

Holy Ghost Ipomopsis
(Ipomopsis sancti-spiritus)

**5-Year Review:
Summary and Evaluation**



Photo: Phil Tonne

**U.S. Fish and Wildlife Service
New Mexico Ecological Services Field Office
Albuquerque, New Mexico**

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5-YEAR REVIEW
Holy Ghost Ipomopsis/*Ipomopsis sancti-spiritus*

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office: Region 2 - Susan Jacobsen, Chief, Threatened and Endangered Species, 505-248-6641; Wendy Brown, Recovery Coordinator, 505-248-x6664.

Lead Field Office: New Mexico Ecological Services Field Office - Eric Hein, Terrestrial Ecosystems Branch Chief, 505-761-4735.

1.2 Methodology used to complete the review:

This review was a collaborative effort with biologists' input from the U.S. Fish and Wildlife Service's (Service) Region 2 Regional Office, New Mexico Ecological Services Field Office, New Mexico State Forestry Division (NMSF), and University of New Mexico (UNM). Phil Tonne, Botanist for Natural Heritage New Mexico (UNM Biology Department), was contracted through a Section 6 grant to gather the relevant information and prepare a draft of the review.

1.3 Background

1.3.1 FR Notice citation announcing initiation of this review:
69 FR 43621, July 21, 2004.

1.3.2 Listing history

Original listing

FR Notice: 59 FR 13836

Date Listed: March 23, 1994

Entity listed: Species, *Ipomopsis sancti-spiritus*

Classification: Endangered

1.3.3 Associated rulemakings: Not applicable.

1.3.4 Review History: Not applicable.

1.3.5 Species' Recovery Priority Number at start of 5-year review:

2C - This indicates a high degree of threat, a high recovery potential, the listed entity is a species, and there is conflict.

1.3.6 Recovery Plan or Outline

Name of plan: Holy Ghost Ipomopsis (*Ipomopsis sancti-spiritus*)
Recovery Plan

Date issued: September 30, 2002.

Dates of previous revisions: The recovery plan has not been revised.

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) Policy

2.1.1 Is the species under review a vertebrate? No.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan? Yes.

2.2.1.1 Does the recovery plan contain objective, measurable criteria?

Yes. The Holy Ghost Ipomopsis (*Ipomopsis sancti-spiritus*) Recovery Plan (Recovery Plan) states: “Downlisting to threatened can occur when a population with at least 2,000 plants per year is maintained in Holy Ghost Canyon, and when four additional populations, each with at least 400 plants, are established and maintained for 10 years in the Upper Pecos River Basin. In addition, the USFS must develop and implement a management plan for the Holy Ghost ipomopsis that ensures the continued protection of these established populations. Downlisting can occur when appropriate population viability targets are identified and reached and when monitoring by the USFS demonstrates that the management plan is successful in protecting the necessary populations.”

In addition, the step-down outline prescribes five primary recovery actions that are necessary to alleviate threats and achieve the recovery criterion:

1. Establish a management plan that protects the current population from existing threats.
2. Study the species’ biology and ecology.
3. Establish a botanical garden population and a seed bank.
4. Search for new populations.
5. Reintroduce Holy Ghost ipomopsis in the upper Pecos River Basin and protect reintroduced populations.

2.2.2 Adequacy of recovery criteria

2.2.2.1 Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?

Yes. The recovery criteria are well written to accommodate new information and to allow for studies to obtain that information. New information suggests that the ratio of flowering plants to rosettes in Holy Ghost Canyon may be higher than previously calculated. Using recent data trends, the proportion of flowering plants to rosettes is discussed below and an updated relationship is discussed. New trends in the population only make the criteria more necessary and urgent because the total numbers of plants, estimated from the number of flowering individuals, may have been overestimated prior to 2008. The implementation of recovery actions should be accelerated to adequately meet the needs of this species. The potential habitat of Holy Ghost ipomopsis within Holy Ghost Canyon is changing, and favorable habitat for this species is apparently more restricted than in the past. Implementation of all aspects of the recovery plan and increased interagency cooperation are needed to protect this species. As time passes, the opportunities for conservation and recovery of Holy Ghost ipomopsis may become increasingly limited, changing the relevance of the recovery criteria.

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

Yes. All listing factors given in the 2002 recovery plan remain relevant to the species.

2.2.3 List the recovery criteria as they appear in the plan, and discuss how each criterion has or has not been met, citing information.

1. The Holy Ghost Canyon population must be maintained at an annual population average of 2,000 plants for 10 years.

This is the minimum acceptable population value that must be maintained to recover the species despite threats from other forest uses and management conflicts within its habitat. To that extent, it falls under the following listing factors:

- A. Present or threatened destruction, modification, or curtailment of its habitat or range.
- B. Over utilization for commercial, recreational, scientific, or educational purposes.
- C. Disease and predation.
- E. Other natural or manmade factors affecting its continued existence.

There are two population data sets covering the Holy Ghost Canyon population along Forest Road 122 (F.R. 122) for Holy Ghost ipomopsis: one spanning from 2002 to 2005 (Maschinski, pers. comm., 2006) and the other from 2003 to 2008 (Sivinski and Tonne 2007, 2008). By estimating flowering plants visible from the road, a yearly average of 334 flowering plants between 2002 and 2005 was found (Maschinski, pers. comm., 2006). The Recovery Plan states that maintenance of 300-400 flowering individuals corresponds with a population estimate of 2,000 total plants during a normal precipitation year, a proportion ranging from 15% to 20% of the population. According to the Recovery Plan, an average of 334 flowering adults falls at the lower end of the desired minimum range for numbers of flowering plants.

More recently, ongoing data have been collected using field counts in monitored plots along F.R. 122, representing samples of the entire Holy Ghost ipomopsis population. Between 2003 and 2008, an average of 703 total plants was counted per year, ranging from 618 to 852. Of the total number of plants, an average of 183 flowering plants and 520 rosettes per year was recorded, with flowering plants comprising 26% of the population (Sivinski and Tonne 2007, 2008). This average falls above the percentage given in the Recovery Plan for calculating the number of total plants. The most recent survey, conducted in September 2008, recorded 117 flowering plants and 505 rosettes, totaling 622 individual plants, with flowering plants making up 19% of the population (Sivinski and Tonne 2008). Based on an additional comprehensive field survey of long-occupied areas along F.R. 122 conducted in August 2008, the September 2008 data from monitored plots represent 47 percent of the estimated population occurring in that area (Tonne, unpublished data, 2008).

Augmentation of the Holy Ghost Canyon population of Holy Ghost ipomopsis along F.R. 122 took place in 2007 using transplanted rosettes from the UNM greenhouse (Sivinski and Tonne 2008). Survival of the 256 rosettes transplanted in 2007 was high, and many flowered, fruited, and set seed in 2008 (Sivinski and Tonne 2008). The 1,321 plants counted in the August 2008, comprehensive surveys revealed 464 flowering adults and 857 rosettes, and included an unknown number of surviving individuals transplanted as rosettes in July of 2007 (Sivinski and Tonne 2008). Due to the presence of surviving transplants in 2008, the annually monitored plots may represent a proportion slightly larger than 47%. This

recovery criterion has not been met. Yearly counts indicate that we are not yet achieving the population parameters outlined by this criterion. It is unclear whether this is a temporary condition that is attributable to drier conditions during the sampling period. Recent population monitoring data showed a spike in the abundance of rosettes following above-average and sustained late-monsoon rains during 2006 (Sivinski and Tonne 2006). Several years of increased precipitation may allow the population to reach established recovery parameters, but it appears prudent to augment the natural population with greenhouse-grown material at this time.

2. *Establishment of four additional populations in the upper Pecos Basin.*

This criterion is an attempt to decrease the vulnerability of the single-population species to chance events such as catastrophic fire or disease. Establishing multiple populations greatly reduces the chances that the species will suffer an unexpected loss of individuals, jeopardizing the survival of the species. This criterion falls under the same listing factors mentioned in recovery criterion 1: factors A, B, C, and E.

Establishing new Holy Ghost *ipomopsis* populations has been a process of trial and error, but the current approach, supported by U.S. Forest Service (USFS) cooperation, shows promise. Attempts to establish a new population through direct seeding and transplantation into Willow Creek appear to have failed (Sivinski and Tonne 2005). Efforts to establish new populations in the Winsor, Panchuella, and Indian Creek drainages, all close to Holy Ghost Canyon in the Santa Fe National Forest, began in 2005. Since the last transplanting of seedlings in 2006, the number of adults has declined, due in part to the natural life cycle of monocarpic plants, which flower once and then die. Although seedlings from previously transplanted individuals have been found, it will be several years before we can properly assess the viability of these populations. Table 1 shows a plant count for the three experimental populations.

Table 1. Plant counts at three experimental populations in the upper Pecos River drainage, 2005-2008.

Site	Year(s) Planted	2006 Count	2007 Seedling	2007 Rosette	2008 Seedling	2008 Rosette	2008 Adult
Panchuela Creek	2005, 2006	464	55	273	56	38	0
Winsor Creek	2005, 2006	422	80	355	85	33	8
Indian Creek	2006	350	0	214	16	22	3
Total		1236	135*	842	157*	93*	11

*Distinguishing seedlings and rosettes of *Ipomopsis sancti-spiritus* from the more common and sympatric *Ipomopsis aggregata* is unreliable.

The methodology for raising and transplanting plants has been refined and appears to be reliable. Increased cooperation by the USFS has been crucial to implementing this process. The human effort was approaching what was needed (cooperative efforts have made this project very promising) but recovery efforts need to continue; the ability of the plants to establish in the areas selected is unclear and will need to be monitored for several years. Drought conditions in the Pecos/Las Vegas Ranger District (Santa Fe National Forest) may be an important factor in the outcome of the experimental plantations. Monsoon rains began just prior to planting the Holy Ghost ipomopsis in early July 2006. Rainfall was steady through the months of July and August, allowing the plants to become well-rooted without the necessity of hand watering as had been necessary in previous years. The break from drought conditions in the area and timing of precipitation may prove critical in the establishment of experimental populations of this species. It will take years to determine whether these experimental populations will become successfully established.

This recovery criterion has not been met.

3. The Holy Ghost Canyon and additional populations must be protected via the development and implementation of a species-specific management plan that protects the species and is consistent with land uses in the area. In addition, the designation of Holy Ghost Canyon as a Botanical Area to highlight its unique botanical status should be considered.

This criterion addresses listing factor D: Inadequacy of existing regulatory mechanisms. If this species is to be downlisted after meeting the criteria in the Recovery Plan, it could easily decline in numbers and have to be uplisted once again due to the fluctuating nature of monocarpic plant population trends. The existence of a USFS management plan that establishes conservation parameters for this species would not only expedite the recovery of this species, but provide protection for it should it be downlisted or delisted.

The USFS is aware of this endangered species and its locations within the Santa Fe National Forest. The USFS, as well as the Service and State of New Mexico, prohibit the unauthorized collection of this species. As long as the Holy Ghost ipomopsis is listed as an endangered species, land uses within its Federal jurisdiction habitats must be reviewed and assessed through the National Environmental Protection Act (NEPA) and the Endangered Species Act (ESA), section 7 consultation processes.

This process has worked for many species and may have been adequate for this species to date. However, there is a pressing need to create a species-specific USFS management plan for the Holy Ghost ipomopsis.

While Holy Ghost ipomopsis receives blanket protections and reviews under NEPA and ESA provisions, this is one of the rarest known species in New Mexico. It is the rarest plant species on the Santa Fe National Forest and has no designated critical habitat. The total occupied habitat for this species consists of a few acres that are subjected to many land use pressures and vulnerable to management decisions. If this species' habitat is inadvertently impacted during a fire-suppression operation or road maintenance project, the entire species may disappear. No steps have been taken to improve the habitat within Holy Ghost Canyon or to study what mechanisms might be useful in expanding the suitable habitat for this species. Writing a USFS management plan and doing the necessary studies to begin conservation activities within the known habitat of this species is a necessary step to conserving this species. In lieu of a USFS management plan for the Holy Ghost ipomopsis, it would be prudent to begin interagency discussions of what conservation steps we might be able to implement in Holy Ghost Canyon.

This recovery criterion has not been met. Steps still need to be taken to develop a USFS management plan for the Holy Ghost ipomopsis or for Holy Ghost Canyon itself. Management needs and habitat parameters of this species in Holy Ghost Canyon still are not clearly understood.

2.3 Updated Information and Current Species Status

2.3.1 Biology and habitat

2.3.1.1 New information on the species' biology and life history:

Both greenhouse propagation and field survival recently have shown success in terms of germination rates, seedling transplant establishment, and seed production from transplants in the field. Transplanting has occurred at the three experimental plots outside of Holy Ghost Canyon and within Holy Ghost Canyon (Sivinski and Tonne 2007, 2008). Greenhouse germination studies on Holy Ghost ipomopsis found a germination rate of 86% and 89% from samples of 100 and 101 seeds, respectively (Tonne, unpublished data, 2005). Seedlings were raised at the UNM greenhouse between 2003 and 2007. During 2003 and 2004, greenhouse-raised seedlings were grown in preparation of transplanting to the field (Sivinski and Tonne 2007). In July 2005, 381 greenhouse seedlings were transplanted to Panchuela and Winsor Canyons in the Santa Fe National Forest (Sivinski and Tonne 2007). The dry conditions required hand watering twice per week for about a month until the monsoons arrived in mid-August (Sivinski and Tonne 2007). The experimental sites had survival rates of 69-89% through the dry winter and spring of 2005 and 2006. Within the next year, 67 percent had mature

seed capsules and 29 new seedlings were found in September, 2006 (Sivinski and Tonne 2007).

In July 2006, 957 new rosettes from the greenhouse were transplanted among the Panchuela Canyon, Winsor Canyon, and Indian Creek experimental locations. Ninety-eight percent of the transplants were successfully established by late September 2006 (Sivinski and Tonne 2007). During the spring of 2007, 842 of the original plants (88%) remained as rosettes (Sivinski and Tonne 2008). By August 2008, 250 rosettes and seedlings were counted, but the overall adult count dropped to 11 individuals with the Panchuela Canyon population exhibiting no flowering adults.

Regeneration within the sites is currently being monitored, but without comparisons to identify adult flowering plants, this information will be of limited use. The recent decrease in overall number likely reflects the loss of plants due to their monocarpic nature. While some transplants died as rosettes the majority flowered, fruited, and died following the natural steps of their life cycle. It is unclear how much viable seed was produced in this process. The survival and germination of seed will hopefully lead to the spread of this plant within these experimental populations.

Seedbank longevity for Holy Ghost ipomopsis is unknown. Another rare congener, *Ipomopsis aggregata* ssp. *weberi*, native to northern Colorado, is known to have relatively short-lived seed (Wilken 1996). Wilken (1996) speculated that the seed bank for this taxon “may become depleted after 5 years.” This may or may not be the case with the Holy Ghost ipomopsis. One trend that may confound potential limitations of the seed bank is that, not only is less seed produced during drought years, the seed that is produced has a higher proportion of lower-weight seed. Drought seed is relatively small and may have a reduced viability in the seed bank.

2.3.1.2 Abundance, population trends, demographic features, or demographic trends:

The method introduced in the Holy Ghost Ipomopsis Recovery Plan for estimating population numbers is to survey the number of flowering plants and estimate the number of immature, non-flowering rosettes based on the flowering adults comprising 15% to 20% of the total population. Recent population data has revealed a wider range with a higher average proportion of flowering adults to rosettes, although the lower range of variation falls within the original estimated ratio (Sivinski and Tonne 2005, 2006, 2007, 2008). From 2003 to 2008, flowering plants have ranged from 15% to 50% of the total plant population of Holy Ghost ipomopsis, with flowering plants representing an average of 26% of the population (Sivinski and Tonne 2008). Assuming that monitored plots

accurately represent the entire population, the original method of estimating the population based on flowering plants comprising 17.5% of the total population appears to need modification to reflect more accurate ratios. Population trends within monitoring plots can be seen in Figure 1 below.

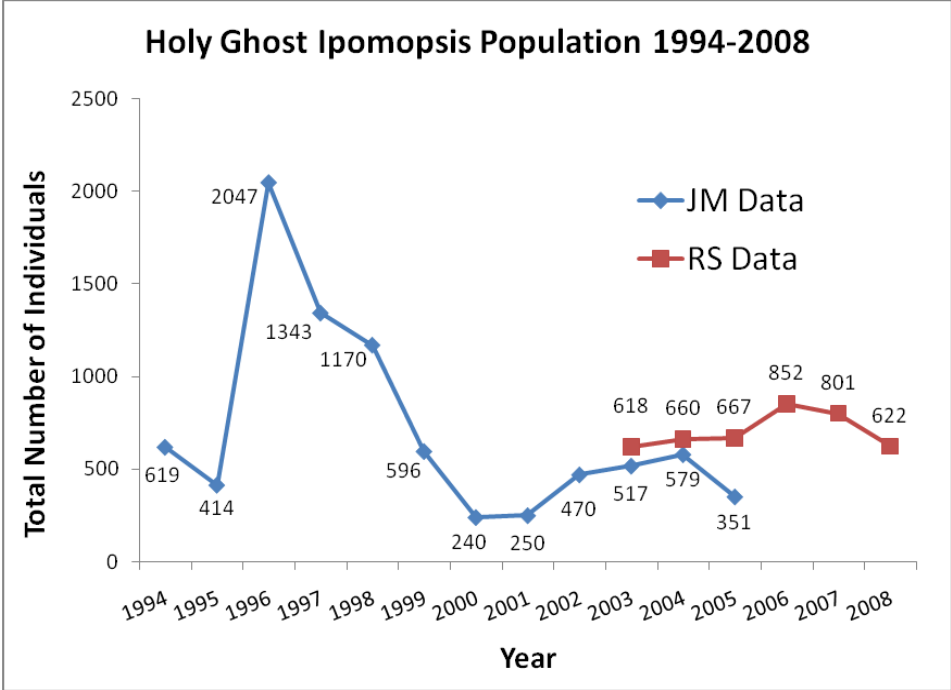


Figure 1. Chart of monitoring plot trends over the last 12 years. The chart shows two monitoring plot series: JM Data represents ten plots monitored by Joyce Maschinski, and RS Data represents seven plots monitored by Robert Sivinski. Numbers represent the total number of individuals (rosettes + adults).

Holy Ghost ipomopsis population estimates were made by multiplying the number of flowering adults observed by a number arrived at through an average ratio of rosettes to adults, e.g. if a 3:1 ratio is assumed and 100 flowering plants are observed, using the multiplier of 4 we estimated a population total of 400. We believe it is more accurate to multiply by a number derived from the current year’s observed ratio, which is compiled each year for Service reports (Sivinski and Tonne 2007, 2008). If combined with a total flowering plant count, there would be an improved population estimate for counts prior to 2003. The 1991 population estimate of 1,250 to 2,500 individuals should be revisited based on this method.

**Holy Ghost Ipomopsis Individuals at Monitored Plots
in Holy Ghost Canyon 2003-2008**

Year	<u>2003</u>	<u>2004</u>	<u>2005</u>	<u>2006</u>	<u>2007</u>	<u>2008</u>
No. flowering plants	117	328	184	130	222	117
No. rosettes	501	332	483	722	579	505
Percent in flower	18.9	49.7	27.6	15.3	27.7	18.8
Total Counted	618	660	667	852	801	622
Estimated Total*	1313	1402	1417	1810	1701	1321

*Estimate in last column based on a derived multiplier of 2.124 (2008 data) between monitoring plots and roadside populations.

2.3.1.5 Spatial distribution, trends in spatial distribution, or historic range:

Field observations indicate that the population is now more limited to the road cut than it was in the late 1990s (Tonne, pers. comm., 2008). Areas where the plants were once abundant below the road are now void of plants. While a formal census was not conducted, all field observations lead to the conclusion that the Holy Ghost population is increasingly confined to a narrow strip associated with F.R. 122. Peripheral colonies within this population have not been adequately surveyed and mapped. If these observations are valid, the yearly average is much lower than the estimated 334. Some of this can be attributable to drought conditions during parts of sampling years.

2.3.1.6 Habitat or ecosystem conditions:

Within Holy Ghost Canyon, field observations were rarely made of the ipomopsis colonies away from F.R. 122. Studies conducted in 2008 have shown that there are peripheral colonies generally occurring in small canopy gaps above the roadside plants. These peripheral colonies were first observed in the late 1990s but were not revisited until 2008 (Tonne, pers. comm., 2008). On June 29-30, 2008, 423 plants were counted in canopy gaps above the roadside population. These plants were in groups of 1 to 61 individuals in forest openings and erosion chutes above F.R. 122 and/or Holy Ghost Creek. This total is based on 147 flowering plants and 276 rosettes associated with identifiable (flowering) plants. An additional 10 rosettes were located, but the species could not be properly identified.

2.3.2 Five-Factor Analysis

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

Occupied habitat for this species is confined to a narrow strip within a single canyon. This narrow, isolated population is vulnerable to significant losses, possibly leading to a severe bottleneck and extirpation due to chance events. The sole population of this species falls within a high-use recreation area. Most of the occupied habitat is along a road to a campground with intermittent USFS leases for 36 summer cabins. The proximity to summer homes creates a situation that has driven management towards a policy of fire suppression. As the forest ages and undergoes structural changes, the potential for catastrophic forest fire becomes more likely. Impacts from road maintenance, recreation, and catastrophic forest fires pose immediate threats to this population. The aging forest also appears to provide less suitable habitat for the species over time as early successional habitats, to which Holy Ghost ipomopsis is best adapted, shrink, or disappear.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

Holy Ghost ipomopsis is subject to casual collection by campers, hikers, and others. However, collection has not been reported as a major concern. In order to establish a research garden at Northern Arizona University and three new populations in New Mexico, a significant amount of scientific collecting has been done. It is difficult to estimate the impact of seed collection under permit. While discretion has been used in the amount of seed removed from natural populations, especially during drought years, this population does not benefit directly from the plants that are produced in the greenhouse. To date, most of the propagated plants have gone into establishing experimental populations. However, during 2007, propagated plants were transplanted back in Holy Ghost Canyon. Future experimental plantings along with disturbance regimes should be conducted in Holy Ghost Canyon. This would offset the amount of seed removed from natural populations and determine management techniques to enhance existing habitat or create additional habitat.

2.3.2.3 Disease or predation:

No disease or predation on the Holy Ghost ipomopsis is presently known. However, the narrow distribution of this species increases its susceptibility to significant losses or extinction from predators or pathogens.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

If Holy Ghost ipomopsis were to be delisted, there would be few regulatory mechanisms in place to protect it. As noted previously, the creation of a species-specific or canyon-specific USFS management plan would increase the conservation opportunities for this species with or without the ESA protections. There are no Federal regulations to protect this species outside of the ESA and benefits afforded to Federally listed species under NEPA protections. Although Holy Ghost ipomopsis is listed by the state of New Mexico, protections provided for this species by state law would not be sufficient for its conservation.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

The spread of exotic species, notably smooth brome (*Bromus inermis*) and Kentucky bluegrass (*Poa pratensis*) within occupied habitat, is becoming a significant problem in Holy Ghost Canyon. These species spread quickly, producing sod-bound areas that appear to exclude Holy Ghost ipomopsis (USFWS 2002; Maschinski 2001). Areas that supported significant numbers of Holy Ghost ipomopsis as recently as 2000 have now been colonized by non-native grasses. Holy Ghost ipomopsis within these areas has decreased noticeably, and in some areas, appears to have been eliminated (Tonne, pers. comm. 2008).

The potential indirect effects of spruce budworm (*Choristoneura fumiferana*) control, using *Bacillus thuringiensis* (BT), also needs management consideration as it could affect pollinators of Holy Ghost ipomopsis as well as the target pest. BT kills spruce budworm but it can also kill non-target moths and butterflies that are known pollinators of Holy Ghost ipomopsis (USFWS 2002).

Holy Ghost ipomopsis occurs along a stretch of 1.9 km (1.2 mi) of F.R. 122 within a narrow strip of a single canyon. The population is vulnerable to chance events such as wildfire and disease (USFWS 2002, Mashinski 1996). Management actions including fire suppression, road maintenance activities, and spruce-budworm control could cause significant impacts to this population as it occurs near summer homes and along F.R. 122. The use of mechanical equipment for road maintenance or to create a firebreak along F.R. 122 could be devastating to the Holy Ghost ipomopsis population (USFWS 2002).

Holy Ghost ipomopsis occurs within a fire-adapted community, yet also in an area that is heavily utilized by the public. Holy Ghost Canyon holds almost 40 leased cabins, a FS campground, and a traditional trout fishing area, making fire management in the canyon a logistical challenge. Since

European settlement, fire frequency has been reduced, and under current Forest Service management, fire suppression has been strictly enforced. Recurrent low-intensity fires were once normal in the ponderosa pine (*Pinus ponderosa*) and mixed-conifer forests where this species occurs (Dick-Peddie 1993). Historic fires created a mosaic of forest seral states and included more open park-like forests preferred by *Ipomopsis* species (Paige 1992; USFWS 2002). Extended fire suppression has led to a closed forest canopy and a decreased herbaceous understory (Moir and Dieterich 1988). Fire has been excluded from Holy Ghost Canyon for at least 80 years. According to the Holy Ghost *Ipomopsis* Recovery Plan (2002), “Forest openings required by Holy Ghost *ipomopsis* are rare and the species has become confined almost entirely to road cuts and other habitat created through human disturbance.” Human disturbance activities that would benefit *ipomopsis* within Holy Ghost Canyon appear to be limited. Timber harvest or significant thinning could potentially simulate the effects of natural fire, reducing the potential for catastrophic wildfire and creating new Holy Ghost *ipomopsis* habitat. There is an increased threat of an intense wildfire due to accumulation of fuels. High-intensity burning could eliminate seeds in the soil, seal soil particles into an impervious surface, and deplete soil nitrogen. Survival of Holy Ghost *ipomopsis* could be very low and much of its habitat made useless after a catastrophic wildfire (USFWS 2002). Introducing some form of disturbance into forest habitat is critical to Holy Ghost *ipomopsis* survival.

Predictions of climate change for the southwest region of the United States involve slightly drier and warmer weather in projected models produced by scientists on the Intergovernmental Panel on Climate Change (2007). Wind patterns and rates of evaporation, along with aspects of extreme weather such as droughts, intense rainstorms, and temperature fluctuations, are expected to be more pronounced and variable (IPCC 2007). Winter snowpack and snow cover is predicted to continue a declining trend in concert with drought conditions, leaving less water available for groundwater recharge to springs and substrate moisture, and possibly earlier warmer temperatures in the spring (IPCC 2007). In western United States mountain regions, earlier and more rapid snow melt in the spring has been linked to global climate change (Kerr 2007). Given that Holy Ghost *ipomopsis* is sensitive to yearly changes in moisture availability and exhibits population decreases during drier periods, if future climate trends become drier, the Holy Ghost *ipomopsis* populations could be negatively affected resulting in decreased numbers and reproductive success.

2.4 Synthesis

Holy Ghost ipomopsis is endemic to a single canyon in the Sangre de Cristo Mountains, New Mexico. Distribution of Holy Ghost ipomopsis within its only known population is patchy, following narrow strips of disturbance, primarily in the cut slopes of the forest road. Peripheral colonies are poorly documented in Holy Ghost Canyon but have been found in forest openings and areas recently disturbed through human activity. Some of these areas, occupied in 1999, no longer support Holy Ghost ipomopsis. Peripheral colonies are likely critical to the recovery of Holy Ghost Ipomopsis but their persistence may depend on adopting new management practices to simulate natural disturbance in Holy Ghost Canyon. Like many other members in the same genus, Holy Ghost ipomopsis is disturbance-adapted, occupying early successional sites in ponderosa pine and mixed-conifer forest.

Holy Ghost ipomopsis is a monocarpic species with an average maturation time of 1.86 years (Maschinski 2001). It grows as a rosette until it reaches a developmental threshold. When environmental conditions are favorable, it sends up an inflorescence, flowers, fruits, and then dies. Population estimates are difficult to make because rosettes of this species are indistinguishable from rosettes of its more common relative, *Ipomopsis aggregata*. The number of rosettes appears to account for most of the population in any given year. However, the ratio of rosettes to adults varies dramatically from year to year, ranging from 1:1 to almost 7:1 (Sivinski and Tonne 2006) and the calculation based on easily visible flowering adults should be revisited.

Monitoring data has captured large fluctuations in the Holy Ghost ipomopsis population, ranging from a high of 2,047 in 1996 to a low of 240 in 2001. Plot monitoring between 2003 and 2008 has shown that the average number of individuals per year is 703, divided into an average of 183 flowering plants and 520 rosettes per year, with flowering individuals comprising 26% of the total number of individuals (Sivinski and Tonne 2007, 2008). Small populations are vulnerable to random events that can lead to population crashes that cause numbers to go below a critical threshold for survival (Shaffer 1987; Holsinger 2000). Maschinski (2001) analyzed the likelihood that Holy Ghost ipomopsis would go extinct in Holy Ghost Canyon. The species was found to be at high risk of extinction, suggesting that plant augmentation and habitat improvement could improve the viability of the population but not eliminate the risk of extinction (Maschinski 2001). Despite large fluctuations and low overall population size, genetic diversity within the population appears to be high for a self-compatible species consisting of a single population (Wolf et al. 1991; supported by a recent unpublished isozyme investigation at UNM).

The Holy Ghost ipomopsis was originally listed in 1994 as a federally endangered species due to its extremely limited distribution, low numbers of individuals, heavy recreational use in the single canyon where the plant is found, and threats to the plant and its habitat from management activities including road maintenance, wildfire and fire management, and possible pesticide application. Timber harvest and fire, that would duplicate historic disturbance regimes and create forest openings, have been prevented due to intensive recreational use in Holy Ghost Canyon over the past 65 years. As a

consequence of protecting this canyon from natural disturbance, the forest grows denser each year, closing up canopy gaps required by the Holy Ghost ipomopsis to become established. Novel threats since the time of listing include the increased forest canopy leading to a higher risk of catastrophic fire, the influx of invasive plants, and potential effects of climate change. To control the spread of invasive plants in Holy Ghost ipomopsis habitat, herbicide spraying could occur which could negatively impact the Holy Ghost ipomopsis. Although future changes in climate remain unpredictable, a pattern of increased dryness could reduce the number of Holy Ghost ipomopsis as evidenced by its responses to wetter and drier periods since monitoring has been conducted. Based on the single population comprised of relatively few individuals, restricted range within one canyon, and significance of current threats, we recommend that the status of the Holy Ghost ipomopsis as federally endangered remain unchanged.

3.0 RESULTS

3.1 Recommended Classification

- Downlist to Threatened**
- Uplist to Endangered**
- Delist** (*Indicate reasons for delisting per 50 CFR 424.11*):
 - Extinction*
 - Recovery*
 - Original data for classification in error*
- No change is needed**

3.2 New Recovery Priority Number: 2

Currently, information describing conflicts within Holy Ghost Canyon that negatively affect the Holy Ghost ipomopsis is not available. At the time of listing, a Recovery Priority Number of 2C was assigned to the species based on the potential for immediate conflict, presumably between recreationalists versus forest management in habitat occupied by the Holy Ghost ipomopsis. The designation of C, implying active conflict between parties at the time of listing, is no longer considered valid. However, Holy Ghost ipomopsis remains vulnerable to recreational impacts, road maintenance and use effects, pesticide spraying, and stochastic events, such as wildfire, disease, and drought. These threats, combined with its occurrence as a single population in a confined canyon and low population numbers, leave the plant at risk of extinction. Therefore, we recommend changing the Recovery Priority Number from a 2C to a 2. A number of 2 means there is a high degree of threat, a high recovery potential, and the listed entity is a species.

3.3 Listing and Reclassification Priority Number: Not applicable.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

We recommend commencing interagency discussions about management issues within Holy Ghost Canyon regarding the following needs:

- archeological surveys, authorized by the USFS, in occupied and potential Holy Ghost ipomopsis habitat that could provide the opportunity for disturbance experiments at a small scale and for WUI project implementation at a large scale;
- design and implementation of disturbance and forest thinning experiments;
- augmentation of the Holy Ghost Canyon population with seed and greenhouse-grown material;
- development of experimental plots to study control of invasive grasses;
- fire management and road maintenance concerns;
- spruce budworm control using BT; and,
- development of a USFS species-specific management plan for the Holy Ghost ipomopsis and/or a USFS area-specific management plan for Holy Ghost Canyon.

Revisit the 1991 population estimate of 1,250 to 2,500 individuals to see if those numbers and the ratio used to estimate the number of flowering adults and rosettes accurately reflect current numbers of Holy Ghost ipomopsis individuals.

Conduct a census of the Holy Ghost Canyon population and map all portions of the population including peripheral colonies. Map all monitoring transects and estimate the portion of the total population represented by monitoring data.

Continue propagation of Holy Ghost ipomopsis for replanting within Holy Ghost Canyon provided that there are projects and clearances in place for their use.

Establish a botanical garden population and a seed bank for restoration efforts.

Establish a Botanical Reserve Area in Holy Ghost Canyon to protect the only naturally occurring population of Holy Ghost ipomopsis.

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USFWS consultations reviewed for this review:

2-22-03-F-366 (Programatic Biological and Conference Opinion: The Continued Implementation of the Land and Resource Management Plans for the Eleven National Forests and National Grasslands of the Southwestern Region; Regional Office, Region 2, U.S. Fish and Wildlife Service), 2-22-03-I-107, 2-22-03-I-170, 2-22-03-I-439, 2-22-04-I-108, 2-22-04-I-403, 2-22-04-I-458, 2-22-04-I-531, 2-22-04-I-619, 2-22-05-I-187, 2-22-05-I-279; the following files were not located, but are thought to be limited to issuance of a species list by the service: 2-22-05-I-118, 2-22-05-I-406, 2-22-05-I-186.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Holy Ghost Ipomopsis/*Ipomopsis sancti-spiritus*

Current Classification: Endangered.

Recommendation resulting from the 5-Year Review:

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By: Julie McIntyre, Recovery Biologist, U.S. Fish and Wildlife Service,
Southwest Region

FIELD OFFICE APPROVAL:

**Lead Field Supervisor, U.S. Fish and Wildlife Service, New Mexico Ecological Services
Field Office**

Approve *Debra Campbell* Date 10-8-08

REGIONAL OFFICE APPROVAL:

Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 2

Acting
Approve *Susan Jacobsen* Date 10.22.08