

Several additional studies show negative short-term responses of Grace's Warbler to moderate and heavy levels of thinning and/or removal of larger trees. In northern Arizona, Battin and Sisk (2011) found that Grace's Warbler abundance was 59% higher on unthinned sites as opposed to sites in which pine stem density was reduced by 80%; additionally, they stated the difference in abundance for Grace's Warbler may have been underestimated given differences in detectability between habitat types. A significant edge effect for Grace's Warbler was also found by Battin and Sisk (2011), with lower densities of Grace's Warbler in untreated areas adjacent to treated areas, suggesting heavy thinning may have significant negative impacts for Grace's Warbler beyond the boundaries of the thinning footprint. In Arizona, Franzreb and Ohmart (1978) documented significantly higher Grace's Warbler density in unlogged versus logged stands. Unlogged stands had approximately 626.2 trees per ha (approximately 254 trees per ac) and logged stands had approximately 167.7 trees per ha (approximately 68 trees per ac). In the Santa Fe National Forest in New Mexico, Bagne and Finch (2009) documented a non-significant negative response for Grace's Warbler abundance after forest thinning that reduced a stand from more than 1,240 trees per ha (approximately 502 trees per ac) to approximately 190 trees per ha (approximately 77 trees per ac). In the Sierra Madre del Sur Mountains in Michoacán, Mexico, Grace's Warbler abundance was negatively affected after selective logging that removed up to 30% of the larger, healthier trees; they also stated that 40-80% of trees in a logged area are usually destroyed due to the construction of logging roads, trees falling over neighboring trees, and machinery (Villasenor et al. 2005). A meta-analysis conducted by Kalies et al. (2010) found a negative mean effect size for Grace's Warbler in relation to overstory removal, and a positive mean effect size for Grace's Warbler in relation to small-diameter tree removal. Finally, in heavily thinned habitat, research shows male Grace's Warblers defend larger territories, suggesting more area is needed to satisfy their foraging requirements in areas with low canopy cover (Stacier and Guzy 2002).

Fire

Grace's Warbler response to fire likely depends upon type and severity. Numerous studies suggest Grace's Warbler responds negatively to high-severity fire that significantly reduces live canopy cover. Although they found comparison of studies difficult due to differences in methodology and quality, in a literature review, Block and Finch (1997) were able to determine that, across all studies reviewed, Grace's Warbler was more abundant on unburned plots as opposed to plots that had experienced wildfire (some of which was described by the reviewers as "stand replacing" and some of which was described simply as "wildfire"). In a meta-analysis, Kalies et al. (2010) also showed a negative mean effect size in relation to wildfire. Bock and Block (2005) found that Grace's Warbler was absent from severe wildfire areas, as opposed to areas that experienced moderate fire severity or unburned areas. Latif et al. (2016) documented a negative relationship for Grace's Warbler occupancy with increasingly severe wildfire. Finally, Johnson and Wauer (1996) documented a Grace's Warbler population decline after high-intensity wildfire. Two studies claim they found a positive relationship with increasing fire intensity for Grace's Warbler. In both studies, however, the authors didn't differentiate between surface fire and canopy fire, resulting in limited usefulness for interpretation of Grace's Warbler response (Kirkpatrick et al. 2006, Flesch 2014).

As opposed to high-severity fire that reduces live canopy cover, it is likely Grace's Warbler populations are not negatively affected by low to moderate-intensity ground fires, after which most large ponderosa pine survive and canopy cover important for foraging is retained. Research by Dickson et al. (2009) supports this hypothesis; they documented a positive relationship between prescribed surface fire and Grace's Warbler density.

Management Conclusions

Results from these studies, as well as from the research discussed in the Ecology and Habitat Requirements section, suggest some thinning may benefit Grace's Warbler populations, but there is a threshold at which it becomes detrimental. Research also suggests thinning that reduces high-severity fire risks, while retaining adequate canopy cover and promoting or retaining large conifer trees, will likely benefit Grace's Warbler. Finally, according to the literature, low-intensity prescribed surface fire can likely be used to maintain thinned sites.

Due to past logging, large ponderosa pine is scarce throughout New Mexico (Reynolds et al. 2013). Research outlined in the Ecology and Habitat Requirements section suggests large coniferous trees are important for Grace's Warbler, as is adequate canopy cover levels, and that these two variables are likely inextricably linked. Because large trees are now found in much lower densities, Grace's Warbler may need more small trees per acre to satisfy their canopy cover requirements. Higher numbers of small trees may not constitute ideal habitat, but it may explain why numerous studies have documented a Grace's Warbler decline after forest thinning. It is hypothesized that, over time, as retained trees in thinned areas grow larger, Grace's Warbler may stop responding negatively and potentially even respond positively. This hypothesis, however, does not take into account potential climate change

impacts on the growth of remaining ponderosa pine. Also, because there is a limit regarding how much a growing tree can compensate for extensive canopy cover loss, if thinning is too extensive, regardless of how large the remaining trees grow, the Grace's Warbler population will likely still be negatively impacted. It took decades for New Mexico's forests to be transformed into dense stands of small trees. To avoid negative short-term impacts on the declining Grace's Warbler population, a slow conversion of dense ponderosa pine forests consisting primarily of small trees, to forests with fewer, larger trees, may be necessary. This slow conversion would require thinning in multiple stages, allowing trees to grow larger between thinning events.

NMACP Habitat Management Recommendations

NMACP recommends the following actions to benefit Grace's Warbler populations in New Mexico, and to minimize or mitigate negative impacts when incorporating this species' needs into multipurpose management plans. Recommendations are based on direct evidence from scientific literature discussed previously, as well as inferences based upon this scientific literature and Grace's Warbler ecology. Recommendations will be refined and updated as more information becomes available in the future. Thorough site-specific assessments and pre-planning are strongly encouraged prior to development and implementation of management actions. For ease of use, units in the following recommendations are provided in the U.S. Customary System, as opposed to the Metric System.

Recommendations

- Use thinning and controlled burn practices to maintain or create mature ponderosa pine forest habitat with characteristics favored by this species; prescription recommendations include:
 - Avoid thinning during the Grace's Warbler breeding season, which runs from approximately the middle of April to the middle of July (Stacier and Guzy 2002).
 - When thinning, maintain canopy cover and trees per acre at the high end of the historical ranges listed below for ponderosa pine forests (Balda 1969, Franzreb and Ohmart 1978, Szaro and Balda 1979, Stacier and Guzy 2002, Bagne and Finch 2009, Kalies and Rosenstock 2013, Reynolds et al. 2013, Flesch 2014):
 - Canopy Cover: 10% - 50% (maintain stands at the high end of this range)
 - Trees per acre: 11.7 – 124 (maintain stands at the high end of this range)*

**Trees per acre and basal area are common metrics measured before and after forest thinning. However, canopy cover and tree size (diameter at breast height) are likely more appropriate metrics for Grace's Warbler habitat suitability. In relation to optimum Grace's Warbler habitat, it is likely canopy cover and size of*

trees is inextricably linked. Therefore, in stands with smaller trees, it is probably necessary to retain more trees per acre after the initial thinning; however, it is hypothesized that as the remaining trees grow larger, and contain larger canopies, it may be possible to remove additional trees, as fewer trees per acre will be required to satisfy Grace's Warbler canopy cover requirements. This hypothesis, however, does not take into account potential climate change impacts on the growth of remaining ponderosa pine. Also, because there is a limit regarding how much a growing tree can compensate for extensive canopy cover loss, if thinning is too severe, regardless of how large the remaining trees grow, the Grace's Warbler population will likely still be negatively impacted. We encourage the incorporation of canopy cover and tree size (diameter at breast height) measurements into monitoring projects. Additionally, we recommend long-term monitoring after thinning to determine Grace's Warbler response after trees grow larger, and whether the number of trees per acre can be reduced further after the remaining trees grow larger.

- When thinning, retain the tallest ponderosa pine trees on your site, while also maintaining appropriate canopy cover levels (as outlined above; Balda 1969, Szaro and Balda 1979).
- When thinning, retain the largest DBH ponderosa pine trees on your site, while also maintaining appropriate canopy cover levels (as outlined above); retaining ponderosa pine above 18 in DBH is particularly important (Kalies and Rosenstock 2013).
- When thinning in a mosaic, conduct light thinning within patches of retained trees to encourage growth of larger ponderosa pine with larger canopies (Kalies and Rosenstock 2013).
- When thinning ponderosa pine forests, retain and/or promote as much Gambel oak as possible (Szaro and Balda 1979, Jentsch et al. 2008, Kalies and Rosenstock 2013); information regarding the relative importance of each Gambel oak life form (shrubby groundcover, pole-sized clumps, and single old-growth trees) for Grace's Warbler is unknown, but given the importance of all Gambel oak life forms for bird diversity and other bird species of conservation concern (Rosenstock 1998, Jentsch et al. 2008), retention or promotion of Gambel oak in all its life forms is recommended.
- Use low-intensity prescribed surface fire (consistent with historic fire intervals) to maintain mature ponderosa pine forest habitat (Dickson et al. 2009); prescribed fire should be conducted outside the Grace's Warbler breeding season, which runs from approximately the middle of April to the middle of July.

Species Conservation Goals

Partners in Flight Goals

The 2016 Partners in Flight North American Landbird Conservation Plan places Grace's Warbler in the "D" Yellow Watch List category. It sets a goal of stabilizing Grace's Warbler populations in the short term and reclaiming a portion of the lost population within the next 30 years (Rosenberg et al. 2016).

NMACP Goals

- Stabilize and reverse current negative population trend on USGS BBS survey routes in the state by maintaining and creating mature ponderosa pine forest habitat with characteristics favored by this species.
- Protect populations and increase suitable habitat availability on all National Forests in New Mexico, with a special emphasis on the following forests, which recent surveys show have the highest, and thus most important, populations of Grace's Warbler in NM: the Santa Fe National Forest, Gila National Forest, Cibola National Forest, and Carson National Forest.
- Better define habitat relationships for Grace's Warbler to allow for refinement of best management practices. This includes: desired levels of canopy cover, ponderosa pine density per size class, interaction between canopy cover and size of ponderosa pine, importance of Gambel oak, and definition of other habitat characteristics preferred by Grace's Warbler.

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