

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

New Mexico Avian Conservation Partners (NMACP)

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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 this species is thought to be less common than historically due to the loss and alteration of 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 impacts from thinning, after remaining trees grow larger, are unknown.

Associated Species

Associated species of ponderosa pine forest include: Chipping Sparrow (*Spizella passerina*), Dusky Flycatcher (*Empidonax oberholseri*), Flammulated Owl (*Psiloscoops flammeolus*), Hepatic Tanager (*Piranga flava*), Lewis's Woodpecker (*Melanerpes lewis*), Plumbeous Vireo (*Vireo plumbeus*), Pygmy Nuthatch (*Sitta pygmaea*), Western Bluebird (*Sialia mexicana*), Western Tanager (*Piranga ludoviciana*), Western Wood-Pewee (*Contopus sordidulus*), and Williamson's Sapsucker (*Sphyrapicus thyroideus*).

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 2020). 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 2020). 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 removal 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. Additionally, these dense forests are now prone to unnatural high-severity 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 stand-replacing fires, 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 the 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 Chihuahuah pine (*Pinus leiophylla*) is also used. Breeding may sometimes extend upslope into mixed-conifer habitat (Stacier and Guzy 2020).

The Grace's Warbler arrives in New Mexico in April, and initiates nesting in May (Stacier and Guzy 2020). 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 2020). 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 canopy cover is important for Grace's Warbler. 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 canopy cover appears to be important for Grace's Warbler, conifer tree size 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 (presumably composed primarily of large trees). In addition to trees with a larger DBH, tall trees also appear to be important. Balda (1969) found that Grace's Warblers foraged extensively in ponderosa pine heights between 12 m (39 ft) and 21 m (69ft).

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 2020). 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 foraging in Gambel oak within severely thinned and moderately thinned strip-cut plots, as opposed to a lightly-thinned silvicultural plot and an unthinned control plot.

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) found the highest average densities of Grace's Warbler in a lightly-thinned silvicultural treatment that was thinned to "upgrade the stand rather than to obtain uniform spacing." Kalies and Rosenstock (2013) found a significant positive relationship with an evenly-spaced forest structure; however, the authors caution that their results are limited because the stands in their study were dominated by small-diameter trees in a uniform distribution.

Habitat Management

Thinning

Grace's Warbler response to forest thinning is dependent upon the overall prescription, and how it relates to historical, pre-European conditions. According to Reynolds et al. 2013, ponderosa pine forests in the Southwest historically had approximately 12 to 124 trees per acre, and 10-50% canopy cover. The following studies suggest Grace's Warbler densities are highest when trees per acre and canopy cover remain at the high end of these historical ranges.

In a northern Arizona study, over the course of three years, Grace's Warbler densities varied, but were higher on average in a lightly-thinned silvicultural plot than on an unthinned control plot, moderately thinned strip-cut plot, and severely-thinned plot. A clear-cut plot in the study lacked any Grace's Warbler detections (See Table 1.; Szaro and Balda 1979)

The lightly-thinned silvicultural plot, which had the highest average densities of Grace's Warbler, reduced a forest stand from 271 ponderosa pine per ha (110 per ac) to 216 ponderosa pine per ha (87 per ac). This represented an approximate 20% reduction in ponderosa pine stem density. The mean tree height was reduced from 14.1 m (46 ft) to 13.2 m (43 ft; see Table 1.). Tree removal in the lightly-thinned silvicultural plot focused on "upgrading the stand as opposed to uniform thinning".

The unthinned control plot, moderately thinned strip-cut plot, and severely-thinned plot all had lower average densities of Grace's Warbler as compared to the lightly-thinned silvicultural plot. The unthinned plot had 583 ponderosa pine per ha (236 per ac) and a mean tree height of 15.5 m (51 ft). After thinning, the moderately-thinned plot had 145 ponderosa pine per ha (59 trees per ac) and a mean tree height of 11.5 m (38 ft). Following thinning, the severely-thinned plot had 60 ponderosa pine per ha (24 per ac) and a mean tree height of 11 m (36 ft; see Table 1.).

Table 1. Forest Metrics and Grace’s Warbler (GRWA) Density From Szaro and Balda 1979

Study Plot	Absolute Tree Density			Mean Tree Height	Canopy Volume (m ³ /ha)	Average GRWA Density (pairs/40ha)
	Ponderosa	Oak	All Trees			
Control (unthinned)	582.5/ha (235.8/ac)	54.3/ha (21.9/ac)	646/ha (261/ac)	15.5m (50.8 ft)	19370	8.5
Pre-treatment Silvicultural (lightly thinned)	271.4/ha (109.9/ac)	22.6/ha (9.1/ac)	294/ha (101/ac)	14.1m (46.2 ft)	23976	not reported
Post-treatment Silvicultural (lightly thinned)	216.1/ha (86.5/ac)	20.1 (8.1/ac)	236/ha (96/ac)	13.2m (43.3 ft)	17039	16.5
Post-treatment Strip Cut (moderately thinned)	145.4/ha (58.8/ac)	34.4/ac (13.9/ac)	181/ha (73/ac)	11.5m (37.7 ft)	6526	12
Post-Treatment Severely Thinned	59.7/ha (24.1/ac)	9/ha (3.6/ac)	69/ha (28/ac)	11m (36 ft)	3990	5.8
Post Treatment Clear Cut	not reported	not reported	not reported	not reported	not reported	0

Notes on treatments and surveys: Grace’s Warbler surveys were conducted from 1973-1975; pre-treatment tree densities, and other vegetation metrics, were only reported for the silvicultural plot; treatment of the silvicultural plot was completed in April 1974; treatment of the strip-cut plot was completed in the spring of 1970; treatment of the severely-thinned plot was completed in the spring of 1969; treatment of the clear-cut plot was completed in the spring of 1967.

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. In Arizona, Franzreb and Ohmart (1978) documented significantly higher Grace’s Warbler density in unlogged versus logged stands. Unlogged stands had 626.2 trees per ha (254 trees per ac) and logged stands had 167.7 trees per ha (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 reduced a stand from more than 1,240 trees per ha (502 trees per ac) to 190 trees per ha (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. What may be driving this is unknown. One potential reason is that more area may be needed to satisfy their foraging requirements in areas with low canopy cover (Stacier and Guzy 2020).

Fire

Grace's Warbler response to fire likely depends upon type and severity. The following studies suggest Grace's Warbler responds negatively to high-severity fire, and positively to low-severity surface fire.

Although they found comparisons difficult due to differences in methodology and quality, Block and Finch (1997) determined 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) showed a negative mean effect size in relation to wildfire. Bock and Block (2005) found that Grace's Warbler was absent from high-severity 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-severity wildfire.

Dickson et al. (2009) documented a positive relationship between prescribed surface fire and Grace's Warbler density. This makes sense given that historically, low-severity surface fires burned in ponderosa pine forests on 0-35 year intervals (Reynolds et al. 2013).

Two studies, Kirkpatrick et al. 2006 and Flesch 2014, found a positive relationship with increasing fire severity for Grace's Warbler; however, the authors didn't differentiate between surface fire and canopy fire, resulting in limited usefulness for interpretation of Grace's Warbler response.

NMACP Habitat Management and Monitoring Recommendations

NMACP Interpretation of the Best Available Science:

- The most important habitat variables for Grace's Warbler appear to be canopy cover and tree size, with higher levels of canopy cover (within the historical range) and larger trees (taller and larger in diameter) being preferred.
- Some thinning may benefit Grace's Warbler populations, but there is a threshold at which it becomes detrimental.
- Heavily thinning dense stands of smaller-diameter trees results in significant short-term population declines.
- Gambel oak may not be a critical habitat component for Grace's Warbler, but the presence of oak may have a positive effect.
- Low-severity prescribed surface fire can likely be used to maintain thinned sites.
- Trees per acre and basal area are common metrics measured before and after forest thinning. However, canopy cover and tree size (height and diameter at breast height) are likely more appropriate metrics for Grace's Warbler habitat suitability.

Based upon the interpretations outlined above, NMACP recommends the following actions to benefit Grace's Warbler populations in New Mexico, and to minimize or mitigate negative impacts when incorporating Grace's Warbler 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, Grace's Warbler ecology, and forest 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 prescribed fire practices to maintain or create ponderosa pine forest habitat with characteristics favored by this species. Grace's Warbler preferred habitat consists of numerous interconnected variables; thus, the prescription items listed below must be implemented together, and are not meant to be stand-alone considerations. 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.

- When thinning, maintain overstory canopy cover at the high end of the historical range listed below for ponderosa pine forests:
 - Canopy Cover: 10% - 50% (maintain stands at the high end of this range)
- 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. *

** It is likely trees per acre and tree size (DBH) are inextricably linked. In other words, the number of ponderosa pine trees needed per acre depends upon the size of the trees (larger trees contribute more to the canopy). For example: 300 small ponderosa pine trees/acre is not ideal, and likely not as good for Grace's Warbler as 100 large ponderosa pine trees; however, both scenarios may provide adequate canopy cover to sustain a Grace's Warbler population.*

Because most ponderosa pine forests in New Mexico today are composed of higher densities of small and medium-sized trees, thinning in stages, allowing trees to grow larger in-between thinning events, may reduce the significant, short-term Grace's Warbler population declines observed in numerous studies (see the case study example on page 12 for more information). This hypothesis, however, needs to be tested.

- When thinning, retain the tallest ponderosa pine trees on your site, while also maintaining appropriate canopy cover levels (as outlined above); retaining ponderosa pine at heights greater than 39 ft is particularly important.
- When thinning in a mosaic, conduct light thinning within patches of retained trees to encourage growth of larger ponderosa pine with larger canopies, while also maintaining appropriate canopy cover levels (as outlined above).
- When thinning ponderosa pine forests, retain and/or promote as much Gambel oak as possible, in all its life forms (shrubby groundcover, pole-sized clumps, and single old-growth trees).
- Use low-severity, low-intensity prescribed surface fire (consistent with historic fire intervals) to maintain mature ponderosa pine forest habitat; 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.
- Incorporate canopy cover and tree size (height and diameter at breast height) measurements into monitoring projects; and conduct long-term Grace's Warbler monitoring at thinned sites, as well as at paired unthinned control sites.

Case Study: Santa Fe County's Ortiz Mountains Open Space



Due to past land management practices, ponderosa pine forests on the property consist of dense stands of small-diameter trees. Few trees exceed 18 in DBH. Canopy cover averages around 54%, which is above the historical average for southwestern ponderosa pine forests, per Reynolds et al. (2013). The County's land management goal is to reduce the risk of high-severity wildfire and improve forest health by slowly transitioning these forests into stands with fewer, larger-diameter trees.

The County hopes to limit negative short-term impacts to wildlife during this process. Surveys across the property indicate extensive use of these forests by Grace's Warbler. Grace's Warbler is a species of conservation need, and a bird whose populations are linked to ponderosa pine forest health. Grace's Warbler is also a relatively easy wildlife species to monitor (as opposed to mammals or herps). The County has therefore selected Grace's Warbler as an indicator species to assess management impacts. To incorporate Grace's Warbler needs into management, Santa Fe County, in collaboration with Defenders of Wildlife, plans to do the following:

- Thin in stages, outside of wildlife breeding seasons, with the first stage reducing canopy cover to approximately 50% (at the high end of the historical range); thinning will occur by removing smaller-diameter trees, removing ladder fuels, and creating or expanding upon existing openings (a mosaic structure was selected based upon historical stand structure as described in Reynolds et al. 2013).

- Retain as many of the tallest and largest (DBH) trees as possible

- Retain all oak

- Monitor canopy cover levels before thinning, and for many years after thinning

- Monitor Grace's Warbler density and/or occupancy before thinning, and at regular intervals after thinning, at both the treatment site and an unthinned control site

- As part of an adaptive management strategy, based upon monitoring results, the following triggers (T) will be used to determine when additional thinning is appropriate:

T1: Trends show decreasing Grace's Warbler densities: refrain from additional thinning until tree size and canopy cover have increased and warbler densities trend upward. *Note at what minimum canopy cover warbler densities began to decrease and avoid thinning beyond this cover level in the future.*

T2: Trends show stable Grace's Warbler densities: continue to lower canopy cover levels in stages. Continue until criteria for T1 or T3 are met.

T3: Trends show increasing Grace's Warbler densities: *Note this target canopy cover level and attempt to thin to this level in the future.* As tree size and canopy cover increase, continue to lower canopy cover levels in stages, without dropping below the noted level.

If you have questions regarding this adaptive management plan please contact Margaret (Peggy) Darr at pdarr@defenders.org. Results from this adaptive management strategy will be shared with the bird conservation community via the NM Avian Conservation Partners listserv. Instructions regarding how to sign up for this listserv may be found on the NM Avian Conservation Partners website at: <http://avianconservationpartners-nm.org/>.

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 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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Disclaimer: the recommendations in this species account do not necessarily reflect the positions of all NMACP steering committee members, or the agencies and organizations they represent.

Some of the science that informed NMACP's habitat management recommendations for Grace's Warbler comes from studies conducted outside of the Southwest (New Mexico and Arizona). NMACP strongly encourages additional research on Grace's Warbler in New Mexico.