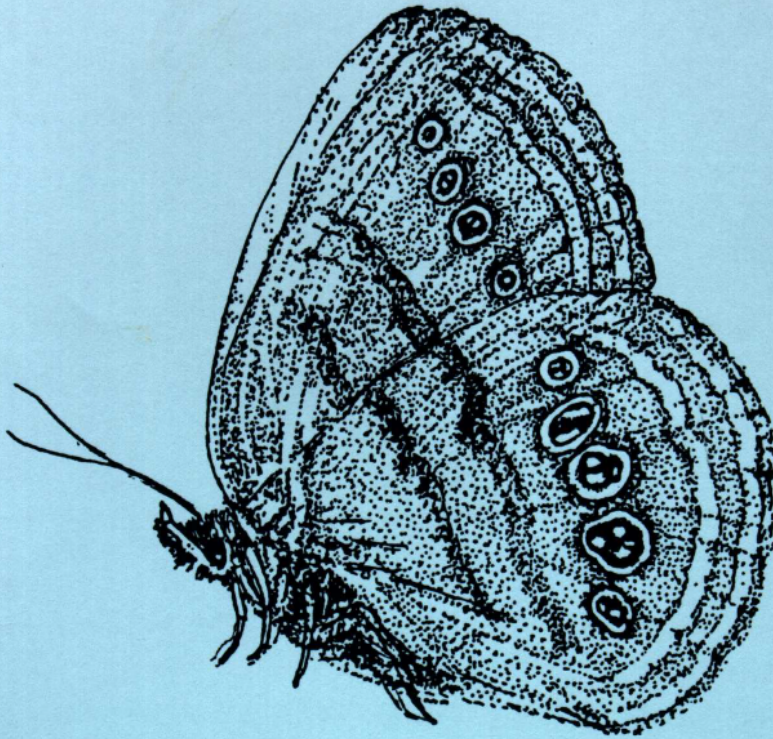


RECOVERY PLAN

Saint Francis' Satyr (*Neonympha mitchellii francisci*)



U.S. Fish and Wildlife Service
Southeast Region
Atlanta, Georgia

RECOVERY PLAN

for

Saint Francis' Satyr (*Neonympha mitchellii francisci*)

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Date: _____

April 23, 1996

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Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1996. Saint Francis' Satyr Recovery Plan.
Atlanta, GA. 27 pp.

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Acknowledgment:

The cover illustration was drawn by Candace Randall, a freelance artist. She drew the illustration from a photograph by Steve Hall of the North Carolina Department of Environment, Health, and Natural Resources in Raleigh, North Carolina.

EXECUTIVE SUMMARY

Current Status: Saint Francis' satyr is listed as endangered. The species, once thought to have been collected to extinction, is now known from only a single metapopulation in Cumberland and Hoke Counties, North Carolina.

Habitat Requirements and Other Limiting Factors: The habitat occupied by this butterfly consists primarily of wide, wet meadows dominated by sedges and other wetland graminoids. These meadows are often relicts of beaver activity and/or periodic wildfires. The species is highly sought after by commercial and private collectors.

Recovery Objective: Downlisting to threatened, followed by delisting.

Recovery Criteria: *Neonympha mitchellii francisci* will be considered for reclassification from endangered to threatened status when the existing metapopulation has been stable or increasing in numbers for at least 10 to 15 years and when a long-term protection and management plan is in place to ensure its continued survival. Delisting will be considered when the existing metapopulation has been protected and stabilized, as described above, and when at least two other populations have been found or established in the sandhills region and have been stable or increasing for 10 to 15 years. Protection and management plans must be implemented before reclassification can be considered.

Actions Needed:

1. Implement protective management for the extant population, including protection from illegal collecting.
2. Survey suitable habitat for additional populations and potential reintroduction sites; reestablish populations within the species' historic range.
3. Manage populations for long-term viability through management agreements, acquisition, registry, cooperative agreements, etc.
4. Monitor existing populations.
5. Conduct research on the biology of the species and on suitable management tools for maintaining its native habitat.
6. Develop techniques for captive breeding to assist in the reestablishment of populations in the wild; maintain captive populations.

Total Estimated Cost of Recovery (000s) : It is not possible to determine costs beyond estimates for the first few years. Future costs will depend on the results of research conducted early in the recovery process.

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Year	Need 1	Need 2	Need 3	Need 4	Need 5	Need 6	Total
1996	10.0	35.0	10.0	8.0	25.0	5.0	93.0
1997	10.0	38.0	10.0	8.0	25.0	2.0	93.0
1998	10.0	33.0	15.0	8.0	25.0	2.0	93.0
TOTAL	30.0	106.0	35.0	24.0	75.0	9.0	279.0

Date of Recovery: Impossible to determine at this time.

PART I

INTRODUCTION

One of the rarest butterflies in Eastern North America, Saint Francis' satyr (*Neonympha mitchellii francisci* Parshall and Kral) was described in 1989 from collections made in North Carolina. Parshall and Kral (1989) stated: "There is not a more endangered butterfly in the eastern U.S. than *N. m. francisci*." Shortly thereafter, Saint Francis' satyr was reported by local lepidopterists to have been collected to extinction (U.S. Fish and Wildlife Service [Service] 1991). However, Schweitzer (1989) suggested that its status at that time was "best given as unknown" and pointed out that reports were conflicting and reliable information was unavailable. The species was rediscovered at the type locality in 1992 during the course of a status survey funded by the Service. Extensive searches were made of suitable habitat in North Carolina and South Carolina, but no other populations of this butterfly were found (Hall 1993, Schweitzer 1989). Because of the extremely limited distribution of this butterfly and the threat of collection, the Service published an emergency rule on April 18, 1994, listing the species as endangered (Service 1994). The final rule listing the species as endangered was published on January 26, 1995 (Service 1995).

Description

Saint Francis' satyr is a fairly small dark brown butterfly and is a typical member of the Satyrinae, a subfamily of the Nymphalidae, which includes many species commonly called satyrs and wood nymphs. The wingspan for the species (including both subspecies) ranges from 34 to 44 millimeters (Opler and Malicul 1992, Parshall and Kral 1989). Saint Francis' satyr and Mitchell's satyr, *N. m. mitchellii*, (also listed as endangered) are nearly identical in size and show only a slight degree of sexual size dimorphism (Hall 1993, Parshall and Kral 1989). Like most species in the wood nymph group, Saint Francis' satyr has conspicuous eyespots on the lower surfaces of the wings. These eyespots have a dark maroon-brown center, and within the eyespots are lighter opalescent patches that reflect a silver cast in certain lights. Unlike the sympatric *N. areolata septentrionalis* (David) (the Georgia satyr), which often has small patches of yellow within the maroon eyespots, Saint Francis' satyr has only the opalescent patches, without the yellow. The border of these dark eyespots is straw-yellow in color, with an outermost border of dark brown. The eyespots are usually round to slightly oval and are well-developed on the forewing as well as on the hind wing. The spots are accented by two bright orange bands along the posterior wing edges and two somewhat darker orange-brown bands across the central portion of each wing. Saint Francis' satyr, like Mitchell's satyr (the nominate subspecies), can be distinguished from its North American congener, *N. areolata*, by the latter's

well-marked eyespots on the upper wing surfaces and brighter inner orange bands on the hind wing, as well by a lighter overall coloration in the female (Service 1991, McAlpine *et al.* 1960, Wilsman and Schweitzer 1991, Hall 1993). The shape of the inner post-median band (the band immediately on the inside of the eyespots) is relatively straight on most Saint Francis' satyrs and noticeably indented on Georgia satyrs.

Distribution

Saint Francis' satyr is extremely restricted geographically. Mitchell's satyr, the nominate subspecies, has been eliminated from approximately half its known range due to a combination of habitat loss and excessive collecting (Service 1991). Only a single metapopulation of Saint Francis' satyr is now known to exist in the sandhills of North Carolina, in Cumberland and Hoke Counties.

Habitat, Life History, and Ecology

The habitat occupied by this satyr consists primarily of wide wet meadows dominated by a high diversity of sedges (*Carex* spp.) and other wetland graminoids. In the North Carolina sandhills, such meadows are often relicts of beaver activity. Saint Francis' satyr has also been observed in pitcher plant (*Sarracenia flava*) swales, with cane (*Arundinaria tecta*), and with the rare plants rough-leaved loosestrife (*Lysimachia asperulaefolia*, federally listed as endangered) and pocosin lily (*Lilium iridollae*, a species of Federal concern). It is, however, unknown whether the satyr uses such swale habitat for feeding, breeding, and perching, or simply as a dispersal corridor. Unlike the habitat of Mitchell's satyr, the North Carolina species' habitat cannot properly be called a fen because the waters of this sandhills region are extremely poor in inorganic nutrients. Hall (1993) states:

Whereas true fens--apparently the habitat of the northern form of *N. mitchellii* (Wilsman and Schweitzer 1991)--are circumneutral to basic in pH and are long-lasting features of the landscape, the boggy areas of the sandhills are quite acidic as well as ephemeral, succeeding either to pocosin or swamp forest if not kept open by frequent fire or beaver activity.

Hall (1993) further states:

Under the natural regime of frequent fires ignited by summer thunderstorms, the sandhills were once covered with a much more open type of woodland, dominated by longleaf pine, wiregrass, and other fire-tolerant species. The type of forest that currently exists along [the creek inhabited by Saint Francis' satyr] can only grow up under a long

period of fire suppression. The dominance on this site of loblolly pine, moreover, is due primarily to past forestry management practices, not any form of natural succession.

In fact, Hall found (1993, 1994) that the ecology of Saint Francis' satyr differed substantially from that of the nominate subspecies:

Rather than being a highly sedentary resident of nearly permanent, calcareous fens (Wilsman and Schweitzer 1991), *N. m. francisci* appears to be a fugitive species whose preferred habitat is available only temporarily at any one location. The type locality (Parshall and Kral 1989) was in fact determined to be an old borrow pit excavated in the early 1970's. Although it still contains the open marshy glades described by Parshall and Kral, its upper end is fast closing in with shrubs and swamp forest trees due to succession, a fate that will overtake the entire site within just a few more years. There is absolutely nothing about this site that suggests the permanence associated with the northern fens occupied by *N. m. mitchellii*, nor were there any other features peculiar to this site (e.g., an unusual soil pH or concentration of rare plant species) that could help explain the highly restricted occurrence of *francisci*.

This habitat type is instead highly similar to the sedge meadows that form successional after beaver ponds are abandoned.... Some use is also made of smaller sedge patches found in burned-out pocosins, hillside seepage bogs, and similar transiently open habitats.

The discovery of these ecological features of *francisci* helped to formulate an hypothesis for the extremely restricted distribution of this butterfly. As has been documented for other lepidoptera (e.g., Harrison *et al.* 1988, Shuey 1994), the existence of a metapopulation is crucial for survival in a region of unpredictable environmental suitability, where any one population cannot survive for more than a brief period. This is particularly true for species specializing on habitats dependent on recurrent disturbance for their existence. They are trapped on the one hand by the devastation brought on by the forces of disturbance and on the other by the more gradual but equally certain extirpation of habitat due to succession. Only through perpetual colonization and recolonization can such a species keep up with the habitat mosaic as it constantly shifts over the landscape.

Parshall and Kral speculated that *N. m. francisci* is a relict from a more widespread southern distribution during the Pleistocene period. Hall (1993) presents the following alternative hypothesis:

The current narrow distribution of *francisci* could also be a result of the enormous environmental changes that have occurred in the southern coastal plain just within the past 100 years [large-scale alteration and fragmentation of habitat due to fire suppression, extirpation of beavers, and other land use changes]. Only the discovery of additional populations or fossil remains can clarify this situation.

The annual life cycle of *N. m. francisci*, unlike that of its northern relative, is bivoltine. That is, it has two adult flights or generations per year. First broods emerge about May 5th and are usually gone by June 6th; the second flight period runs from about July 26th to August 21st (Parshall and Kral 1989). As with many other butterflies, weather can strongly influence the dates of emergence and decline. In 1992, record cold temperatures in May delayed the emergence of both broods by nearly a month (Hall 1993). Larval host plants are believed to be graminoids such as grasses, sedges, and rushes. A single observation has been made of a female ovipositing on a grass (*Dicanthelium [=Panicum] dichotomum* var. *dichotomum*), but it is unknown whether this is the host plant. Several sedge species, including *Carex glaucescens*, *C. lurida*, and *C. turgescens*, were also found within 1 meter of the oviposition site (Erich Hoffman, Department of Defense, Fort Bragg, personal communication, 1994). Little else is known about the life history of this butterfly, but patterns are probably similar to those of the nominate subspecies.

Based on rearing experiments conducted by McAlpine *et al.* (1960), *N. m. mitchellii* eggs are probably laid on the host plant (which has not yet been identified), or possibly on the litter beneath it, and hatch within about 7 to 10 days. The early summer brood probably completes its development in less than 80 days, with pupation taking about 2 weeks of this time. The second brood probably overwinters in the fourth late larval instar as in the nominate subspecies. Extensive feeding and growth resume in the spring before pupation takes place. Like the caterpillars of other satyrs, larval *mitchellii* are green- and white-striped and spindle-shaped, which helps them blend into their surroundings. Their heads have a bilobed shape, and their posterior ends are bifurcated, as with most satyrine caterpillars. The larvae probably live upon the leaves of the host plant or within shelters built by sewing leaf-blades together with silk. Pupation probably occurs in the foliage. The chrysalis is green initially, gradually transforming to brown. McAlpine *et al.* (1960) found that the larvae of the nominate subspecies fed on a variety of sedge species in the lab and concluded that the species' restricted

occurrence could not be explained by its choice of food plants. However, the natural food plant(s) are still unknown. Following larval development and pupation, males typically emerge first; females are often the last to emerge and the last to disappear in a given generation.

Threats and Conservation Measures

Because of its relatively recent discovery and the vast changes that have occurred in the landscape over the past two centuries, it is impossible to determine what the original range of Saint Francis' satyr might have been. However, based upon its demonstrated dependency on periodic fires and the general trend of fire suppression on private lands, it seems reasonable to assume that it once occupied a more extensive area. This assumption is further supported by extensive recent searches of suitable habitat where the species could not be found. As stated by Hall (1993):

In order for *francisci* to have survived over the past 10,000 years, there must surely have been more populations and greater numbers of individuals than apparently now exist.... As is true for many species that were once widespread in the sandhills, massive habitat alteration must also be a major factor in the diminution of the range of *francisci*...reductions in *francisci*'s range would have accompanied the extensive loss of wetland habitats in the coastal plain. Again, the draining of swamps, pocosins, Carolina bays, savannas, flatwoods, and bogs for conversion to agriculture and silviculture is well known. In the case of *francisci*, however, the extirpation of beavers from the Carolinas may have been the greatest factor.

Beavers had been virtually eliminated from North Carolina by the turn of the century. Reintroductions began in 1939, but it was several decades before they again became an agent for the creation of the sedge meadow habitats favored by Saint Francis' satyr (Hall 1993, Woodward and Hazel 1991). Hall (1993) further states:

As the landscape mosaic of open woodlands and wetlands of the coastal plain declined throughout the past two centuries, the range of *francisci* must have become increasingly fragmented. Although isolated populations may have persisted as long as suitable habitat remained, the structure of their metapopulation would have been destroyed. Opportunistic colonization of newly available habitats as well as the repopulation of sites wiped clean by fire or other catastrophe would have become eventually impossible; one by one, the isolated remnants would have blinked out of existence. Although again speculative, the fracturing of metapopulations has been used to explain the decline of

the arogos skipper and a number of butterflies associated with the tall-grass prairies (Panzer 1988, D. Schweitzer, personal communication). That *francisci* was a relict to begin with only exacerbated this problem; the overall effect was to bring it as close to extinction as any butterfly in the country.

Both subspecies of *Neonympha mitchellii* are highly prized by collectors, including commercial collectors who often systematically collect every individual available. Two populations of the nominate subspecies are strongly suspected to have been extirpated by collectors, and others are believed extremely vulnerable to this threat (Service 1991). As mentioned earlier, the single known population of Saint Francis' satyr was so hard hit by collectors in the 3 years following its initial discovery that it was believed to have been collected to extinction. Subsequent to the emergency-listing of the nominate subspecies and prior to the listing of the southern subspecies, the North Carolina population was the last where *Neonympha mitchellii* could legally be collected. Collectors reportedly visited the known site every day throughout the flight periods, taking every adult they saw (reports cited in Hall 1993). After this first wave of over-collection, many unsuccessful searches for the butterfly were made before it was eventually rediscovered. Numbers of individuals then seen were much lower than those reported by Parshall and Kral (1989). Following the emergency-listing of Mitchell's satyr, the North Carolina Natural Heritage Program received several inquiries from collectors about access to this last available population. Several expressed apprehension about any restriction on collecting of this rare and much-sought-after satyr. Even though part of this population is somewhat protected from collectors by virtue of being within dangerous artillery impact areas, intensive collecting is still possible and could reduce total population numbers below the levels needed for long-term survival. What is known about this species' life history and ecological requirements indicates that it is dependent upon a large metapopulation structure in order to colonize new sites or recolonize those from which it has been extirpated (Hall 1994).

The Service is aware of an illegal trade in listed, protected, and rare butterflies. Collecting of butterfly species that exist in small colonies or the repeated handling and marking (particularly of females and/or in years of low abundance) can seriously damage the populations through loss of individuals and genetic variability (Gall 1984, Murphy 1988, Singer and Wedlake 1981). The collection of females dispersing from a colony can also reduce the probability that new colonies will be founded. Butterfly collectors pose a threat because they may be unable to recognize when they are depleting colonies below the thresholds of survival or recovery, especially when the area is visited for a short period of time (Collins and Morris 1985). Although collectors generally do not adversely affect the healthy, well-dispersed populations of common butterfly species, a number of rare species, such as those that are highly valued by collectors, are vulnerable to extirpation or

extinction from collecting. Species with small populations at only a few sites may be adversely affected by the cumulative effects of removal of very few individuals from a site by a few collectors. Unscrupulous collectors, who take every specimen they can find on successive days, could eliminate populations of some species in just a few years.

Insects are not protected from collection under North Carolina law. There are also no Department of Defense regulations that would restrict the collecting of Saint Francis' satyr in North Carolina. Federal listing of this species provides legal protection against indiscriminate taking and illegal trade, but monetary incentives are apparently now high enough to induce collectors to take considerable risks in order to collect rare species. The recent felony convictions of three collectors for poaching and commercially dealing in 11 species of federally listed butterflies throughout the country (including collections from within national parks and other protected preserves) indicate that the threat from commercial exploitation is real (U.S. Department of Justice 1995, Hall 1994).

Although the habitat occupied by this species is dependent upon some form of disturbance to set back succession (e.g., periodic fire and/or beaver impoundments), intense fires at critical times during the life cycle of the species can eliminate small colonies. Historically, this wouldn't have been a problem since there were undoubtedly other adjacent populations that could recolonize extirpated sites. However, the sole surviving metapopulation of this species now consists of 20 small colonies. The actual area occupied by the species totals approximately 57 acres. This fact makes Saint Francis' satyr more vulnerable to such threats as catastrophic climatic events, inbreeding depression (depending on actual population size), disease, and parasitism.

Part of the occupied area is adjacent to regularly traveled roads, where there is the threat of toxic chemical spills into the species' wetland habitat. Current military use of the impact areas is favorable to this species; the frequent fires associated with shelling are undoubtedly a principal reason why the species is surviving on military land and not on the surrounding private land. Department of Defense personnel are aware of the species' plight and have been cooperative in protection efforts. However, heavy siltation is a problem on this military installation; it could threaten the small drainages occupied by the species. Although troop movements directly through an area occupied by the satyr could have negative impacts, this has not occurred to date; these activities have now been directed away from areas where the satyr occurs. Other potential threats to the species include pest control programs (for mosquitoes or gypsy moths) and beaver control.

Conservation and Management

Management and monitoring efforts for Saint Francis' satyr have been initiated by the U.S. Army. This program, along with the research conducted by the North Carolina Natural Heritage Program in cooperation with the Army, has produced important information on the biology and ecology of the animal, as summarized in the "Habitat, Life History, and Ecology" section above.

The Service maintains responsibilities under the Endangered Species Act of 1973, as amended (Act), for listing, recovery, grants to the states, and consultation with Federal agencies. Section 7 of the Act requires Federal agencies to consult with the Service if their actions may affect listed species or adversely modify critical habitat. Critical habitat was not designated for Saint Francis' satyr because of the serious threat of collecting.

In addition, the Service is involved with the issuance of incidental take permits pursuant to Section 10 of the Act and the enforcement of prohibitions against take under Section 9 of the Act.

Strategy for Recovery

Due to the severely restricted range of this species in the wild and its consequent vulnerability, the first priority for recovery is to protect and maintain the last remaining metapopulation. The successional forces that are actively maintaining this species' habitat; namely, periodic fires and beaver activity, must be continued.

MONITORING OF THE AREA BY ENFORCEMENT PERSONNEL DURING THE SPECIES' FLIGHT PERIODS IS ESSENTIAL TO CONTROL POACHING.

Annual monitoring of the remaining population (through the use of transect counts or other appropriate means, is essential to define normal population fluctuations and the movement of colonies into or out of changing habitats. Additional research must be conducted to provide a better understanding of the species' life history and habitat requirements, as well as demographics and metapopulation dynamics.

Existing knowledge of this species' life history and habitat requirements is currently limited. However, when additional information becomes available, areas that support adequate amounts of suitable habitat will be evaluated as potential reintroduction sites. If sufficient numbers of such sites are located, they could then be mapped and incorporated into a geographic information system and grouped into recovery areas based on geographic proximity, similarity of habitat, and potential for genetic exchange.

Although much remains to be learned about Saint Francis' satyr, expansion of the last remaining population and the reintroduction of this species to additional sites are essential to its long-term survival and recovery. As stated by Hall (1994):

Based on expanding efforts to restore sandhills habitat by prescribed burns, as well as the parallel efforts at wetland restoration being made by beavers, there are now many sites suitable for reintroduction of *francisci* in the Sandhills region of the Carolinas, including the Northern and Northeastern Training Areas at Fort Bragg, Sandhills Gamelands, Sandhills National Wildlife Refuge, and Fort Jackson. Given the colonizing ability suspected for *francisci*, transplantation of just a few gravid females should be sufficient to propagate new metapopulations in these areas. [Obviously continued input of new individuals will be necessary to minimize inbreeding, until the long-term goal of genetic fitness is achieved for the newly-established populations (D. Schweitzer, The Nature Conservancy, pers. com., 1995).]

If successful, these recovery efforts will not only safeguard this subspecies from epidemics and catastrophic weather, but may make this butterfly so common as to create a crash in its value on the black market, and return it to the ranks of butterflies whose main interest is ecological. Based on what we now know about the biology of this subspecies, there is every reason to believe that it has high potential for recovery and delisting, following coordinated management and reintroduction efforts.

PART II
RECOVERY

A. Recovery Objectives

Saint Francis' satyr will be considered for reclassification from endangered to threatened status when the existing metapopulation has been stable or increasing in numbers for at least 10 to 15 years and when a long-term protection and management plan is in place to ensure its continued survival. In the long run, population size is one of the most critical aspects of viability. Schweitzer (personal communication, 1995) has suggested, based upon experience with other rare butterflies, that a viable metapopulation should generally consist of at least 200 adults per brood. As more specific information on this species becomes available, this number may be revised. Delisting will be considered when the existing metapopulation has been protected and stabilized and when at least three other populations have been found or established in the sandhills region and have been stable or increasing for 10 to 15 years. Population fluctuations are believed to be substantial; a period of 10 to 15 years is believed to be essential to define "naturally occurring" fluctuations. Protection and management plans must be implemented for all populations before reclassification can be considered.

B. Narrative Outline

1. Protect and manage existing populations and essential habitat. Only one metapopulation of Saint Francis' satyr is currently known to exist, in the sandhills region of North Carolina. Protection and management of this population is essential to the species' survival.
 - 1.1 Monitor existing populations. Long-term monitoring (a minimum of 10 to 15 years) is essential in order to define natural (and unnatural) population fluctuations and to further document habitat use and the response of the species to habitat changes. Population size should be estimated, using transect counts.
 - 1.2 Protect existing populations. The existing population is entirely on land managed by the Department of Defense. Although it is obvious that this species' continued survival is largely due to military training activities on this installation, any Federal action that could potentially be detrimental to this species should be closely reviewed through the Section 7 consultation process with the Service. The reduction of certain types of military training activities could detrimentally reduce the frequency of the fires upon which this species depends for survival. Because of the threat from poachers, the area occupied by the species should be closely monitored by enforcement personnel during the flight periods to eliminate illegal take. **BECAUSE OF THE THREAT FROM ILLEGAL COLLECTORS, IT IS ESSENTIAL THAT SPECIFIC INFORMATION ON THE LOCATION OF COLONIES BE KEPT CONFIDENTIAL.**
 - 1.3 Manage for the long-term survival of existing populations. Periodic fire and beaver activity, operating on a landscape scale, are believed to be essential to the survival of this species. Prescribed fire, as well as military activities that result in incidental periodic burning, should be continued. Refinements may need to be made in the season, intensity, and frequency of burning.

A management plan for each occupied site (including those where additional colonies are eventually established) should be developed to address habitat management needs and threats to the habitat and/or population. Management goals, strategies and time lines for achieving those goals, and funding sources should be included in

the plan. Management plans should be coupled with monitoring plans, and both should be reviewed and revised as necessary or after significant changes in threats, management, research, or status of the species occurs.

The remaining wet meadows and swales inhabited by Saint Francis' satyr are now an uncommon feature of the landscape. Some of these areas provide habitat for other rare species, including the pocosin lily and rough-leaved loosestrife. Habitat requirements of these other species will be taken into account so that management for Saint Francis' satyr does not detrimentally affect them.

2. Continue research into the species' life history, ecology, and reasons for decline. Thanks primarily to the efforts of Steve Hall of the North Carolina Natural Heritage Program and Erich Hoffman with the Department of Defense, Fort Bragg, North Carolina, much is now known about this species' ecology and habitat use that was not known a few years ago. However, investigations should continue in order to define the species' movement patterns, recolonization patterns and capabilities, habitat use (for reproduction, nectaring, perching, and dispersal), host plant species, optimal timing for burning, and the exact relationship of the species with beavers and other wetland creation and/or disturbance agents.
3. Conduct searches for additional populations. The discovery of additional wild populations of Saint Francis' satyr would facilitate recovery efforts, provide additional genetic diversity for potential reintroductions, and allow for a better analysis of ecological relationships of the species within its habitat. Searches have been conducted throughout potentially suitable habitat in the sandhills of both North Carolina and South Carolina. However, populations that have been reduced to very low numbers are easily missed, even by the most thorough observers. Information developed by Hall (1993, 1994) should be used to prioritize additional areas of suitable habitat for searching, and this information should be modified and updated as appropriate. The best habitats should be searched during several successive flight periods.
4. Establish additional wild populations within historic range. Because of the extremely restricted range of this satyr and the consequential vulnerability of this one metapopulation to catastrophe, the establishment or discovery and protection of additional populations is essential for the species' long-term survival and recovery. The most likely possibilities for successful reintroductions include (1) the Northern, Northeastern, Central and Western Training Areas at Fort Bragg and the Sandhills

Gamelands in North Carolina and (2) Fort Jackson and the Sandhills National Wildlife Refuge in South Carolina. The establishment of populations on these lands will be possible only with the complete cooperation of the managing agencies and on-site personnel. As more is learned about this species' habitat use and ecology, additional potential reintroduction sites may be identified. Obviously, thorough searches of potential sites must be conducted prior to any reintroduction in order to ensure that the species is not already present.

Ownership information will be compiled for occupied and restorable habitat areas, and landowners will be contacted by the Service and asked about their interest in participating in the recovery of Saint Francis' satyr. Sites designated for protection would be selected based upon the species' habitat needs and the willingness of landowners to participate in recovery efforts.

Mechanisms for protecting a sufficient amount of habitat within each recovery area could include fee title acquisition, conservation easements, and/or voluntary management agreements over key properties by Federal, State, or local governments or appropriate nonprofit conservation organizations. The methods used will depend, to a great extent, upon management needs of the species in each block of habitat and upon the willingness of the landowners to participate in conservation efforts. Generally, breeding habitat should be permanently protected. Movement corridors may be protected through easements and voluntary management agreements. Voluntary agreements should include a thorough description of each entity's commitment and role in the recovery of Saint Francis' satyr. Signatories to the agreements should include all interested landowners, the Service, and appropriate State agencies.

It is unknown at present how much habitat would be needed within each recovery area to reduce the risk of extinction from stochastic events and ultimately ensure the species' recovery. Additional data are needed on mortality rates, dispersal, and habitat variables before models of population viability can be developed. However, to start with, a minimum of 200 to 300 individuals per brood should be the goal for each population in the recovery areas. Recovery areas will not include zones of residential and commercial development, agricultural land, or areas that have otherwise been permanently altered by human actions.

The same long-term protection and provision for management must be extended to these newly established populations. In order to demonstrate that these populations are self-sustaining and capable of long-term

survival and to account for the variability of environmental conditions and normal population fluctuations, intensive monitoring for a minimum of 10 to 15 years is essential.

The possibility and advisability of establishing and using captive colonies for reintroduction purposes should be investigated. Although the natural food plant of the species is still unknown, larvae will almost certainly eat a variety of sedges (Schweitzer, personal communication, 1995). However, before reintroductions can be considered, much more basic life history information will have to be known (e.g., the identity of the host plant, etc.). Ideally, captive populations should be maintained at a minimum of two facilities in order to decrease the possibility of accidental loss of the entire captive population. The presence of individuals in captivity should not be considered a substitute for their maintenance in the wild.

5. Develop information and education programs. Coordination with the public is particularly important for the recovery of the Saint Francis' satyr in order to dispel misperceptions, eliminate the threat of illegal taking, and foster partnerships with landowners. Through judicious public education efforts (without divulging specific locality information that might further endanger the species), the public should be made aware of the value of this species as an indicator of overall ecosystem health and as an indicator of what the landscape of the Carolina sandhills originally looked like. By studying this species' decline, researchers are obtaining a clearer picture of the natural role of fire and beaver activity in this ecosystem. The publication of articles and notices in scientific journals would also increase awareness with regard to this endangered species and other rare or unique species that may be similarly dependent upon periodic fire and other landscape-scale natural disturbance. Articles or press releases should be developed for local newspapers that would stimulate the interest and cooperation of lay readers.

Two educational programs, one targeting elementary and middle school-age children and the other targeting high school through adults, should be prepared and presented at schools and other local venues.

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PART III

IMPLEMENTATION SCHEDULE

Priorities in column one of the following implementation schedule are assigned as follows:

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

Key to Acronyms Used in This Implementation Schedule

DOD - Department of Defense

FWS - U.S. Fish and Wildlife Service

LE - Law Enforcement Division, U.S. Fish and Wildlife Service

R4 - Region 4 (Southeast Region), U.S. Fish and Wildlife Service

RW - Refuges and Wildlife Division, U.S. Fish and Wildlife Service

SCA - State Conservation Agencies - State plant conservation agencies in North Carolina--the Plant Conservation Program (North Carolina Department of Agriculture) and the Natural Heritage Program (North Carolina Department of Environment, Health, and Natural Resources)

TE - Endangered Species Division, U.S. Fish and Wildlife Service

SAINT FRANCIS' SATYR IMPLEMENTATION SCHEDULE

Priority	Task Number	Task Description	Task Duration	Responsible Agency		Cost Estimates (\$000's)			Comments
				FWS	Other	FY1	FY2	FY3	
1	1.2	Protect existing populations.	Ongoing	R4/TE, LE	SCA, DOD	10.0	10.0	10.0	
1	1.3	Manage for the long-term survival of existing populations.	1 year	R4/TE	SCA, DOD	10.0	10.0	15.0	
2	1.1	Monitor existing populations.	Ongoing	R4/TE	SCA, DOD	8.0	8.0	8.0	
2	2	Continue research into the species' life history, ecology, and reasons for decline.	5 years	R4/TE	SCA, DOD	25.0	25.0	25.0	
2	3	Conduct searches for additional populations.	5 years	R4/TE	SCA, DOD	20.0	20.0	20.0	
2	4	Establish additional wild populations within historic range.	15 years	R4/TE and RW	SCA, DOD	20.0	20.0	15.0	
3	5	Develop information and education programs.	2 years	R4/TE	SCA, DOD	2.0	2.0	---	

PART IV

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PART V

APPENDICES

APPENDIX B

GLOSSARY OF TERMS

conservation plan - A plan developed for the conservation and management of a species or ecosystem. Conservation measures specified in a conservation plan generally include, but are not limited to, habitat protection, habitat management, and land use practices. They may also include additional measures or methods of conservation, such as artificial propagation and population augmentation.

emergence - exit of an adult insect from an immature stage. Compare with hatching.

endemic - confined to a specific geographic area and found nowhere else.

extinction - the complete disappearance or death of a species from its total range. Compare with extirpation.

extirpation - the disappearance of a species from a particular area but not from the total range. Compare with extinction.

Habitat Conservation Plan (HCP) - a plan developed for the management of lands for the specific purpose of meeting federal requirements for obtaining an incidental take permit pursuant to Section 10(a) of the Endangered Species Act of 1973, as amended.

habitat management plan - a plan developed for the purpose of maintaining habitat for certain species and/or ecosystem conservation.

hatching - exit of an immature insect from the egg stage. Compare with emergence.

hind wing - the rear wing of a butterfly.

holometabolous - undergoing a complete or four-stage metamorphosis (egg, larva, pupa, and adult) and exhibiting dramatic changes in body form and habits at each stage.

instar - the immature insect between molts during development.

larva (plural=larvae) - the immature and wingless form, commonly known as a caterpillar, that hatches from the egg of a holometabolous insect and that will eventually transform into a pupa prior to reaching adulthood.

mandibles - the first of the paired mouth appendages in insects and other arthropods; usually jawlike (in chewing forms) or needlelike (in sucking forms).

metamorphosis - a series of marked and more or less abrupt changes in the form of a developing insect. See holometabolous.

metapopulation - a collection of subpopulations of a species, each occupying a suitable patch of habitat in a landscape of otherwise unsuitable habitat.

occupied habitat - areas utilized for breeding, nectaring, and shelter habitats and adjoining dispersal corridors.

oviposition - egg-laying.

ovipositor - an organ used by insects for depositing eggs in a place suitable for their development.

population - a group of individuals at a given locality that interbreed when mature.

potential habitat - area(s) containing suitable habitat components that are not currently occupied by Saint Francis' satyr and/or areas that could feasibly be managed for Saint Francis' satyr.

proboscis - elongate, often extensile, mouth parts of insects that take liquid food.

pupa (plural=pupae) - an intermediate, usually quiescent, stage in the life cycle of a holometabolous insect in which the insect is usually enclosed in a hardened cuticle (chrysalid) or in a cocoon and from which the adult will eventually emerge.

recovery area - an area containing one or more populations or potential habitat for at least two viable populations.

viable population - a threshold level at which the population has a reasonable chance of survival or sustainability over time.