

# HOLY GHOST IPOMOPSIS

*(Ipomopsis sancti-spiritus)*

## RECOVERY PLAN



P. Tonne (photographer). New Mexico Rare Plant Technical Council. 1999.  
New Mexico Rare Plants. Albuquerque, NM: New Mexico Rare Plants Home Page.  
<http://nmrareplants.unm.edu> (Version 15 March 2002).

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Region 2  
U.S. Fish and Wildlife Service  
Albuquerque, New Mexico

**HOLY GHOST IPOMOPSIS**  
*(Ipomopsis sancti-spiritus)*

**RECOVERY PLAN**

Prepared by

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for

Region 2  
U.S. Fish and Wildlife Service  
Albuquerque, New Mexico

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**Concurrence:** \_\_\_\_\_  
Regional Forester, Southwest Region

**Date:** \_\_\_\_\_

**Concurrence:** \_\_\_\_\_  
Secretary, New Mexico Energy, Minerals, and Natural Resources Department

**Date:** \_\_\_\_\_

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### Literature Citations should read as follows:

U.S. Fish and Wildlife Service. 2002. Holy Ghost Ipomopsis (*Ipomopsis sancti-spiritus*) Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 51 pp.

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## ACKNOWLEDGEMENTS

The author gratefully acknowledges the comments and receipt of unpublished data from Dr. Joyce Maschinski at the Arboretum at Flagstaff. Drs. Tim Lowrey and Dieter Wilken provided information and points of clarification on genetics and *Ipomopsis* life history. Additional information and guidance were received from Dr. Charlie McDonald, Regional Botanist for the U.S. Forest Service (USFS), Region 3, Gail Tunberg of the Santa Fe National Forest, and Reggie Fletcher and Teresa Prendusi, formerly of the USFS Region 3 Regional Office. Special thanks go to residents and home owners of the Holy Ghost Canyon area: Huie Ley, Chris Long, Melinda Horn King, Ron Horn, Marion Noel, Milton and Nancy Flechtel, Chris Long, Bob Jameson and George Morse who contributed their observations and concerns during the preparation of this recovery plan. Wendy Brown of the Service's Region 2 Regional Office coordinated the final revisions to this plan with the assistance of Anna Maria Munoz of the New Mexico Ecological Services Field Office, Dr. Charlie McDonald, and Bob Sivinski. The Service is grateful to Dr. David Robbins and Dave Bennet of the Holy Ghost Canyon Homeowners Association, Mr. Huie Ley, San Miguel County Commissioner, and Dr. Joyce Maschinski for review of the final document.

## EXECUTIVE SUMMARY

**Current Status:** Holy Ghost ipomopsis is listed as endangered. It occurs as a single population of about 2,500 plants (of which 150 - 650 flower per year) in about 2.2 miles of Holy Ghost Canyon in the southern Sangre de Cristo Mountains of north-central New Mexico.

**Habitat Requirements and Limiting Factors:** Holy Ghost ipomopsis grows mostly on disturbed cut-slopes of Forest Road 122 in an open ponderosa pine forest. Potential immediate threats to this species include small population size, road maintenance, recreation impacts, and catastrophic forest fire. In the long term, preventing natural disturbances that result from events like wildfire reduces the number of early successional sites for this species.

**Recovery Objective:** The interim objective of this plan is downlisting to threatened, with a final goal of delisting.

**Recovery Criteria:** 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 Holy Ghost ipomopsis that ensures the continued protection of these established populations. Delisting 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.

**Major Actions Needed:**

1. Establish a management plan that protects 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.

**Estimated Total Cost of Recovery (\$000):**

<u>Year</u>	<u>Need 1</u>	<u>Need 2</u>	<u>Need 3</u>	<u>Need 4</u>	<u>Need 5</u>	<u>Total</u>
2003	21.5	63.0	13.0	17.0	9.6	124.1
2004	26.0	59.0	10.0	17.0	6.7	118.7
2005	24.0	50.0	2.0	10.0	6.7	92.7
2006	24.0	50.0	2.0	0.0	10.5	86.5
2007	24.0	50.5	2.0	0.0	13.5	90.0
2008	14.0	8.0	2.0	0.0	13.5	37.5
2009	14.0	1.0	2.0	0.0	6.5	23.5
2010	14.0	0.0	2.0	0.0	6.5	22.5
2011	14.0	0.0	2.0	0.0	3.5	19.5
2012	<u>17.0</u>	<u>0.0</u>	<u>2.0</u>	<u>0.0</u>	<u>3.5</u>	<u>22.5</u>
<b>Recovery Cost</b>	192.5	281.5	39.0	44.0	80.5	637.5

**Date of Recovery:** Downlisting this species could occur as early as 2018. Delisting could occur as early as 2023.

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## PART I - INTRODUCTION

### Brief Overview

Holy Ghost ipomopsis (*Ipomopsis sancti-spiritus* Wilken & Fletcher) was given endangered status under the Endangered Species Act of 1973, as amended (Act), on March 23, 1994 (U.S. Fish and Wildlife Service 1994). It is

**Holy Ghost ipomopsis was designated as an endangered species in 1994.**

known only from Holy Ghost Canyon in the Sangre de Cristo Mountains of the Santa Fe National Forest in north-central New Mexico. It is a relatively newly discovered species named in 1988 by Dr. Dieter Wilken, an expert on the phlox family, and Reggie Fletcher, a U.S. USFS botanist. The single known population grows in open mixed conifer forest.

**It is known from a single canyon in the southern Sangre de Cristo Mountains.**

Most of the occupied habitat is along a road to a campground and is in an area where the USFS leases land for summer homes. Impacts from road maintenance, recreation, and catastrophic forest fire are immediate management concerns. The potential indirect effects of spruce budworm control also need management consideration. In the long term, the present land uses in the canyon influence management away from frequent disturbances that produce the early successional habitats to which Holy Ghost ipomopsis is best adapted. The recovery priority number for Holy Ghost ipomopsis is 2C, which means it is a full species with a high level of threats and a potential for immediate conflict, but also with a relatively high potential for recovery.



## Taxonomy and Systematics

Holy Ghost ipomopsis is in the phlox family (Polemoniaceae) and is a member of the *Ipomopsis aggregata* complex of species and subspecies. Several botanists who collected

**Wilken and Fletcher named Holy Ghost ipomopsis in 1988 after others failed to realize it was a unique species.**

Holy Ghost ipomopsis in the past failed to realize it was a unique species. E.T. Wherry annotated E.F. Castetter's (University of New Mexico) early collections of Holy Ghost ipomopsis as *Gilia pringlei* A. Gray. Martin and Hutchins (UNM) collected Holy Ghost ipomopsis and treated it in the *Flora of New Mexico* (Martin and Hutchins 1981) as *Ipomopsis*

*aggregata* (Pursh) V. Grant subsp. *candida* (Rydb.) W.A. Weber, which has frequent flower color variations from white to pink to red. Finally, Wilken and Fletcher (1988) closely examined flower structure to clearly demonstrate that Holy Ghost ipomopsis is a distinct species. They speculate its closest relative is *Ipomopsis arizonica* (Greene) Wherry, which occurs in north-central Arizona and south-central Utah (Wilken and Fletcher 1988).

Wolf *et al.* (1991) used enzyme electrophoresis to show Holy Ghost ipomopsis has a high degree of genetic similarity with almost all other members of the *I. aggregata* complex and is closest to skyrocket (*I. aggregata* subsp. *formosissima* (Greene) Wherry) that grows in the same area as Holy Ghost

**Genetic studies help confirm the status of Holy Ghost ipomopsis as a unique species.**

ipomopsis. However, they also found it does not cluster with any other *Ipomopsis* population and is more distinct genetically than most other members of the complex.

Genetic variation is surprisingly high in Holy Ghost ipomopsis for a self-compatible species with only one known population. Differences in corolla lobe length, corolla lobe shape, and flower color shade are evident throughout the population in Holy Ghost Canyon. Wolf *et al.* (1991) found through enzyme electrophoresis that the amount of genetic variation in the Holy Ghost ipomopsis population is similar to the amount of variation in more common and widespread members of the *I. aggregata* complex. Wolf *et al.* (1991) hypothesize the genetic variation is present because Holy Ghost ipomopsis evolved very recently (within the last 10,000 years) from another genetically variable species. Hybridization could also have caused the variation in Holy Ghost ipomopsis, but Wilken and Fletcher (1988) observed no obvious hybrids between Holy Ghost ipomopsis and skyrocket in Holy Ghost Canyon. This, however, does not rule out the possibility of rare, less detectable hybridizations that could transfer some skyrocket genes to the Holy Ghost ipomopsis population.

Paige and Whitham (1985) observed some Arizona populations of *Ipomopsis aggregata* where plants with lighter colored flowers (pink to white) become more frequent in the latter part of the flowering season when pollinator frequency shifts from diurnal hummingbirds to nocturnal hawkmoths. Similar genetic variation producing pink flowers could have existed in the Sangre de Cristo Mountains of New Mexico. Further genetic and morphological differentiation of pink-flowered plants could have promoted reproductive isolation through pollinator specialization and resulted in the differentiation of Holy Ghost ipomopsis into a distinct species.

## Morphology

Holy Ghost ipomopsis is an herbaceous biennial or short-lived perennial that can remain as a low rosette of leaves for several years before it flowers and dies. The mature plant has one or a few erect stems 3 - 8 decimeters (dm) (12 - 32 inches

**The flowers of Holy Ghost ipomopsis are adapted for moth and butterfly**

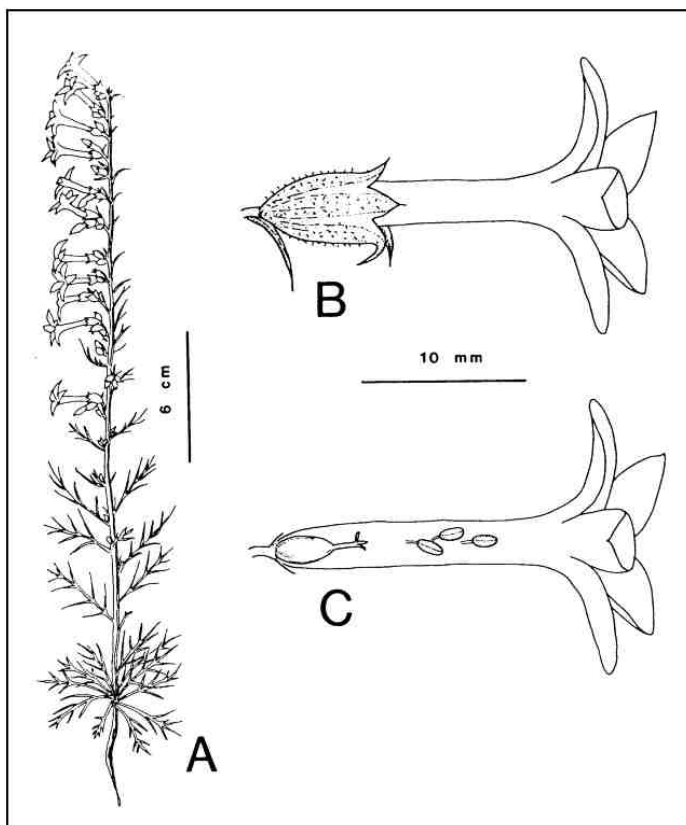


Figure 1. Holy Ghost ipomopsis, A. whole plant, B. flower, C. cutaway of flower showing position of stamens and pistil. Illustration by D. Wilken. Reprinted with permission from D. Wilken and R. Fletcher, "*Ipomopsis sancti-spiritus* (Polemoniaceae), a new species from northern New Mexico," *Brittonia*, Vol. 40, p. 49, copyright 1988, the New York Botanical Garden.

(in)) tall. The basal and stem leaves are pinnately divided with sharp points terminating each division. The flowers are pink, tubular, and terminate in five spreading lobes. The stamens and the short style of the ovary are deep inside the flower tube (Figure 1). The closely related and similar appearing skyrocket also occurs in Holy Ghost Canyon; however, it has orange-red flowers with stamens and style exerted beyond the throat of the corolla tube. The orange-red color and exerted stamens and style of skyrocket are adaptations for hummingbird pollination while the pink flowers and included style and stamens of Holy Ghost ipomopsis are

adaptations for moth and butterfly pollination.

## Distribution and Abundance

Holy Ghost ipomopsis is known from a single population in the Sangre de Cristo Mountains of San Miguel County in north-central New Mexico (Figure 2). Plants are relatively continuous in scattered patches for about 3.5 kilometers (km) (2.2 miles (mi)) of Holy Ghost Canyon beginning 1.6 km (1.0 mi) above the confluence with the Pecos River then up Holy Ghost Creek to the confluence with Doctor Creek. There are about 80 hectares (ha) (200 acres (ac)) of occupied habitat. The Santa Fe National Forest manages most of the habitat. The USFS maintains a campground and leases land in Holy Ghost Canyon as the Holy Ghost Summer Home Area.

**The only known population is estimated to have 2,500 plants.**

The density of Holy Ghost ipomopsis is difficult to determine because young plants are indistinguishable from skyrocket(Sivinski 1991). About 80 percent of the population grows on, or immediately adjacent to, the west-facing cut-slopes along Forest Road 122 in Holy Ghost Canyon. Plant density varies from small dense patches (5 plants/m<sup>2</sup>) to single, isolated plants found greater than 50 m from others. Subsequent surveys estimated young plants outnumber adults three to one, and there are 150 to 650 adults (flowering plants) during various years (J. Maschinski, the Arboretum at Flagstaff, pers. comm. 2002). Maschinski (unpublished data) monitored 10 transects in Holy Ghost Canyon and found that the total number of plants varied from 2,047 in 1996 to 250 in 2001. During this period, rainfall patterns greatly influenced seedling recruitment and population size.

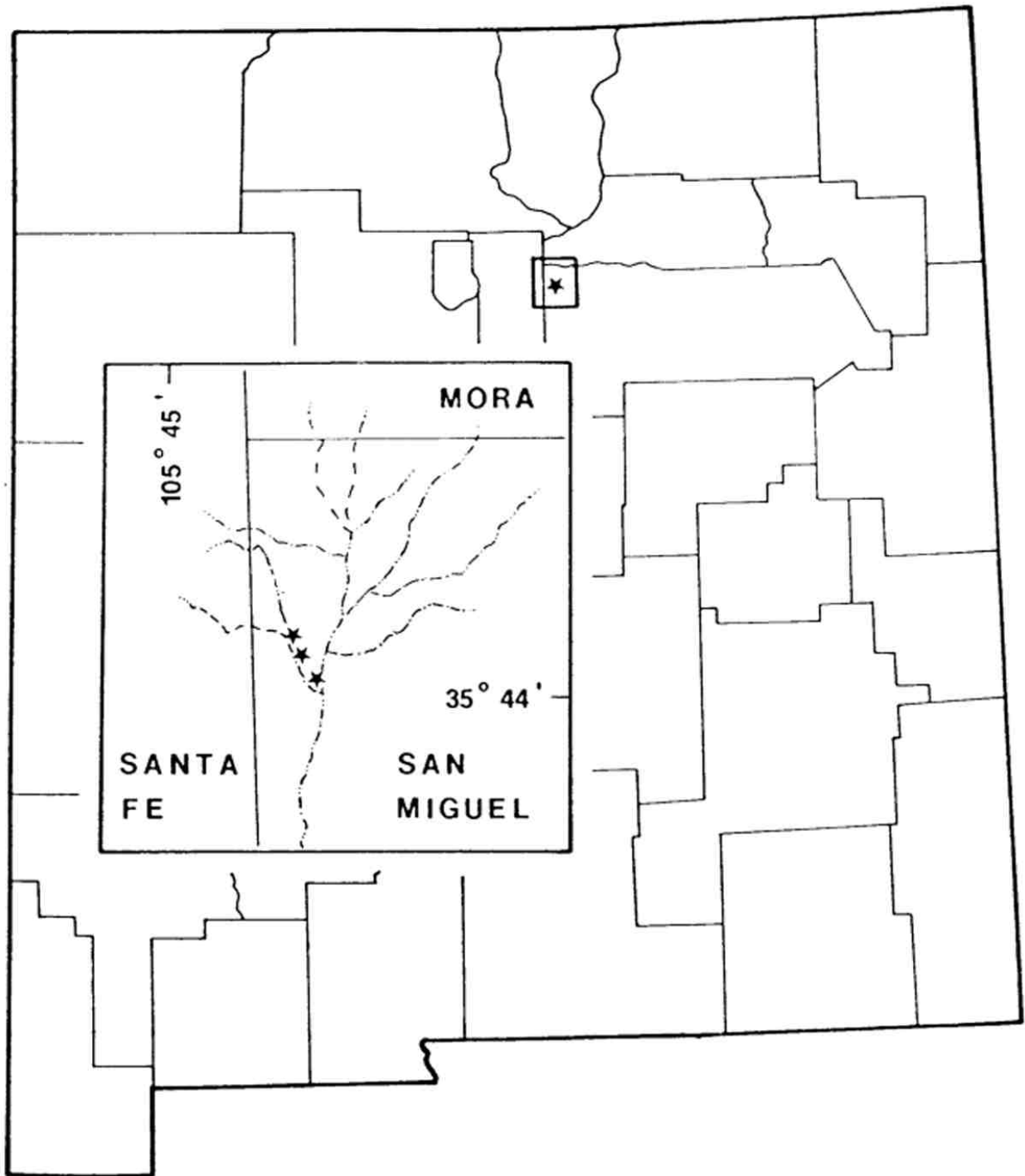


Figure 2. Location of Holy Ghost ipomopsis population.

There are anecdotal reports from USFS employees and Holy Ghost Summer Home Area residents that the number of flowering plants from year to year varied greatly in past decades, with the highest densities occurring in the 1920s to 1940s when several hundred miners worked in the Terrero Mines (presently abandoned) and lived in the Holy Ghost area.

### Habitat

**Holy Ghost ipomopsis grows best on bare mineral soils.**

Holy Ghost ipomopsis grows on relatively dry, steep, west to southwest-facing slopes on about the lower one-third of the canyon side (excluding the creek riparian margin). The geologic substrate is partly weathered Terrero Limestone. Holy Ghost ipomopsis appears to grow best in bare mineral soils with its highest densities on disturbed sites such as road cuts. The occupied habitat in Holy Ghost Canyon ranges in elevation from 2,350 - 2,500 m (7,730 - 8,220 ft).

Holy Ghost ipomopsis occurs in the Rocky Mountain montane conifer forest plant community (Brown 1982). Commonly associated species are ponderosa pine (*Pinus ponderosa*), Douglas fir (*Pseudotsuga menziesii*), aspen (*Populus tremuloides*), Gambel oak (*Quercus gambelii*), mountain mahogany (*Cercocarpus montanus*), Woods' rose (*Rosa woodsii*), big head bricklebush (*Brickellia grandiflora*), poison ivy (*Toxicodendron rydbergii*), Indian hemp (*Apocynum cannabinum*), western yarrow (*Achillea millefolium*), white ragweed (*Hymenopappus newberryi*), and nodding onion (*Allium cernuum*).

There are no obviously unique habitat characteristics that would account for the restricted distribution of this endangered

**Habitat characteristics do not appear to explain the restricted distribution of this endangered plant.**

plant. Holy Ghost ipomopsis is being cultivated at the Arboretum at Flagstaff, Arizona, where it grows well on volcanic soils (Maschinski, pers. comm. 1995).

### Life History and Ecology

Holy Ghost ipomopsis is often a biennial, but it can live for several years as a nonreproductive rosette before producing a flowering stem (Dieter Wilken, Santa Barbara Botanic Garden,

**Plants live for several years then die after flowering.**

pers. comm. 1991). Average maturation time is 1.86 yrs (Maschinski 2001). It flowers only once then the entire plant dies. If a browsing herbivore removes the stems from a reproductive adult, one or more new flowering stems ultimately replace the lost shoots (Sivinski, pers. obs.). This compensating growth response is well-studied for the closely related *Ipomopsis aggregata* (Paige and Whitham 1987; Paige 1992a; Paige 1994) and *I. arizonica* (Maschinski and Whitham 1989). Assuming Holy Ghost ipomopsis has a similar compensating response to herbivory (or flower picking), then a grazed plant may produce more flowers and fruits than an ungrazed plant if the maturing flower stalk is removed early in the season and nutrients are not limited. If the mature flower stalk is removed late in the season and/or nutrients are limited, then a grazed plant may not produce as many fruits as an ungrazed plant. If the flower stalks are removed when plants are in full bloom, usually in August, no fruit may be produced because there is not enough time left in the growing season for the plant to recover (Maschinski, pers. comm. 2002).

Holy Ghost ipomopsis usually grows in open areas relatively free of dense grass cover. Occasionally, plants are in the understory of trees and shrubs. Plants may produce more fruit when growing in open habitat as was demonstrated for *I. arizonica* (Maschinski and Whitham 1989). Skyrocket has a similar preference for open habitat (Sivinski, pers. obs.).

**Periodic forest fires may have maintained suitable open habitat in the past.**

Periodic forest fires may have played a significant role in maintaining suitable open habitats in the past. A study of *I. aggregata* in burned versus unburned areas in an Arizona ponderosa pine forest similar to Holy Ghost Canyon demonstrated a 116-fold increase in seed germination for the burned areas and after 2 years a 6-fold increase in established plants (Paige 1992b). Holy Ghost ipomopsis may have a similar response if the fire is not so catastrophically hot that it welds and sterilizes the soil. However, the effects of fire on Holy Ghost ipomopsis have not been studied.

Maschinski (1996) conducted pollination studies on Holy Ghost ipomopsis. Flowers were bagged to eliminate natural pollinators and the anthers were removed from test flowers. The test flowers received either no pollen, pollen from other flowers of the same plant, or pollen from flowers of another plant. Pollination with flowers from the same plant

**Pollination studies show plants are self-compatible, but there must be a pollinator for fertilization to occur.**

produced fruits 57 percent of the time, showing Holy Ghost ipomopsis is self-compatible. Pollination with flowers from other plants produced fruits from 9.5 - 77 percent of the time depending on the pollen donor. The large range of success for pollination between plants shows there is discrimination for the paternal



pollen source. This has also been observed in the related *I. aggregata* (Waser and Price 1989). Bagged flowers excluded from pollinators and test flowers receiving no pollen set no fruits. Therefore, Holy Ghost ipomopsis must have pollinators for either self- or outcross-fertilization and it must have fertilization to produce fruits (*i.e.*, it is not apomictic). Butterflies have been seen probing Holy Ghost ipomopsis flowers (Sivinski 1991). Paige and Whitham (1985) observed hawkmoths visiting the pink-flowered forms of *I. aggregata* in Arizona. Tonne (2000) studied pollinators of Holy Ghost ipomopsis in 1999 and documented 8 species of arthropods visiting study plants. Three species, the Snow's skipper (*Paratrytone snowi*), the golden skipper (*Poanes taxiles*), and the sphinx moth (*Hyles lineata*) appeared to be the primary pollinators.

Fruits of Holy Ghost ipomopsis develop in the late summer and early autumn. Germination trials revealed no special requirements to break seed dormancy, but the highest percentage of germination occurred after four weeks or eight weeks of cold treatment. This indicates seed germination most likely occurs during the spring and early summer months after the winter cold period (Maschinski 1996).

**Seeds have no special germination requirements, but germinate better with a cold treatment.**

### **Reasons for Listing - Impacts and Threats**

According to the Act (50 CFR part 424), a species may be determined to be endangered or threatened due to one or more of the following five factors: (1) the present or threatened destruction, modification, or curtailment of its habitat or range; (2) Overutilization for commercial, recreational, scientific, or educational purposes; (3) Disease or predation;

(4) the inadequacy of existing regulatory mechanisms; and (5) other natural or manmade factors affecting its continued existence.

**The Service described five primary threats to Holy ghost ipomopsis that justified listing.**

The Service (1994) justified listing the Holy Ghost ipomopsis as Federally endangered for the following reasons: (1) its extremely limited distribution, with only one known population (factor 1); (2) heavy recreational use in the single canyon where the plant is found (factors 1, 2); (3) the plant was not adequately protected by existing regulations or management plans (factor 4); (4) management activities, including road maintenance and potential spruce budworm control, posed a significant threat (factors 1, 5); and (5) fire and timber harvest, two activities that create habitat for Holy Ghost ipomopsis, have been excluded from the plant's known range because of the development of summer homes and recreation in the canyon (factors 1, 5). Details regarding threats and reasons for listing follow.

Limited Distribution

Holy Ghost ipomopsis is found in a single population of approximately 2,500 plants in one canyon on the Pecos Santa Fe National Forest. The population is vulnerable to stochastic events such as wildfire and disease.

A related threat is the apparently limited reproductive success of Holy Ghost ipomopsis, leading to a possible deficit of compatible alleles for pollination or inbreeding depression. In controlled pollination studies, only 13% of the flowers of a sample of 10 plants successfully set fruit (Maschinski and Sivinski, unpublished data 2002). In comparison, the more common species *Ipomopsis arizonica* has an average of 76% of flowers

successfully set fruit.

### Heavy Recreational Use

There are approximately 36 summer cabins and a USFS campground within Holy Ghost Canyon. A nearby trout stream is used by anglers resulting in intense recreational

**A few plants get picked for wildflower bouquets.**

use during the months the plant is flowering. Impacts to Holy Ghost ipomopsis from recreation are mostly from residents and campers who walk the forest road and occasionally pick native wildflowers. Holy Ghost ipomopsis is pleasingly showy and sometimes taken. When the flowering stem is broken off, some plants will produce new stems from the lateral buds. This response has been studied in other species of *Ipomopsis*. For *I. aggregata*, Paige (1992a) found fruit and seed production equal between plants with stems removed late in the flowering season and undamaged plants. For *I. arizonica*, Maschinski (1989) found fruit and seed production lower for plants with late season stem removal than for undamaged plants. No studies of this compensating growth response have been done for Holy Ghost ipomopsis; however, Maschinski (Arboretum at Flagstaff, pers. comm. 2002) has noted that plants with broken stems in August produced no fruit for the season.

### Inadequate Protection by Regulatory Mechanisms

Prior to listing, no Federal law protected the Holy ghost ipomopsis and no USFS management plan had been developed for the species. Now listed as Federally endangered, the Act prohibits the malicious damage, destruction, or removal and reduction to possession of plants occurring on Federal lands. However, because of the heavy recreational use within the plant's range and its attractive flower, it continues to be

vulnerable to unauthorized picking. A comprehensive USFS management plan is needed to assure the population's continuing viability.

### Management Activities

Dependence on human disturbance to create habitat puts Holy Ghost ipomopsis directly in the path of future ground-disturbing activities. About 80 percent of the plants grow on the cut-slopes of Forest Road 122. An increase in recreation in the canyon has increased the volume of traffic on this very narrow road. When two vehicles meet, one of them must pull off the road to let the other pass. Some Holy Ghost ipomopsis plants are close enough to the road to be crushed when this happens. But, if the road were widened to accommodate more traffic, the slopes would be recut and the existing population nearly eliminated.

Heavy equipment could also be used to widen the road for a fireline during future attempts to control wildfire in the canyon. New habitat would be created, but any ipomopsis recolonization would be from a small subset of surviving individuals, which could decrease the genetic variability of the species.

**Sod-forming non-native grasses may now occupy some Holy Ghost ipomopsis habitat.**

Soil disturbance can open an area to weedy non-native plants and may make the habitat unsuitable for ipomopsis. Alien grasses like smooth brome (*Bromus inermis*) and Kentucky bluegrass (*Poa pratensis*) are especially aggressive and quickly produce sodbound areas that appear to exclude Holy Ghost ipomopsis. Forest managers and ranchers have traditionally encouraged the spread of these pasture grasses for forage production and erosion control. These non-native species have become so thoroughly naturalized in the Sangre de Cristo Mountains there is no way to eliminate them from Holy Ghost Canyon. However, some control of these

species may be possible in target areas to encourage Holy Ghost ipomopsis.

The control of spruce budworm is a potential pest management impact. This moth larva can defoliate large areas of Douglas fir forest, which

**The use of BT to control spruce budworm could kill Holy Ghost ipomopsis pollinators.**

is the forest type on the west side of Holy Ghost Canyon. When infestations occur in high elevation residential areas, the State Forestry Division receives requests to apply *Bacillus thuringiensis* (BT) as a pesticide. BT kills spruce budworm, but it can also kill non-target moths and butterflies that are known pollinators of Holy Ghost ipomopsis.

#### Exclusion of Fire and Timber Harvest

Prior to European settlement of the southern Rocky Mountains, natural fires frequently influenced the ponderosa pine and mixed conifer forests where Holy Ghost ipomopsis grows. Recurrent low-intensity fires were normal in these New Mexico forests until strict fire suppression became a significant focus of

**The forest openings Holy Ghost ipomopsis needs are rare due to decades of fire suppression.**

forest management (Dick-Peddie 1993). These fires maintained open park-like forests that are the preferred habitats of *Ipomopsis* species (Paige 1992). Extended fire suppression produces dense thickets and suppresses the herbaceous understory (Moir and Dieterich 1988). This trend is obvious in Holy Ghost Canyon where fire has been excluded for at least 80 years. The 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. As these disturbance sites are recolonized by trees and shrubs, Holy Ghost ipomopsis numbers decline. Because frequent prescribed fire is incompatible with the present use of the area, this species is now dependent on recurrent

soil disturbance associated with Forest Road 122 and the residential home sites in Holy Ghost Canyon. These activities may be insufficient to create or maintain enough habitat to perpetuate a viable population of Holy Ghost Ipomopsis. Timber harvest or significant forest thinning could potentially simulate the effects of natural fire and create *Ipomopsis* habitat. The principle land uses in the canyon are now summer homes and recreation. Timber harvest, which conflicts with these uses, has been eliminated from the canyon for several decades.

Wildfire, which will eventually recur in Holy Ghost Canyon, is now potentially detrimental to Holy Ghost ipomopsis. With almost a century of fire exclusion, the accumulated fuels could produce an unnatural catastrophic wildfire (Gail Tunberg, pers. comm. 1995). High-intensity burning can eliminate most of the seeds in the soil, seal the soil particles into an impervious surface, and deplete soil nitrogen (Freeman 1984; White and Wells 1984). Survival of Holy Ghost ipomopsis could be very low and much of its habitat made useless for many years after a catastrophic wildfire. Thus, forest thinning may be the most prudent approach to conserving both the plant and the summer homes in the area.

**Wildfire is now a threat due to accumulation of fuels and the possibility of a high intensity burn.**

## Conservation Measures

Taking and Trade Prohibitions. The Act prohibits maliciously damaging, destroying, or removing and reducing to possession any endangered or threatened plants from areas under Federal jurisdiction. For all other areas, the Act prohibits removing, cutting, digging up, damaging, or destroying endangered plants in knowing violation of any State law or

regulation, including State criminal trespass law. For any endangered or threatened plants, the Act and the Lacey Act also prohibit their sale, offer for sale, import, export, or commercial transport in interstate or foreign commerce. Permits can be issued for otherwise prohibited activities that contribute to the conservation of endangered or threatened species.

Holy Ghost ipomopsis is a New Mexico State endangered plant species listed in 19 NMAC 21.2 under the statutory authority of the New Mexico Endangered Plant Species Act (9-10-10 NMSA). This law prohibits removal with the intent to possess, transport, export, sell, or offer for sale any State-listed plants from places in New Mexico where they naturally grow. Listed species can only be collected under permit issued by the State Forester for scientific studies and impact mitigation. The State law, however, does not apply to Federal employees during the course of their duties within lands of their jurisdiction.

A USFS permit is required to collect plants from the Santa Fe National Forest. These permits are issued for the collection or study of threatened or endangered species after the Service issues its permit. The USFS permit authorizes only those activities the Service has already approved.

Section 7 Requirements. Section 7 of the Act requires Federal agencies to ensure their actions will not jeopardize the continued existence of endangered or threatened species, or destroy or adversely modify any designated critical habitat areas. Consultation with the Service may be informal (requests for lists of species, or discussion of effects of a proposed action) or formal (when a Federal agency determines an action may adversely affect a listed species or destroy or adversely modify critical habitat).

Under Section 7(a)(1) of the Act, all Federal agencies are directed to "...utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species...." That is, the Act not only directs agencies to prevent further declines in species through avoidance of adverse impacts, but also directs them to undertake proactive programs to move species toward recovery.

Research. Scientific research on Holy Ghost *ipomopsis* began shortly after Wilken and Fletcher (1988) described the species. Wolf *et al.* (1991) included it in their enzyme electrophoretic studies of *Ipomopsis* and found it to be one of the most genetically distinct entities in the *I. aggregata* complex. Dr. Joyce Maschinski established ten long-term monitoring plots in 1994 to study demography and reproduction in the Holy Ghost Canyon population. These plots have been monitored through 2002. Dr. Maschinski also conducted germination and propagation studies at the Arboretum at Flagstaff. Her germination research determined optimal germination occurs after 4 or 8 weeks of cold stratification (42° F). Pollination studies at the Arboretum at Flagstaff found 57 percent fruit set in self pollination trials, but success required mechanical pollen placement on the stigma. Outcross pollination trials resulted in 9.5 - 77 percent fruit set depending on the pollen donor (Maschinski 1996). Dr. Maschinski sampled surface soils from Holy Ghost Canyon and exposed them to favorable gemination conditions in order to quantify the soil seed bank, but no Holy Ghost *ipomopsis* germinated from these samples. She also found flower morphology and pollen production in Holy Ghost *ipomopsis* to be variable (Maschinski, unpublished data).

Maschinski (2000) analyzed the extinction risk of Holy Ghost *ipomopsis* with and without



management and found that the plant has a high risk of extinction, which is reduced but not eliminated by management of habitat. Habitat suitability criteria, response to fire, seed dispersal and longevity, plant competition, and potential for hybridization have not been formally studied.

The New Mexico Forestry Division, USFS, and Service have searched for suitable reintroduction sites. Several sites were identified in 1999 that have potential for possible Holy Ghost ipomopsis seeding trials. Further evaluation of these sites, and identification of additional sites should be conducted through a USFS Management Plan in coordination with the above agencies and other stakeholders. Potential reintroduction sites will have more variation in soils, exposure, elevation, vegetation structure, and plant community than Holy Ghost Canyon. Therefore, the seeding trials will experimentally test the ecological amplitude of Holy Ghost ipomopsis as well as establish new populations.

## **PART II - RECOVERY**

### **Objectives and Criteria**

The objective of recovery is to protect and manage Holy Ghost ipomopsis so that it will sustain itself indefinitely in its natural habitat. Only one population of Holy Ghost ipomopsis is known. It is vulnerable to damage or destruction from a variety of human activities and natural catastrophic events. In order to consider downlisting the Holy Ghost ipomopsis to threatened status, the following must be accomplished:

1. The Holy Ghost Canyon population must be maintained at an annual population average of 2,000 plants. Total plant numbers are most efficiently estimated by surveying the number of flowering plants, which would be 300-400 individuals for a population of 2,000 plants during a normal precipitation year (Maschinski, pers. comm. 1995). Achieving this objective may

**Downlisting to threatened requires: (1) Maintenance of the current population in Holy Ghost Canyon at an average of 2,000 plants per year, (2) establishment of four additional populations in the upper Pecos Basin, and (3) implementation of a management plan to assure the continued survival of the species.**

require research on such factors as essential habitat criteria, habitat longevity through the seral stages of forest succession, the effects of forest fire or other practices that simulate fire, and reproductive biology in order to identify effective management practices. It is also possible that the population may need augmentation from captive populations (Maschinski, pers. comm 2002).

2. Even under optimal management, the single population of Holy Ghost ipomopsis is susceptible to extinction through chance events such as catastrophic fire or disease. Therefore, it will continue to be endangered until more populations are discovered or new populations established in other suitable habitats. Inbreeding depression studies on the related *I. aggregata* suggest that a minimum of 100 flowering plants are

**Downlisting requires additional populations because one catastrophe could destroy the present population.**

necessary to maintain a healthy breeding population (Herschel and Paige 1995). Approximately 25 percent of Holy ghost ipomopsis plants actually flower each year. The Service estimates five separate populations (including Holy Ghost Canyon) are needed to ensure some populations will survive

a catastrophic event. Therefore, the second requirement for reclassification of Holy Ghost ipomopsis to threatened status will be to establish at least four additional self-perpetuating Holy Ghost ipomopsis populations, each with at least 400 plants, in areas where the land uses are compatible with the needs of the species. The populations should be established on Santa Fe National Forest or State of New Mexico lands within the upper Pecos River Basin and must persist at or above the 400-plant level for five years before downlisting can be considered.

3. The Holy Ghost Canyon and additional populations must be protected through 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.

To determine the criteria for removing the Holy Ghost ipomopsis from the Federal list of endangered and threatened species, the following additional steps will be necessary:

1. Conduct additional long-term research, possibly including a population viability analysis, to evaluate the appropriate numbers of plants, populations, and the population distribution necessary to assure the long-term survival of the species. Evaluate existing population status with respect to this information and adjust as necessary.

**Criteria for removing Holy Ghost ipomopsis from the Endangered Species list will be determined after further research provides more knowledge about long-term population viability.**

2. Monitor the original and all reintroduced populations for a minimum of 10 years after downlisting goals are reached to ensure that the current management plan addresses the long term conservation of the established populations.

## Outline of Recovery Actions

The following is an outline of the recovery actions needed to attain the objectives of this plan. Recovery actions are listed in a step-down form with broad categories of recovery actions stepped-down to specific tasks. Tasks listed here also appear in the Implementation Schedule (Part III of this plan), in which costs and scheduling are estimated and lead responsibilities for specific tasks are identified.

1. Protect the Holy Ghost ipomopsis population and habitat from existing threats. Holy Ghost ipomopsis presently exists as a single population in a relatively small area and is vulnerable to extinction. Additional planning and management actions may be needed to ensure the species can persist in its natural habitat.
  
11. Develop and implement a management plan to prevent detrimental impacts to Holy Ghost ipomopsis. This species occurs only on the Santa Fe National Forest. The USFS should review existing land management plans to determine if they contain adequate direction for the management of Holy Ghost ipomopsis. If existing plans are inadequate, new plans or supplements to existing plans should be written in coordination with the Service. An adequately detailed plan would describe ways to prevent significant impacts to Holy Ghost ipomopsis from

agency actions in Holy Ghost Canyon.

111. Develop home owner cooperation in the Holy Ghost Summer Home Area.

The USFS leases part of Holy Ghost Canyon to individuals who have built summer homes. The cooperation of these home owners is essential to recovering the species. Local people play an important role in protecting this plant from vandalism, educating other visitors to the canyon, taking care not to introduce weedy plants to the area, protecting the habitat (and their homes) from catastrophic wildfire, and providing small areas of recurrent disturbance as habitat for the species.

112. Develop criteria for the maintenance of Forest Road 122. About 80 percent

of the existing population grows on the cut-slopes of Forest Road 122 in Holy Ghost Canyon. Occasional repeated disturbance of these cuts may be beneficial in maintaining areas of suitable habitat in otherwise overgrown pine forest. Grading small presently unoccupied road areas would create more habitat for Holy Ghost ipomopsis. Future work to straighten or widen the road should include plans to scrape and stockpile topsoil that could contain Holy Ghost ipomopsis seeds and to harvest seed from plants that will be affected. The topsoil and seeds should be replaced on the new cut-slopes. The roadside should be inspected annually for invasion of noxious weeds. Any weed control should be done by hand rather than with herbicides.

113. Develop and implement a fire management plan for Holy Ghost Canyon.

Decades of fire exclusion from Holy Ghost Canyon have produced an overgrown forest and fuel loads that could carry a high-intensity fire. Prescribed low-intensity fire or the clearing of fuel breaks in and above the canyon would reduce the hazard of a catastrophic fire and create open habitats for *ipomopsis*. Residents of the canyon could clear defensible spaces around their homes that also create *Ipomopsis* habitat.

114. Consider designating Holy Ghost Canyon as a Botanical Area. USFS Botanical Area designation would acknowledge the unique botanical character of the canyon. Botanical Areas are educational opportunities for the public. Pamphlets or signs should be made available at the Holy Ghost Campground that discuss and illustrate the plant diversity of the canyon and the need to not pick wildflowers.
  
12. Revise management plans as needed when new information becomes available. As research progresses and new observations accumulate, USFS plans may need occasional revision to direct better management of the species.
  
13. Monitor the Holy Ghost ipomopsis population for general condition, reproductive success, and to identify any needed revisions to management plans. The Holy Ghost Canyon population should be monitored annually to detect any population declines or reduction of reproductive effort. When additional locations are seeded, the monitoring at Holy Ghost Canyon can serve as a control to help evaluate results for the new populations.

14. Ensure continuing compliance with applicable Federal and State laws and regulations. All applicable existing laws need continuing compliance. These laws include the Endangered Species Act, the New Mexico Endangered Plant Species Act, the Lacey Act, the National Forest Management Act, and the National Environmental Policy Act.

Under Section 7(a)(1) of the Act, all Federal agencies are directed to "...utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species...."

That is, the Act not only directs agencies to prevent further declines in species through the avoidance of adverse impacts, but also directs agencies to undertake proactive programs to move species toward recovery. For Holy Ghost ipomopsis, these proactive programs include the management, research, and reintroduction tasks identified in this plan.

2. Complete studies to determine the habitat and biological requirements of Holy Ghost ipomopsis. Some preliminary research has been done on Holy Ghost ipomopsis reproduction (Maschinski 1996), and demography study plots are being monitored. However, little has been done to understand the relationships between the plant and such habitat variables as soil type, sunlight, moisture regimes, associated species, and disturbance.
21. Determine habitat requirements. This information is essential to ensure continued survival of the existing population in Holy Ghost Canyon and ultimately the survival of any reintroduced populations. The determination of whether this plant

is a restricted endemic or a species that can spread to additional habitats will help focus the direction of some recovery actions such as determining appropriate reintroduction sites.

211. Determine the ecological amplitude of Holy Ghost ipomopsis through seeding trials in other slightly different habitats. Nothing about the soils or plant community in Holy Ghost Canyon indicates the habitat is unique. Seeding trials on other substrates, elevations, and exposures can test the ecological amplitude of Holy Ghost ipomopsis to determine if its present restricted distribution results from special habitat requirements or from other factors like limited dispersal potential.

212. Research community dynamics and ecology. Little is known about the dynamic processes that shape the habitat of Holy Ghost ipomopsis. It presently grows mostly on graded road cuts. More understanding is needed about the natural forces that contribute to habitat suitability and availability.

2121. Research seral stage. Information is needed about the successional trend of the road cuts, their present seral stage, and expected longevity of vegetation phases.

2122. Research response to surface disturbing activities. The majority of the plants in Holy Ghost Canyon grow on human-created habitats associated with road cuts and summer homes. The response of



plants to new disturbance needs to be studied through experimental seeding and monitoring of small disturbance plots. Interested homeowners should be encouraged to participate in monitoring and research. If found to be suitably adapted, plans could be made to reintroduce Holy Ghost ipomopsis in conjunction with new disturbance activities such as road grading and logging in the upper Pecos River Basin.

2123. Response to fire. Recurrent low-intensity fire is an important ecological process for conifer forests in the Rocky Mountains. These fires may have played a significant role in maintaining suitable habitats for ipomopsis in Holy Ghost Canyon. Small experimental burn plots would be useful for studying the effect of fire in Holy Ghost ipomopsis habitat. These plots might be placed either in Holy Ghost Canyon or included in the experimental design of some of the seeding trials in other canyons.
2124. Research response to livestock and wildlife grazing. Livestock grazing is presently excluded from Holy Ghost Canyon. If new populations are established at other locations within active grazing allotments, comparisons should be made between grazed and ungrazed habitats for seed production and seedling establishment.
2125. Research interactions with other plant species. Studies should be done to determine when pine-oak forest habitats become too

overgrown to be suitable for Holy Ghost ipomopsis. Research is also needed to determine if Holy Ghost ipomopsis is restricted to steep road cuts because the grass cover in forest openings makes flatter habitats unsuitable. Invasive grasses such as smooth brome and Kentucky bluegrass may be especially significant in restricting habitat availability for Holy Ghost ipomopsis.

22. Research reproductive biology. All aspects of reproduction from flowering to the germination and establishment of new plants need to be understood for successful management, and for possible cultivation and restoration. Some studies of pollination mechanisms and germination have already been done (Maschinski 1996; Tonne 2000).
  
221. Identify primary pollinators. Tonne (2000) studied pollinators of Holy Ghost ipomopsis in 1999 and documented eight species of arthropods visiting study plants. These insect pollinators are susceptible to pesticide applications. Additional work in identifying the primary pollinators and understanding their life histories and habitat requirements may help avoid serious pesticide impacts.
  
222. Compare seed production and viability between self-pollinated plants and outcrossed pollinations. Holy Ghost ipomopsis is unique in the *I. aggregata* complex for its ability to set fruits by self-pollination. This is an important characteristic for species that colonize new habitats. Yet Holy Ghost ipomopsis is restricted to a single canyon. This rare plant may be self-

compatible, but these offspring may be less viable than outcrossed offspring.

223. Determine seed production. The number of seeds per capsule, variation in production per capsule, and capsules per flowering stalk need to be determined. These data should be used to identify any inbred genetic factors that may limit production of viable seed or determine if seed set is low enough to contribute to the rarity of Holy Ghost ipomopsis.
  224. Determine length of seed viability. Research on Holy Ghost ipomopsis seed viability would benefit management and reintroduction projects. Success or failure of seeding trials could be determined quickly if seed viability is short. Knowing the length of seed viability is also necessary for establishing the maximum seed storage period.
3. Maintain plants in cultivation at a botanical garden and establish a seed bank. The natural population of Holy Ghost ipomopsis is at a critically low level and a single catastrophic event could cause its extinction. A cultivated population and seed bank should be established in a more controlled environment to ensure against total loss of the species. Collecting from Holy Ghost Canyon should follow the Sampling Guidelines for Conservation of Endangered Plants (Falk and Holsinger 1991) to ensure an adequate sample of the species' genetic diversity is obtained. These guidelines call for sampling from 10 - 50 individuals per population and recommend using the higher end of this range for species with the life history characteristics of Holy Ghost ipomopsis. Because of the small population size in Holy Ghost Canyon, this collecting

should be coordinated with other workers doing conservation projects that require collecting. It may be necessary to spread collecting over several years. The Arboretum at Flagstaff, a participating garden of the Center for Plant Conservation, is cultivating Holy Ghost ipomopsis and has seed at the National Seed Storage Laboratory in Fort Collins, Colorado.

4. Survey potentially suitable habitats. Additional inventory is needed to find any populations that were overlooked in previous surveys and to find potential sites for reintroduced populations.
  41. Search previously unsurveyed areas for new populations. There are areas of suitable habitat in the Santa Fe River Basin that should be surveyed for additional populations of Holy Ghost ipomopsis. An unsubstantiated report of Holy Ghost ipomopsis in the Panchuela Creek Campground area should also be investigated.
  42. Identify potential sites for reintroduced populations. There should be 15 - 20 potential sites selected that match our current understanding of the habitat preferences of the species. These will be relatively dry, steep, west to southwest-facing slopes of partly weathered Terrero Limestone with bare mineral soils and little other herb or shrub competition at elevations between 7,500 - 8,500 ft. The sites should be separated sufficiently so that a single catastrophic event is unlikely to destroy more than one site. The sites should be selected in areas where Holy Ghost ipomopsis will be compatible with present and anticipated land uses.

5. Develop and implement a plan to establish more populations. Full recovery of Holy Ghost ipomopsis requires the establishment of more populations in other canyons in the area to reduce the risk of extinction from a single catastrophic event. This plan calls for establishment of at least four additional self-perpetuating populations in natural habitats before Holy Ghost ipomopsis can be reclassified to threatened status. The reintroduction plan should consider all phases of reintroduction including seed selection and production, site preparation, planting methods (seeding or greenhouse-grown plants), monitoring, and subsequent management.

51. Evaluate the need for “non-essential experimental” status for the reintroduced populations. Reintroduced populations have the same protections under the Act as natural populations unless they are designated as “experimental”. Under this designation (Section 10(j) of the Act), all individuals in an experimental population are treated as threatened species regardless of the original listing designation. If an experimental population is also considered “non-essential”, it is treated as a species proposed for listing for the purposes of Federal agency Section 7 consultation. Experimental populations are designated through the Federal rule-making process, including proposed and final rules published in the *Federal Register* for public review. The purpose of experimental population designations is to create the regulatory flexibility needed to remove or reduce opposition to reintroduction programs. If there is no opposition to reintroduction, there is no need to designate an experimental population. Early cooperation between the USFS and the Service to standardize protocol and streamline any required Section 7 consultation processes should remove concerns over a potential regulatory burden. The careful selection of Holy Ghost ipomopsis reintroduction

sites to be compatible with current and anticipated land uses might avert the need to designate experimental populations for this species.

52. Collect a representative sample of seed from Holy Ghost Canyon. Follow the Sampling Guidelines for Conservation of Endangered Plants (Falk and Holsinger 1991) to adequately sample the genetic variability of Holy Ghost ipomopsis. These guidelines call for sampling from 10 - 50 individuals per population. The guidelines recommend using the higher end of this range for species with the life history characteristics of Holy Ghost ipomopsis. Because of the small population size in Holy Ghost Canyon, it may be necessary to spread collection over several years. A total of 2,950 Holy Ghost ipomopsis seeds representing 573 genets collected in 4 years have been stored at the Center for Plant Conservation National Seed Storage Laboratory in Fort Collins, Colorado (J. Maschinski, pers. comm. 1999, 2002). However, stored seed has a limited life span, so the existing collection may need to be augmented.
53. Establish a nursery for seed production. The natural population is small and should not be used as the direct source of seed for repeated reintroduction attempts. A nursery is needed to produce bulk quantities of seed that can be used for direct seeding, producing nursery-grown stock for outplanting or for ecology and reproductive biology experiments. Initial attempts at an *ipomopsis* nursery have had limited success. Difficulty with seedling establishment, seed production, and seed collection that be overcome before seeds can be produced in sufficient quantity to support reintroductions.

531. Refine methods for seedling establishment. Previously, there has been high mortality of seedlings grown in the greenhouse. After germination and normal growth to the cotyledon stage, most plants wither and die. The causes of this death must be identified and corrected.
532. Determine and correct causes of low seed production. Although nursery-grown plants flower profusely, many plants produce few seeds. An absence of pollinators or genetic incompatibility in a small population have been speculated as possible causes. The causes of low seed production need to be determined and corrected, or the number of nursery-grown plants needs to be increased to compensate for low seed production per plant.
533. Develop better methods of seed harvesting. Seeds that are collected before the capsules open do not germinate well and when the capsules open the seeds immediately fall out. Flowering stems have buds, open flowers, immature fruits, mature fruits, and opened fruits all at the same time. This makes it difficult to enclose the stem in a bag that will catch seeds without damaging flowers that have not yet opened. Seed harvesting methods need to be developed that will lead to the collection of mature seeds while still letting the plant flower as long as possible.
54. Develop protocols for transplanting nursery-grown plants into the wild and for directly planting seeds into new areas. Researchers have grown various species of *Ipomopsis* in the greenhouse and then transplanted them successfully to the field (D. Wilken, Santa Barbara Botanic Garden, *in litt.* 1998). But, there have

been no reintroductions with nursery-grown plants of Holy Ghost ipomopsis due to problems of seedling mortality. In the only reintroduction attempt so far, 1,800 seeds were planted in Willow Creek Canyon; only one plant reached maturity and flowered. It will require either thousands of seeds or a different seeding technique to make a reintroduction from seeds successful.

541. Develop transplanting methods. Once the problems of starting plants in a greenhouse or nursery are overcome, methods to successfully transplant these plants will have to be developed. This will involve number of transplants, timing of transplanting, soil preparation, possible supplemental watering, possible fertilizing, and plot design and marking.

542. Develop seeding methods. Seeding needs to be done in a way that will optimize the likelihood of successful germination and establishment. This may include soil preparation, soil retention structures to prevent seeds from washing away, and experimentation with seeding depth and watering protocols. Optimal cross-pollination distances in skyrocket have been determined to be between 2 and 10 meters (Waser and Price 1989). Therefore planting numerous small patches at each site is appropriate, assuming the optimal outcrossing distance is similar for Holy Ghost ipomopsis. A seeding plan should describe number of seeds per site, number of seeds per patch, number of seed patches per site, minimum and maximum distance between patches, and markers for site identification.

55. Plant reintroduced populations. All approved reintroduction sites should be



planted as soon as sufficient seed or plants are available.

56. Monitor reintroduced populations. Each reintroduced population should be monitored for at least five years even if there is no immediate germination or, for transplanted plants, the appearance of a next generation. If there is successful establishment, the site should be monitored for 10 years to determine if the new population meets the criteria for downlisting.
  57. Plant alternate sites, if needed. If any of the initial reintroduced populations fail because of unsuitable habitat or incompatibility with the prevailing land use, alternate sites should be selected and planted.
  58. Revise USFS plans as necessary to incorporate new populations. When monitoring begins to show a reintroduced population on the Forest is self-perpetuating and becoming successful, the USFS should revise any necessary management plans to treat the site as an established population.
6. Encourage public awareness and support for the preservation of Holy Ghost ipomopsis. Awareness and support for recovery can be developed through local education and through outreach using public media. Holy Ghost ipomopsis is an interesting and attractive plant that should have an immediate constituency among garden clubs and nature lovers. Information in this plan and USFS management plans will help dispel inaccurate perceptions about possible restrictive land uses due to the presence of this plant.

7. Use the results of monitoring and research studies to determine if populations can sustain themselves and to establish criteria for removing the species from the list of threatened and endangered species.
  71. Continue to assess the population viability and risk of extinction for Holy Ghost ipomopsis. Utilize long-term data. Evaluate the cost and benefit of conducting a population viability analysis workshop for Holy Ghost ipomopsis and determine whether that is the best approach to understanding population viability for the species. Conduct viability workshop if feasible and appropriate.
  72. Establish delisting criteria. Research and summarize all available information. Revise and implement recovery plan as warranted by new information.
8. Develop a post-recovery monitoring plan. The 1988 amendments to the Act require a species be monitored for at least 5 years after delisting. When the recovery goals have been met, a monitoring plan should be developed to assess the health of the natural and introduced populations after delisting. The plan should specify types and levels of decline that would trigger the return of Holy Ghost ipomopsis to the Federal endangered species list. Given the extreme fluctuations observed in the Holy Ghost Canyon population, longer-term monitoring may be appropriate.

## **Minimization of Threats to Holy Ghost Ipomopsis through Implementation of Recovery Actions**

The final rule listing the Holy Ghost Ipomopsis (USFWS 1994) evaluated threats to the

species in terms of five listing factors. Implementation of the above recovery actions would minimize these threats as follows:

Listing Factor 1: The present or threatened destruction, modification, or curtailment of its habitat or range. The Holy Ghost ipomopsis is only known to occur in one area that is heavily used for recreation and summer homes. Natural fire, grazing, and timber harvest that would help to maintain the forest openings required by Holy ghost ipomopsis are not occurring. As a result, the plant has become associated almost exclusively with the manmade openings created by USFS road 122. Road maintenance poses a significant threat to the existing population. The use of herbicides and pesticides also poses a potential threat through direct killing of plants or through effects on its pollinators. Implementation of recovery actions 1 - 14 would address these threats through the development of a management plan to sustain and protect Holy Ghost ipomopsis habitat. Recreational use, prescribed fire, forest thinning, road maintenance, and the use of pesticides and herbicides would be specifically addressed in this management plan. Recovery Actions 2 - 224 reduce the threat of extinction by promoting a better understand the biological and ecological requirements of the plant. Recovery Actions 4 - 58 address the need to discover or reintroduce additional populations.

Listing Factor 2: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes. There are no known economic uses for Holy Ghost ipomopsis. However, the low population numbers make the species vulnerable to harm from scientific and non-scientific collecting. Implementation of recovery actions 11- 111 would reduce threats by establishing a management plan for the species, and by developing home owner cooperation in protecting the plant from vandalism and in educating others to its value.

Recovery action 114 is to pursue designation of Holy Ghost Canyon as a botanical area, which would increase public awareness about the significance of the species. Recovery action 14 ensures continuing compliance with applicable Federal and State laws and regulations, which include enforcement of prohibitions against malicious damage, destruction, or removal of plants on Federal lands, and the requirement for permits to remove plants for research or conservation.

Listing Factor 3: Disease or Predation. No significant disease or predation threats have been identified for Holy Ghost ipomopsis.

Listing Factor 4: The Inadequacy of Existing Regulatory Mechanisms. The listing of the Holy Ghost ipomopsis put in place additional protection for the plant through Sections 7 and 9 of the Endangered Species Act, which require interagency cooperation on Federal projects and prohibit the malicious damage, destruction, or removal of plants on Federal lands, respectively. Recovery action 14 calls for continuing compliance with these laws and regulations. Additional protections are afforded through Recovery Actions 111, developing home owner cooperation in protecting the plant, and 114, possible designation of Holy Ghost Canyon as a Botanical Area.

Listing Factor 5: Other Natural or Man-made Factors Affecting its Continued Existence.

The Holy Ghost ipomopsis is most threatened by its extremely limited distribution and low reproductive success. Recovery Actions 1 - 14 address many of the current threats through development of management plans to protect the species and possible designation of Holy Ghost Canyon as a Botanical area. Action 6 educates and involves the public in the plant's recovery. Recovery Actions 2 - 224 addresses threats through

research to better understand and manage for the species' biological and ecological requirements. Recovery Action 3 protects the species from extinction by cultivating plants at a botanical garden and establishing a seed bank. Recovery Action 4 to 42 identify any additional populations of Holy Ghost ipomopsis not currently known, as well as potential reintroduction sites. Recovery Actions 5 - 58 develop the site locations, seed base, techniques, and implementation of reintroduction of additional populations to reduce the threat of extinction. Action 7 reduces threats by evaluating existing information and possibly conducting additional research to determine population viability and delisting criteria. Action 8 assures that recovery actions were successful through long-term monitoring and management plans after the plant has reached recovery goals.

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### PART III – IMPLEMENTATION SCHEDULE

The following Implementation Schedule outlines actions and costs for the Holy Ghost ipomopsis recovery program. It is a guide for meeting the objectives discussed in Part II of this plan. The schedule indicates task priorities, task numbers, task descriptions, duration of tasks, responsible agencies, and estimated costs. These actions, when accomplished, should recover Holy Ghost ipomopsis and protect its habitat. It should be noted that the estimated monetary needs for all parties involved in recovery are identified for the first 3 years only, and therefore do not reflect total recovery costs. An estimate of costs to reach the downlisting objectives for this species is carried out for ten years in the EXECUTIVE SUMMARY, page iii. It is the intention of the Service to revise and update this recovery plan in five years, at which time the costs to reach downlisting and delisting objectives will be reassessed. Costs are estimated to assist in planning and do not obligate any involved agency to expend the estimated funds. Although work with private home owners is identified in this plan, they are not obligated to expend any funds for the recovery of this species.

#### Task Priorities

- Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.
- Priority 2 - An action that must be taken to prevent a serious decline in species population/ habitat quality, or some other significant negative impacts short of extinction.
- Priority 3 - All other actions necessary to meet the recovery objectives.

#### Abbreviations Used

- FWS - Fish and Wildlife Service
  - ES - Ecological Services Field Office
  - LE - Law Enforcement, FWS
- FS - U.S. Forest Service
- NM - State of New Mexico
- CPC - Center for Plant Conservation

HOLY GHOST IPOMOPSIS RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIOR-ITY #	TASK #	TASK DESCRIPTION	TASK DURA-TION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES (\$000)			COMMENTS
				FWS		Other	YEAR 1	YEAR 2	YEAR 3	
				Region	Program					
1	111	Develop home owner cooperation	2	2	ES	FS	1.0 1.0	1.0 1.0		Part of mgt. planning
1	112	Develop road maintenance criteria	1			FS	1.0			Part of mgt. planning
1	113	Develop and implement a fire management plan	5			FS	2.5	10.0	10.0	Part of mgt. planning
1	13	Monitor the Holy Ghost Canyon population	Ongoing			FS	3.0	3.0	3.0	
1	14	Ensure compliance with applicable laws and regulations	Ongoing	2	ES LE	FS NM	2.0 1.0 5.0 1.0	2.0 1.0 5.0 1.0	2.0 1.0 5.0 1.0	
1	211	Do seeding trials to determine ecological amplitude of Holy Ghost ipomopsis	6	2	ES	FS NM	3.0 3.0 1.0	3.0 3.0 1.0	3.0 3.0 1.0	Part of ecological studies. Do with Task 5
1	2122	Study plant response to surface disturbance	5	2	ES	FS NM	1.0 5.0 1.0	1.0 5.0 1.0	1.0 5.0 1.0	Part of ecological studies
1	2123	Study plant response to fire	5	2	ES	FS NM	3.0 5.0 1.0	3.0 5.0 1.0	3.0 5.0 1.0	Part of ecological studies
1	2125	Study interactions with other plants	5	2	ES	FS NM	3.0 5.0 1.0	3.0 5.0 1.0	3.0 5.0 1.0	Part of ecological studies

HOLY GHOST IMPLEMENTATION SCHEDULE, CONTINUED

PRIOR-ITY #	TASK #	TASK DESCRIPTION	TASK DURA-TION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES (\$000)			COMMENTS
				FWS		Other	YEAR 1	YEAR 2	YEAR 3	
				Region	Program					
1	221	Identify pollinators	2	2	ES		5.0	5.0		Part of reproductive biology studies, some work has been done.
1	223	Determine seed production	2	2	ES	FS	3.0 1.0	3.0 1.0		Part of reproductive biology studies
1	224	Determine length of seed viability	7	2	ES		5.0	1.0	1.0	Part of reproductive biology studies
1	3	Maintain plants in cultivation and establish a seed bank	Ongoing	2	ES	CPC	10.0 3.0	7.0 3.0	2.0	
1	42	Identify potential reintroduction sites	2	2	ES	FS NM	3.0 2.0 2.0	3.0 2.0 2.0		Do with Task 41
1	52	Collect seeds for a seed production plantation	3	2	ES	FS NM	0.5 0.5 0.2	0.5 0.5 0.2	0.5 0.5 0.2	Part of reintroduction program
1	53	Establish a seed production plantation	6	2	ES	FS NM	2.0 2.0 1.0	2.0 2.0 1.0	2.0 2.0 1.0	Part of reintroduction program
1	54	Develop a seeding protocol	1	2	ES	FS NM	0.3 0.3 0.3			Part of reintroduction program

HOLY GHOST IMPLEMENTATION SCHEDULE, CONTINUED

PRIOR-ITY #	TASK #	TASK DESCRIPTION	TASK DURA-TION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES (\$000)			COMMENTS
				FWS		Other	YEAR 1	YEAR 2	YEAR 3	
				Region	Program					
1	57	Plant alternate sites, if needed	2	2	ES	FS NM				Part of reintroduction program. Begin in year 7.
2	114	Consider Botanical Area designation for Holy Ghost Canyon	1			FS	2.0			Part of mgt. planning
2	12	Revise management plans as needed	Ongoing			FS	0.5	0.5	0.5	Part of mgt. planning
2	2121	Study successional trend of road cuts	5	2	ES	FS NM	2.0 2.0 1.0	2.0 2.0 1.0	2.0 2.0 1.0	Part of ecological studies
2	2124	Study response to livestock and wildlife grazing	5	2	ES	FS NM	3.0 3.0 1.0	3.0 3.0 1.0	3.0 3.0 1.0	Part of ecological studies
2	222	Compare seed viability between self-pollinated and out crossed pollination	5	2	ES		5.0	5.0	5.0	Part of reproductive biology studies
2	41	Search for new populations	3	2	ES	FS NM	6.0 3.0 1.0	6.0 3.0 1.0	6.0 3.0 1.0	
2	51	Evaluate the need for "non-essential experimental" designations	1	2	ES	FS	1.0 1.0			Part of reintroduction program

HOLY GHOST IPOMOPSIS RECOVERY PLAN IMPLEMENTATION SCHEDULE, CONCLUDED

PRIOR-ITY #	TASK #	TASK DESCRIPTION	TASK DURA-TION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES (\$000)			COMMENTS
				FWS		Other	YEAR 1	YEAR 2	YEAR 3	
				Region	Program					
2	7	Use the results of monitoring and research studies to determine if populations can sustain themselves and to establish criteria for delisting	Ongoing	2	ES	FS NM	0.5 0.5 0.5	0.5 0.5 0.5	0.5 0.5 0.5	
2	71	Evaluate the cost and benefit of conducting a population viability analysis. Conduct viability workshop if appropriate	1	2	ES	FS NM		5.0	15.0	May be most appropriate just prior to downlisting
3	72	Research and summarize all available information pertinent to establishing delisting criteria. Establish criteria, design and implement plan for full recovery and delisting	3	2	ES	FS NM				downlisting goals are met
3	8	Develop a post-recovery monitoring plan	1	2	ES					Monitor for 5 years after delisting
		Totals					125.6	123.7	107.7	

### APPENDIX A

## Comments Received on the Draft Recovery Plan during Public Review in 1999 and Stakeholder/Peer Review in 2002

*Comment Letter #1*



United States  
Department of  
Agriculture

Forest  
Service

Southwestern  
Region

517 Gold Avenue, SW  
Albuquerque, NM 87102-0084  
FAX (505) 842-3800  
V/TTY (505) 842-3292

File Code: 2670

Date: APR 23 1999

Jennifer Fowler-Propst  
Field Supervisor  
USDI-Fish and Wildlife Service  
New Mexico Ecological Services Field Office  
2105 Osuna NE  
Albuquerque, NM 87113

Dear Ms. Fowler-Propst:

In response to your request for comments on the draft Holy Ghost Ipomopsis (Ipomopsis sancti-spiritus) Recovery Plan, the following was provided by Reggie Fletcher, Regional Ecologist, who discovered and co-described the plant.

Overall, we have little to comment on the proposed Recovery Plan and we feel the recovery actions should be implementable. However, the wildfire impacts discussion beginning at the bottom of page 12 are somewhat misleading. The draft states, "high-intensity burning can eliminate most of the seeds in the soil, seal the 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 for many years after a catastrophic wildfire." High intensity burns can result in the impacts stated, but the habitat for the Ipomopsis is, as noted in the draft, on sites where there is little potential for such fires. The plant does not compete well with other species and does well on low nitrogen sites. Alteration of the fire regime has provided vegetation conditions unfavorable to the plant. Even a high intensity burn adjacent to existing populations would likely favor the plant's expansion, provided a seed source were available, within a short time. Such has been noted with other close relatives of this plant. Re-establishing the natural fire regime in the surrounding plant community is likely key to long-term survival for the Holy Ghost ipomopsis.

|-|

The criteria needed to delist the Holy Ghost ipomopsis are given on page 22. "The Service estimates that eight separate populations (including Holy Ghost Canyon) are needed to ensure some populations will survive a catastrophic event." Since the estimate of eight needed populations appears to be arbitrary, might not a progressive intermediate recovery step of downlisting to threatened be appropriate? In this manner, the effectiveness of developing suitable habitat, other than roadsides and the persistence of plantings, can be tested without complete removal of protection under the Act, while downlisting to threatened would show and reward progress toward recovery.

1-2



*letter done by EAP caring for the Land and Serving People  
with WOOD. FAXed + public filed.*



Jennifer Fowler-Propst

2

We appreciate the opportunity to comment on the draft document and look forward to its completion.

Sincerely,



JAMES R. LLOYD  
Director, Wildlife, Fish and Rare Plants

CONCUR	DATE	STAFF
OM		
KF	4/22/99	EAR
TYPIST:vm	4-22-99	EAR/MSA



09/19/2002 10:50 FAX 505 842 3152

USDA FOREST SVC

*Comment Letter # 2*



United States  
Department of  
Agriculture

Forest  
Service

R3 Regional Office

333 Broadway SE  
Albuquerque, NM 87102  
FAX (505) 842-3800  
V/TTY (505) 842-3292

File Code: 2670  
Date: SEP 16 2002

Bryan Arroyo  
Assistant Regional Director, Ecological Services  
U.S. Fish and Wildlife Service  
P.O. Box 1306  
Albuquerque, NM 87103

Dear Mr. Arroyo:

This responds to your request dated August 16, 2002, to review the Draft Holy Ghost Ipomopsis Recovery Plan. Holy Ghost Ipomopsis is an endangered plant found only in Holy Ghost Canyon on the Pecos-Las Vegas Ranger District of the Santa Fe National Forest.

The draft plan accurately describes the current knowledge of the species and proposes appropriate measures for its recovery. The downlisting criteria appear appropriate and we agree with the decision to gather more species-specific information before establishing delisting criteria. Since this plant is known from only a single canyon with a current population of about 2,500 plants, we believe it is appropriate to recommend establishing additional populations on State and National Forest lands in the vicinity of the current population. 2-1

We believe the responsible parties to accomplish recovery tasks are appropriately identified in the recovery plan implementation schedule. It is highly appropriate for the USDA Forest Service to develop and implement a management plan for this species, to develop a monitoring program, to identify sites to establish additional populations, and to work with the Fish and Wildlife Service, State of New Mexico, and private partners on other recovery tasks.

Our other comments, which are mostly editorial in nature, are marked on the enclosed copy of the plan. These comments have been E-mailed to Wendy Brown of your staff. If you have questions or need further assistance, please contact Charlie McDonald, Regional Botanist at (505) 842-3228.

Thank you for the opportunity to comment on this plan. We look forward to working with the Fish and Wildlife Service and others to recover Holy Ghost Ipomopsis.

Sincerely,

*Harv Forsgren*  
for HARV FORSGREN  
Regional Forester

Enclosure

cc: Forest Supervisor, Santa Fe National Forest



04/17/2002 13:34 5057572737

USDA FOREST SERVICE

PAGE 02



United States  
Department of  
Agriculture

Forest  
Service

Pecos/Las Vegas  
Ranger District

P.O. Box 429  
Pecos, NM 87552  
(505) 757-6121

Comment Letter #3

File Code: 2600

Date: May 26, 1999

Fish and Wildlife Service  
NM Ecological Services Field Office  
Attn: Charlie McDonald, Endangered Species Botanist  
2105 Osuna N.E  
Albuquerque, Nm 87113

Dear Mr. McDonald:

Enclosed is Comments on the Draft Holy Ghost Ipomopsis Recovery Plan by the Santa Fe National Forest, Pecos/Las Vegas Ranger District.

On Friday, May 14, 1999 the Pecos/Las Vegas Ranger District met to discuss the options of the Draft Holy Ghost Ipomopsis Recovery Plan. Our primary concern were the nine sites selected for possible seeding trials.

We reviewed each of the 9 identified sites and prioritized them based on habitat characteristics and potential conflicts. The following criteria were identified as priority areas.

Forest priority areas included:

- \* Canyons with no public access, where road maintenance would not be a high priority
- \* Areas with existing access roads to old mines that are not used or used very little, and where disturbed areas already exists
- \* Existing access roads that could be combined with the de-commissioning road projects on the Forest.

We reviewed the nine options with the above considerations in mind.

- 1) The north fork of Dalton Canyon.

On April 28, 1999 the district Wildlife Biologist and Bob Sivinski with the New Mexico Forestry Division surveyed this area for a potential seeding site. The areas identified are along the main road and do not meet Forest priority areas. There are areas in north Dalton Canyon off the main road that could possibly be evaluated for seeding.

- 2) Indian Creek Canyon.

3-1



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USDA FOREST SERVICE

PAGE 03

This area along through the Jones Hill Mining claim was identified as a suitable site. The mining claim is active so coordination with the mining operation would make this an ideal location.

3.1, cont

3) Terrero Mine Spoil reclamation site, lower Willow Creek.

This would be an ideal site since the lower part of Forest Road 645 is planned for decommissioning and is scheduled to be obliterated and abandoned.

4) Upper Willow Creek Canyon.

This area is in the same vicinity as number 3. The road between area 3 and 4 is scheduled to be obliterated. This is also a site that meets Forest Service priorities.

5) Lower Windsor Creek Canyon.

This site is not recommended. This is an area where road maintenance is a high priority. It is a highly used recreational road and it leads to several summer homes. The right of way on this road also has a high potential for future power lines.

6) Panchuela Creek Canyon

This site is not recommended due to the high recreation use and road maintenance needs. There are areas where the trail crosses the creek with good potential for seed dispersion but not along the main road.

7) Jacks Creek road reclamation.

The road to Jack's Creek is also a high maintenance priority and would not be an ideal seeding site. This site is not recommended.

8) Rito Manzanares Canyon

This is not a desirable location. There are lots of multiple use activities throughout this canyon. It is a high road maintenance priority. It is also has private property.

9) Rito Ruidoso Canyon

This canyon is not a high priority. It is also a high road maintenance priority and would not be recommended

**COMMENTS**

42. Identify potential sites for reintroduced populations.

Although 9 sites have been identified in the plan, other suitable sites have not been identified. A comment should be added that states that other potential sites may be used with or before

---

Comment Letter #4

File Code: 2670

Date: September 9, 2002

Wendy Brown  
U.S. Fish and Wildlife Service  
Division of Endangered Species  
P.O. Box 1306  
Albuquerque, NM 87103-1306

Dear Ms. Brown

The Santa Fe National Forest has completed a review of the draft Recovery Plan for the Holy Ghost Ipomopsis dated August 2002. This version of the Recovery Plan is acceptable. The Forest has no further comments at this time.

4-1

Sincerely,

(By electronic mail)

/s/ Lee Johnson  
LEE JOHNSON  
Forest Biologist

Comment Letter #5



"Sivinski, Robert"  
<BSIVINSKI@state.nm.us>

09/09/2002 02:51 PM

To: "'Wendy\_Brown@fws.gov'" <Wendy\_Brown@fws.gov>  
cc:  
Subject: RE: HGI comments

Hi Wendy:

I have no further comments on the HGI Recovery Plan. I notice that establishing a botanical garden population and seed bank has been added as a major action. I think this has no real purpose, but am not opposed to it as long as it does not detract from establishing new wild populations.

5-1

Yes! I would be interested to learn what Joyce is doing. Please Fax her comments to me at 505-476-3330.

Thanks,,, Bob

(By Electronic Mail)



Comment Letter #6



"Dieter Wilken"  
<dwilken@sbbg.org>  
09/06/2002 11:44 AM

To: <wendy\_brown@fws.gov>  
cc:  
Subject: comments on Holy Ghost Ipomopsis Recovery Plan

Wendy Brown  
U.S. Fish and Wildlife Service  
Division of Endangered Species  
PO Box 1306  
Albuquerque NM 87103-1306

Dear Ms. Brown:

I am writing these comments in response to a request from your office in regard to the Recovery Plan for the Holy Ghost Ipomopsis. I read the most recent version, dated August 2002.

I find it substantially correct with regard to information content and with respect to its recommendations.

However, I believe that it has not given attention to the fact that this species is being monitored and studied by Dr. Joyce Maschinski of the Arboretum at Flagstaff. This institution is a member of the Center for Plant Conservation, and is maintaining a seed collection for recovery purposes, in addition to conducting original research on the biology of the plant. These studies are ongoing and continue to provide important information regarding life history and appropriate propagation methods. Consequently, the Arboretum at Flagstaff probably has additional information that will be useful to its recovery.

6-1

Yours most sincerely

Dieter Wilken

(By electronic mail)

Central California Center for Plant Conservation

Santa Barbara Botanic Garden

Comment Letter #7



"Ruthie & David  
Robbins"  
<drmrobb@worldnet.at  
t.net>

To: "Wendy Brown" <wendy\_brown@fws.gov>  
cc:  
Subject: HG Ipomopsis recovery plan

09/02/2002 11:03 AM

Wendy,

Thank you very much for the updated recovery plan for the Holy Ghost Ipomopsis. It is a through and interesting report. The Holy Ghost Homeowners Association is completely in support to your efforts and if we can assist in any meaningful way in the recovery plan we would be delighted. Please let me know what we can do either individually or as an association.

Sincerely,  
David N. Robbins  
Prescient Holy Ghost Homeowners Association

7-1

(By Electronic Mail)



Comment Letter # 8



TRANSITION ZONE HORTICULTURAL INSTITUTE, INC.

April 20, 1999

Jennifer Fowler-Propst  
 Field Supervisor  
 New Mexico Ecological Service Field Office  
 2105 Osuna NE  
 Albuquerque, NM 87113

Dear Ms. Fowler-Propst:

I am writing to comment on the draft Holy Ghost Ipomopsis Recovery Plan. Below are several specific comments.

p.7 I concur that plant density within Holy Ghost Canyon varies from small dense patches to single isolated plants. To update the information about the 10 monitoring plots, I have included a table of total individuals per year and have broken down the numbers into seedlings, rosettes, and adults I have recorded in 5 seasons. This information can be used to present variations in the proportions of adults over this time period.

8-1

Year	Adults	Rosettes	Seedlings	Total
1994	253	276	35	619
1995	133	206	75	414
1996	74	367	1510	1951
1997	212	889	189	1290
1998	318	483	333	1134

p.9 Regarding compensation in Holy Ghost Ipomopsis, my observation is that picking is the most prevalent source of damage to plants. Because the largest plants are selected, the impact on the population is severe. Because the picking tends to occur when stalks are full of flowers, there is little hope for compensation. The damaged plants in my monitoring plots generally produce far fewer fruits than undamaged plants.

8-2

p. 12 I caution against translating the fire suppression ideas to the Holy Ghost ipomopsis scenario. Holy Ghost ipomopsis is growing in a mixed conifer habitat. Although there is ponderosa pine forest present, the presence of aspens, spruce and fir indicate that moisture conditions are different in Holy Ghost Canyon than in ponderosa pine forests. That said, I do feel that *Ipomopsis sancti-spiritus* is a disturbance species. My studies indicate that plant reproduction is far greater in plots with greater amounts of sunlight throughout the day. Although prescribed fire may not be realistic in Holy Ghost Canyon due to the presence of summer homes, thinning may be possible. This should be considered in 2123(p.29).

8-3

p. 13-14 I concur with the great threat that road widening, alien grasses, and BT pose to the species.

8-4



p.22 typo in paragraph "Even under optimal management" line 7, heathy should be healthy

p.28 2121 I believe it is well established that this species and other members of the genus require disturbance. I don't think it is necessary to document the seral stage. However, I do feel that response to surface disturbance is a pertinent and important avenue of research, especially because road widening activities may occur and thinning may be considered to improve habitat within the Holy Ghost Canyon.

8-5

p.31 222, 223 Recent research by Bob Sivinski and myself indicates that there are serious reproductive limitations in the species. Fruit set is extremely limited both in the wild and in cultivation—possibly due to genetic reasons. I have observed, but have not quantified the presence of sterile anthers. In cross-pollinations of 50 individuals, half of the plants were not compatible. The potential of inbreeding depression is high and warrants further investigation.

8-6

p.32, 34 (52) As part of the work with the Center for Plant Conservation, 2950 Holy Ghost Ipomopsis seeds representing 573 genets collected in 4 years are stored at the National Seed Storage Laboratory in Ft. Collins, CO.

8-7

p.33 I concur that it is very important to establish other populations. Whether seeds or rosettes are planted out, water will be the key to survival. Any artificial population should include a 4-week period of monitoring and watering to assure success of the reintroduction.

8-8

I hope these comments will be helpful. If you should have any further questions, please contact me.

Sincerely,



Joyce Maschinski  
Interim Director

**APPENDIX B****Response to Comments****Comment Letter #1. James Lloyd, USFS, Director, Wildlife, Fish and Rare Plants. April 23, 1999.**

- 1-1. The section on exclusion of fire and timber harvest is now found on page 15. We agree that re-establishing the natural fire regime in the surrounding community may be key to the long-term survival of the plant, and have made the development of a fire management plan a primary recovery action (see action 113, p. 24). Because of summer home development in the canyon, wildfires will continue to be suppressed, and we have recommended consideration of selective thinning and prescribed fire where possible as a way of maintaining the open spaced needed by Holy Ghost ipomopsis. Whether the population would actually survive a catastrophic fire is a subject for debate.
- 1-2. We agree that it is appropriate to include an intermediate step for downlisting Holy Ghost ipomopsis to threatened, and have made downlisting the objective for the final plan. Delisting criteria will be established when additional information regarding developing suitable habitat, seeding techniques, and population viability is obtained.

**Comment Letter # 2. Harv Forsgren, USFS, Southwest Region, Regional Forester. September 16, 2002.**

- 2-1. Thank your for your review, comments, and support in the development of this plan. We have incorporated most of your comments and look forward to working with you in the implementation of the plan.

**Comment Letter # 3. Daniel A. Crittenden, USFS, District Ranger, Pecos/Las Vegas Ranger District. May 26, 1999.**

- 3-1. We agree that further coordination on identification of potential reintroduction sites would be valuable. We have removed all reference to specific reintroduction sites in the plan, and have suggested that the USFS, the State, and the Service work cooperatively to identify appropriate reintroduction sites that are compatible with current land uses. We included the identification of these sites as part of the development of a USFS Management Plan for Holy Ghost ipomopsis, which is a major action (Executive Summary, p iv, and Recovery Outline, section 11, p 23).

**Comment Letter # 4. Lee Johnson, USFS Biologist, Santa Fe National Forest, Pecos/Las Vegas Ranger District. September 9, 2002.**

- 4-1. Thank you for your review, comment, and support of the Holy Ghost ipomopsis recovery plan.

**Comment Letter # 5. Bob Sivinski, Botanist, New Mexico Energy, Minerals, and Natural**

**Resources Department, Forestry Division. September 9, 2002.**

- 5-1. Thank you for your work in the development of the draft Holy Ghost recovery plan, and for your review, comment, and support of the revisions to the plan.

**Comment Letter #6. Dr. Dieter Wilken, Botanist. Central California Center for Plant Conservation, Santa Barbara Botanic Garden. September 6, 2002.**

- 6-1. Dr. Joyce Maschinski provided substantial input to the original draft plan, and graciously shared new information with us in the development of the final plan (see comment letters #8 and #9).

**Comment Letter # 7. Dr. David N. Robbins. President, Holy Ghost Homeowners Association. September 2, 2002.**

- 7-1. Thank you for your review, comments, and support of the Holy Ghost ipomopsis recovery plan. The Service looks forward to working with you in the implementation of the plan.

**Comment Letter #8. Dr. Joyce Maschinski, Director, the Arboretum at Flagstaff. April 20, 1999.**

- 8-1. See comment 9-1.
- 8-2. We have revised the discussions of the effects of picking flowering plants on pp. 8-9 and p. 13 to include your observations.
- 8-3. See comment 1-1. We have included forest thinning as a possible method of simulating the effects of natural fire (p. 14), and we also included forest thinning in the discussion of experimental disturbance plots in section 2123 (p.25)
- 8-4. Thank you for your comment.
- 8-5. We have corrected the typographical error. With regard to our discussion of seral stage research (section 2122, p. 25), we are referring to research on the length of time that Holy ghost ipomopsis habitat can remain suitable without management interference, not to documenting whether or not the plant is adapted to early successional stage habitat.
- 8-6. See response to comment 9-3.
- 8-7. We have included the information regarding seed collection and storage in the discussions of recovery objectives and criteria, pp 28 and 30.
- 8-8. Thank you for your comment.

**Comment Letter # 9. Dr. Joyce Maschinski, Director of Research, the Arboretum at Flagstaff. August 31, 2002.**

- 9-1. We have incorporated this updated information into the discussion of plant densities and the variability in numbers of flowering plants on pages 5-7.
- 9-2. We have incorporated your data on the variability in numbers of flowering plants, as above, and modified the discussion on p. 7 to say that “there are anecdotal reports .....that the number of flowering plants varied greatly in past decades....etc.
- 9-3. We have incorporated your observations and data in the discussion on reproductive issues page 12.
- 9-4. See response to comment 8-7.
- 9-5. We agree that low reproduction in the single and declining population in Holy Ghost canyon are major concerns. However, the total number of populations or plant numbers required for population viability is not well understood for Holy Ghost ipomopsis. We believe that the protection and maintenance of the current population at 2,000 or more individuals, combined with the successful restoration of four additional populations, would in fact warrant downlisting the plant to threatened status, which would still provide protection for the plant. However, the recovery plan will undergo revision before final delisting criteria can be established, and if new information suggests that five populations are not adequate protection from catastrophic loss, then the downlisting criteria can be revised to reflect that information.