

# Plan for the Controlled Propagation, Augmentation, and Reintroduction of

## **Dakota skipper**

*(Hesperia dacotae)*



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**Contents**

I.	Executive Summary.....	4
II.	Introduction .....	5
III.	Definitions of Terms Used in this Plan .....	5
IV.	Justification for Captive Rearing, Augmentation and Reintroduction.....	6
A.	Status of the species .....	6
B.	Likely Population Trends.....	10
C.	Threats .....	11
D.	Contributions to the Species' Recovery.....	12
E.	Summary of CBSG Workshop– Dakota Skipper Working Group.....	12
F.	Reintroduction Justification .....	13
V.	Goals, Objectives and Actions.....	15
VI.	Basic Biological Knowledge .....	17
A.	Dispersal.....	17
B.	Dakota Skipper Habitat Descriptions .....	18
C.	Habitat Needs by Life Stage .....	20
D.	Climate .....	21
VII.	Feasibility and Design.....	22
A.	Selected Founder Populations and Genetic Considerations.....	22
B.	Animal welfare .....	23
C.	Disease and parasite considerations .....	23
D.	Social feasibility.....	24
E.	Regulatory compliance .....	25
F.	Resource availability .....	26
G.	Disaster preparedness .....	27
VIII.	Risk Assessment .....	27
A.	Risk to source populations.....	27
B.	Ecological Risk .....	30
C.	Disease risk.....	33
D.	Associated invasion risk .....	34
E.	Gene escape and population genetic consequences.....	34
F.	Socio-economic risks.....	34
G.	Financial risks .....	35

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H.	Risks of inaction .....	36
IX.	Release and Implementation .....	36
A.	Selecting Collection Sites .....	36
B.	Collections and <i>Ex situ</i> Rearing .....	36
C.	Selecting Release Sites .....	37
D.	Release strategy .....	39
E.	Disposition of excess progeny.....	42
X.	Monitoring and continuing management.....	42
A.	Demographic performance.....	42
B.	Behavioral monitoring .....	45
C.	Ecological monitoring.....	45
D.	Genetic monitoring .....	46
E.	Health and mortality monitoring .....	46
F.	Socio-economic monitoring .....	46
G.	Continuing Management .....	47
H.	Habitat management .....	47
XI.	Exit strategy .....	48
XII.	Dissemination of Information .....	49
XIII.	Literature Cited .....	50
XIV.	Appendix A- Criteria for Reintroduction and Founder Site Selection .....	53
XV.	Acknowledgements.....	60

## I. Executive Summary

The Dakota skipper, *Hesperia dacotae*, has vanished from over 74% of once known occupied sites and was listed under the Endangered Species Act as Threatened in 2014 (USFWS 2014). This species occurs nowhere else but remnant tall grass prairies. Suitable habitat for Dakota skippers has become largely isolated and fragmented. Natural dispersion between sites is highly unlikely without anthropomorphic intervention. For sites where Dakota skippers have become extirpated, reintroduction is the only option to restore the species to where it once was.

This document outlines a plan to reintroduce Dakota skippers from the Minnesota Zoo's Prairie Butterfly Conservation Program to The Nature Conservancy's (TNC) Hole-in-the-Mountain (HIM) Preserve (Lincoln Co., MN) beginning in 2017. The breeding program at the Minnesota Zoo began in 2013 strictly as an insurance program to preserve genetic diversity. In addition to breeding Dakota skippers at the Zoo, the *ex situ* population has been supplemented by wild-collected eggs annually from populations in northeastern South Dakota and northwest Minnesota. The Prairie Butterfly Conservation Program has successfully grown this *ex situ* Dakota skipper population each year, to the point where the insurance program can be maintained and excess progeny are being produced that can be utilized for release.

The strategy moving forward for Dakota skippers is to combine the insurance population program with reintroduction using zoo-reared pupae. These pupae represent both multi-generational Zoo lineages and newly collected specimens from extant populations the previous year (head-starting). Only specimens from northeastern South Dakota lineages will be utilized in the initial release, pending ongoing population genetics studies.

At this time, reintroduction is only being considered for sites in Minnesota at this time due to logistical, partnership, ecological, and financial benefits. The TNC HIM Preserve was chosen as the initial release location based on scoring compared to other candidate sites within the Dakota skipper's historic range in Minnesota. The Preserve is composed of six management units. The initial release will take place in the designated 'Central Unit', in a location chosen for its high quality habitat. A single release location will be used in the first year of reintroductions, to maximize the opportunity for released males and females to contact each other. The release itself will consist of placing 150-250+ pupa into a stationary closed box at the release point and releasing adults as they eclose. The expected timing of release is mid-June. A second release, one week after the initial release, will be carried out using any Dakota skippers that pupate later.

The long term goal of the project is for the TNC HIM Preserve as well as the adjacent Hole-in-the-Mountain and Altona Wildlife Management Areas (Minnesota Department of Natural Resources) to become occupied by Dakota skippers. We hope that the units will behave as a functional metapopulation. Collectively, we are referring to all of these units combined as the Greater HIM Complex.

Releases will take place within the TNC 'Central Unit' for at least three years. Each year, survey efforts will begin once the first pupae are released. Fixed transects will be established in the Central Unit and surveyed daily (as possible) to track occupancy and dispersal of adults over time, with additional regularly surveyed routes established throughout the entire Greater HIM Complex. In 2020, after three years of augmentation, releases will discontinue, followed by two years of additional surveys to track persistence. Surveys will inform future actions (e.g. if additional augmentation is needed, and where future reintroductions of Dakota skippers might take place within the Greater HIM Complex). Depending on the success of the Zoo-based rearing efforts, if there are an additional 150-250+ pupa beyond what was needed to augment the 'Central Unit,' additional sites within the Greater HIM Complex may be identified for release. Any additional sites selected for release would follow a similar timeline with three years of continued augmentation followed by a two year evaluation period.

The following plan details these above activities and justifies the need for reintroduction planning and monitoring. Additionally, the plan addresses the need for continued communication with adjacent land owners and outreach with the adjacent city of Lake Benton. This document focuses on the reintroduction of the Dakota skipper to the Greater HIM Complex. This document does not address the long-term efforts needed for species recovery across its range, or address what will be needed for long term persistence.

## II. Introduction

Controlled propagation, augmentation, and reintroduction have become important tools for the recovery of threatened and endangered organisms. In a number of cases, they form the basis for an urgent course of action to either restore or maintain existing population levels. The guiding principle of these efforts should be to minimize risks to extant populations and their habitats, and avoid harm to existing populations of non-target species. The primary purpose of augmentations or reintroductions should be to establish free-ranging, self-sustaining wild populations of the species.

U.S. Fish and Wildlife Service (Service) plans to cooperate with the Minnesota Zoo, The Nature Conservancy (TNC), and Minnesota Department of Natural Resources (DNR) to reintroduce the Dakota skipper at TNC's Hole-in-the-Mountain Preserve (HIM) in southwest Minnesota by releasing Zoo-reared larvae or pupae. This plan is intended to explain the rationale for pursuing this reintroduction, how it will be achieved to minimize risks and maximize the likelihood for success, how the project will be evaluated and, if and when appropriate, terminated.

The Dakota skipper was listed as a Threatened species under the Endangered Species Act in 2014 and has been extirpated from numerous sites within its historic range. At some of these sites, conditions, including habitat quality and land management, may be suitable to support a reintroduced population. The Minnesota Zoo's Prairie Butterfly Conservation Program has been successful at rearing the species *ex situ* to the extent that there may be enough individuals available to now attempt to reestablish a population through reintroduction.

The purpose of this plan is to provide a comprehensive risk assessment of the proposed reintroduction of Dakota skipper using zoo-reared individuals. We used IUCN guidelines (2013) to facilitate our assessment of ecological, social and economic risks, and to aid development of collection, release, and monitoring strategies.

We intend to update or amend this plan to fully evaluate long-term *ex situ* conservation activities leading to species recovery, including inter-site reintroductions and establishment of an insurance population.

## III. Definitions of Terms Used in this Plan

Definitions used in this plan generally follow or are modified from the definitions provided in the International Union for the Conservation of Nature's (IUCN) Guidelines for Reintroductions and Other Conservation Translocations (2013) and the IUCN Guidelines on the Use of *Ex situ* Management for Species Conservation (2014).

**Captive Rearing** is defined as the careful maintenance of portions of generations, if not complete generations, of a species in a controlled environment (e.g. a zoo) to advance the conservation of the species. This includes those individuals maintained over multiple generations under these controlled conditions (e.g. the offspring of zoo-breeding in an insurance population, below) or under more short-term operations (like head-starting, below).

**Ex situ** is defined as conditions under which individuals are spatially restricted with respect to their natural spatial patterns or those of their progeny, are removed from many of their natural ecological processes, and are managed on some level by humans.

**Head-start program** is defined as a demographic manipulation that removes individuals from the wild to reduce mortality during a specific life stage and then subsequently returns those same individuals to the wild.

**Insurance population program** is defined as a program that maintains a viable *ex situ* population of the species to prevent predicted local, regional or global species extinction and preserve options for future conservation strategies.

**Reintroduction** is defined as the intentional movement and release of an organism inside its indigenous range from which it has disappeared.

**Translocation** is defined as the human-mediated movement of living organisms from one area, with release in another. Reintroduction is a type of translocation.

**Augmentation** is defined as the intentional movement and release of an organism into an existing population of conspecifics.

## IV. Justification for Captive Rearing, Augmentation and Reintroduction

### A. Status of the species

The Dakota skipper historically ranged in native prairie grasslands across much of the northern Great Plains, from northeast Illinois west to northern Iowa, and north through western Minnesota, eastern South Dakota, most of North Dakota, and into southern Manitoba and Saskatchewan. Populations of the Dakota skipper were distributed among patches of native grassland in the species' historical range as both isolated populations and as groups of populations that we presume interact (or at least did so historically) by dispersal - i.e., metapopulations.

However, Dakota skippers, like many other prairie butterflies, appear to have been extirpated from large portions of their historic range. Indeed, as detailed below, it has apparently disappeared from at least three-fourths of all known historically documented populations in the last few decades. It is now apparently extinct in the southern portions of its documented range in Illinois, Iowa, and southern Minnesota. Despite being present in at least 11 Minnesota counties in the early 2000s, with strong populations in three counties across four metapopulation complexes, there is now only one known remaining predictable population remaining in Minnesota. The size of this last population has also recently declined dramatically, from thousands of adults annually in the 1980s to the low hundreds annually between 2013 and 2016 (Minnesota Department of Natural Resources). The Dakota skipper was listed by the State of Minnesota in 1984 as a Threatened Species, but its status was elevated to State Endangered in 2013 in response to the numerous documented extirpations and declines. In response to concurrent range-wide declines, the U.S. Fish and Wildlife Service (hereafter, "the Service") listed the Dakota skipper federally as Threatened Species in October 2014.



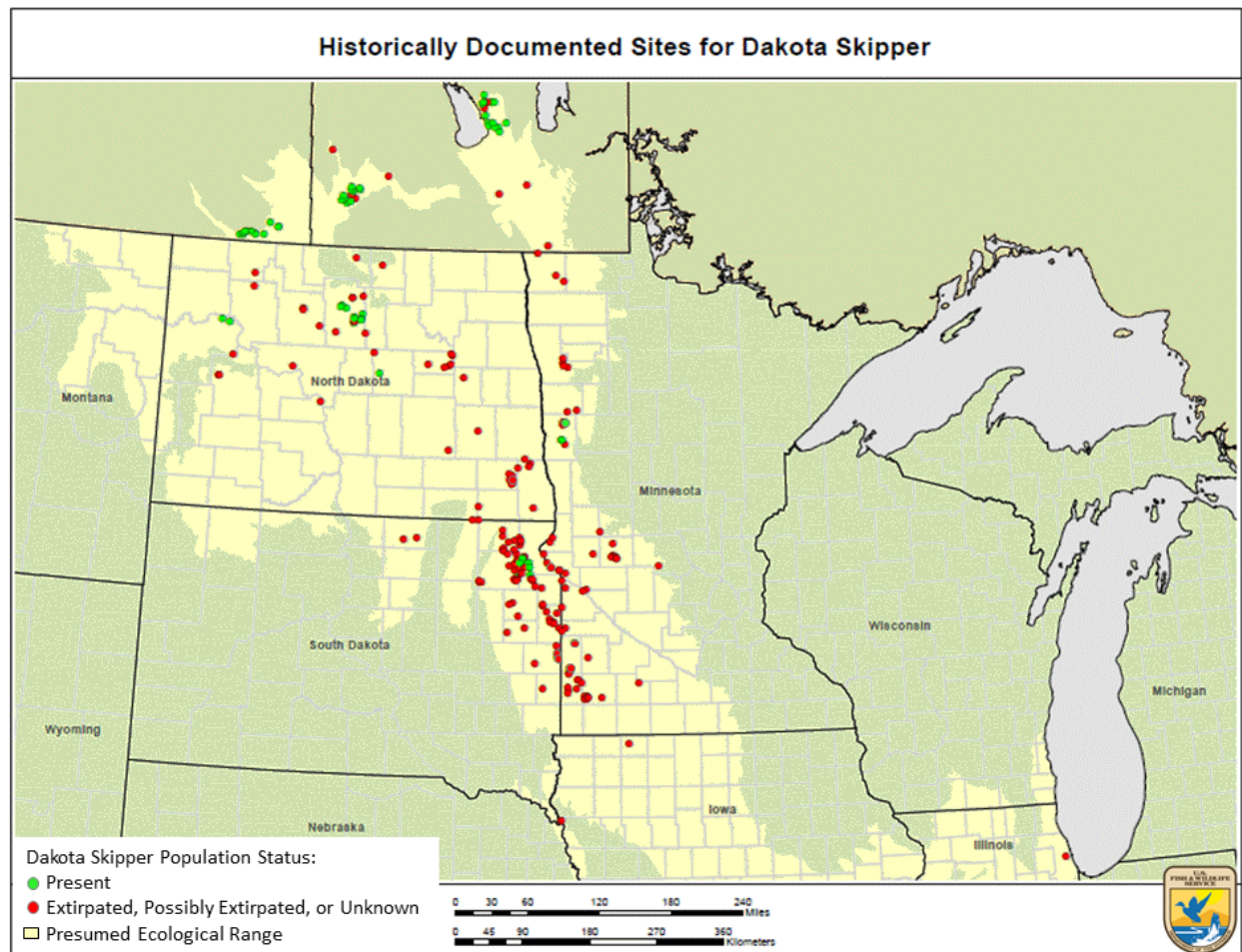


Figure 1. Presumed extant and extirpated historic populations of Dakota skipper and its inferred ecological range.

Dakota skipper populations exist as either (1) isolated populations that are too far from other populations to allow for dispersal or (2) groups of subpopulations near enough to one another to allow for dispersal. The maximum likely dispersal distance for Dakota skippers is unknown, but individuals may not typically move more than 5-8 kilometers away from core (natal) habitats (R. Westwood, pers. comm. 2016). Therefore, to group Dakota skipper survey records into putative metapopulations, the Service used the following definition, adapted from the metapopulation definition used for the Karner blue (*Lycaeides melissa samuelis*) in its recovery plan (U.S. Fish and Wildlife Service 2003): Dakota skipper metapopulations are comprised of subpopulations that occupy habitat patches that are no more than five kilometers from one another, on average, with the maximum distance separating occupied patches of no more than 8 kilometers.

To use this definition to identify metapopulations of the Dakota skipper, the Service used a survey dataset that contains geographic coordinates and other attribute data associated with over 1,900 surveys conducted in the range of the species. The geographic coordinates associated with each survey record represent 1) the approximate center point of the habitat patch surveyed; 2) the approximate center point of multiple Dakota skipper observations reported within a patch; or, 3) precise locations (points) of Dakota skipper observations.

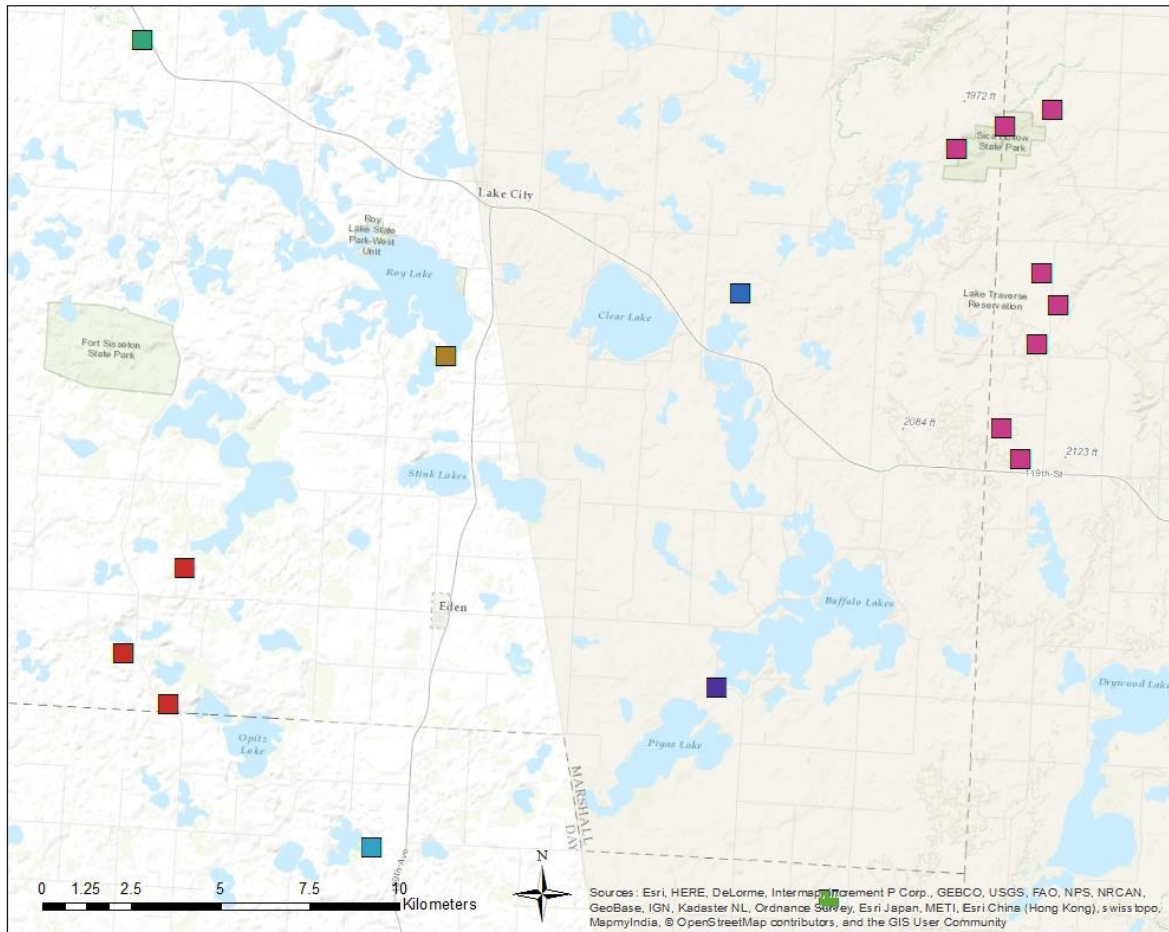


Figure 2 - An example output of the delineation of Dakota skipper populations based on the location of survey records. Squares represent approximate center points of habitat patches where the Dakota skipper was found; 2) the approximate center points of multiple Dakota skipper observations reported within a patch; or, 3) precise locations of Dakota skipper observations. Squares with the same color are grouped into putative metapopulations based on the definition described in the text; other populations are isolated.

With respect to this definition, the Service treated each survey record (point) as a distinct subpopulation (Figure 2) and reviewed mean distances among survey records to determine which should be grouped into metapopulations. For example, if the average distance among a group of survey points was greater than 5 km, outlying survey points were eliminated until the average distance among the remaining points was no more than 5 km. The resulting points represented groupings of subpopulations (metapopulations) or isolated populations. We used only extant subpopulations (survey records) to determine these groupings. Survey records that represented extirpated subpopulations were not used to determine metapopulation groupings.

This analysis indicates that there are 73 distinct Dakota skipper populations, over half of which are isolated. The mean number of subpopulations per metapopulation is 2.6, but more than half of the areas (38) consist simply of a single, isolated population (Figure 3). The viability of many populations is unclear though since the species has not been recorded since 2006 in over one-third of the 73 areas due to limited survey activity (Figure 4).



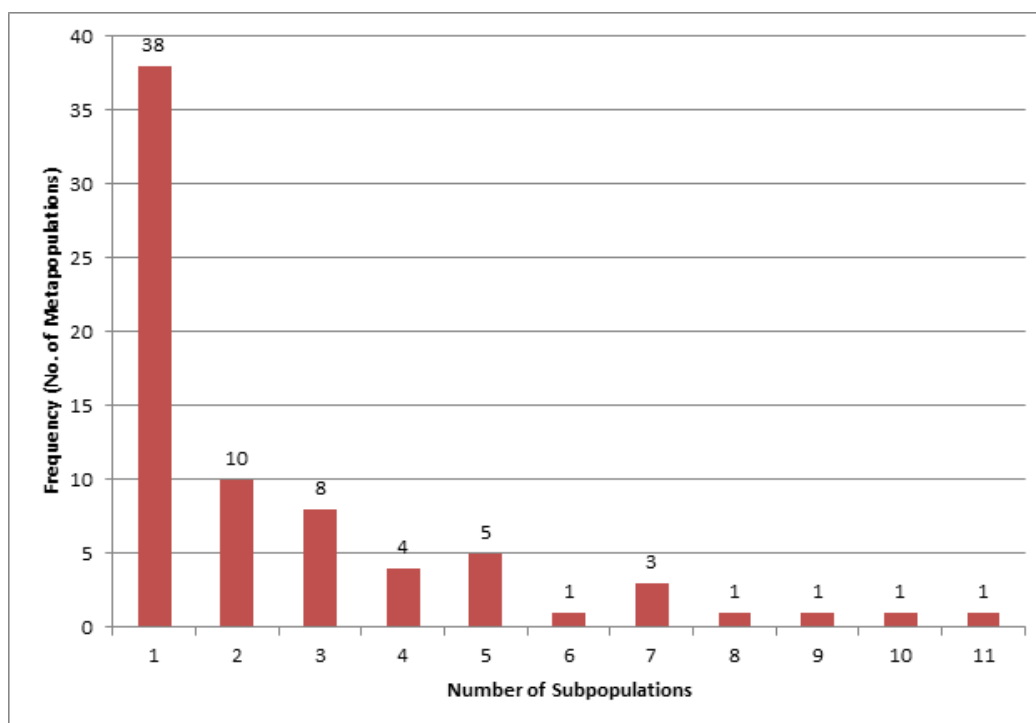


Figure 3 - The number of subpopulations that comprise metapopulations of the Dakota skipper. Over half (52%) of identified metapopulations consist simply of a single isolated population.

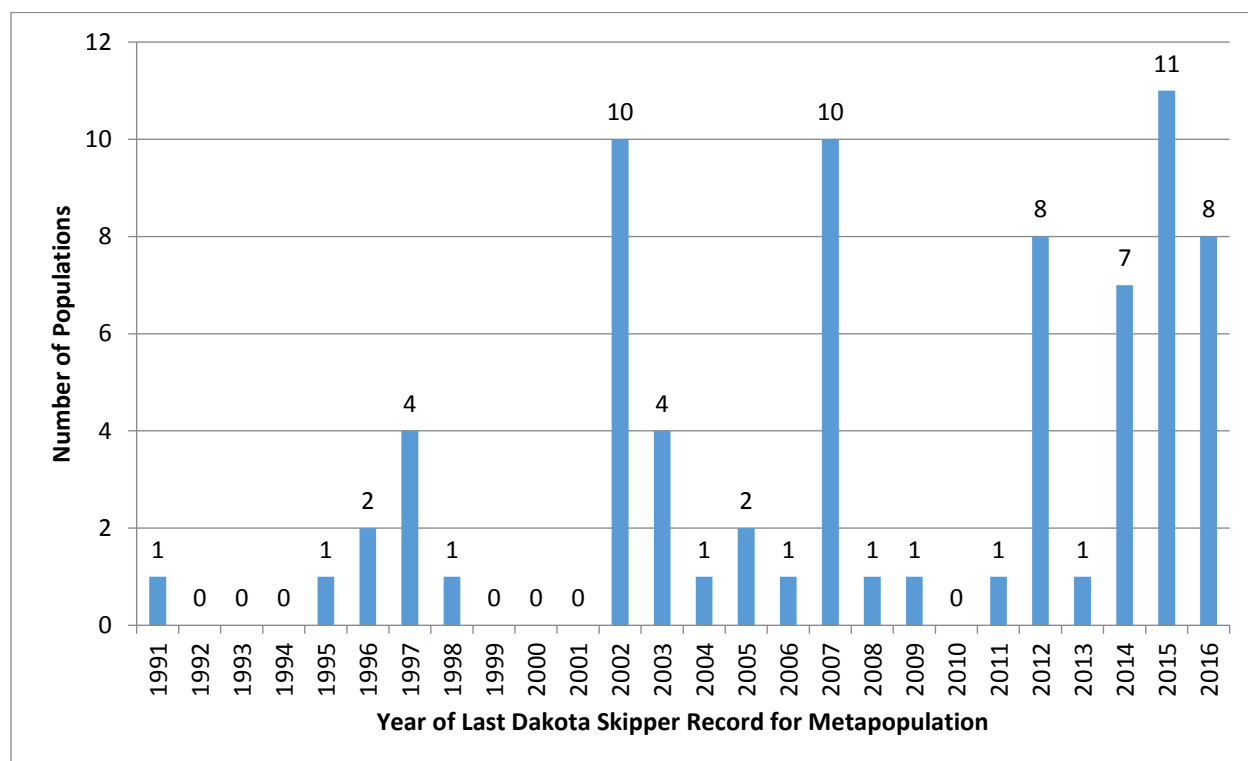


Figure 4. The last year that the Dakota skipper was recorded in the 75 extant populations (37 isolated populations and 38 putative metapopulations). Due primarily to limited survey efforts, the presence of the Dakota skipper has not been recorded since before 2006 for more than one-third of the populations.

## B. Likely Population Trends

Like many butterfly species endemic to native grasslands in the Upper Midwest, the Dakota skipper has experienced dramatic declines across its historic documented range, and some remaining populations are apparently less abundant than they were historically. While it may not be at imminent risk of extinction based on the number of extant populations, the Dakota skipper is at risk of experiencing significant declines in the near future that could change the species' status dramatically. The decline of the Poweshiek skipperling (*Oarisma poweshiek*) is a case in point. The Poweshiek skipperling experienced a greater than 95% decline across its range since approximately 2000 and is now imminently imperiled with extinction. It once formerly occurred with the Dakota skipper in native prairie habitats in Iowa, Minnesota, South Dakota, and North Dakota, but recent surveys indicate that it is now apparently gone from those states and only a few hundred individuals may remain globally. The Dakota skipper itself has been extirpated from sites in Minnesota that were until recently considered strongholds for the species, including the Prairie Coteau Scientific and Natural Area and Hole-in-the-Mountain Prairie region. Numerous other populations of the species in Minnesota have evidently been extirpated and it may now exist in Minnesota in only a single metapopulation at Felton Prairie in Clay County. A single individual was found in the nearby Bluestem Prairie in 2015, but intensive efforts to find the species there in 2016 were unsuccessful.

Many of the extant Dakota skipper populations are actually of questionable status. A preliminary analysis of survey data suggests that as few as 22% of the extant metapopulations may exhibit a consistent and continuous presence that may be indicative of viability (R. Royer, Minot State University retired, pers. comm. 2016). Among metapopulations that have been surveyed during at least four years since 2000, only 22% have positive detections in greater than 90% of those years. If the threshold for positive detections is lowered to 80% of years surveyed since 2000 as a standard for 'consistent and continuous' observations, only 28% of the 73 metapopulations would still be considered to have met this preliminary standard of metapopulation health. Thus, only 8-10 metapopulations may be relatively stable globally, based on these preliminary analyses. Concerted surveys are critically needed across the range, particularly at under-studied historic localities, to better understand the actual status of Dakota skippers globally.

Metapopulations face a wide variety of threats and the continued existence of many may be subject to land management decisions that are made without regard to their effects on the Dakota skipper. Two-thirds (67%) of subpopulations are either Vulnerable or Highly Vulnerable to habitat conversion that would lead to their extirpation and about 72% are in private ownership, managed under the authority of the North Dakota Department of Trust Lands or the South Dakota Highway Department. Although Dakota skipper habitats can be conserved on these lands, the type of ongoing attention to the actions that may be needed to maintain high quality habitats for the species cannot be guaranteed as landowners and land managers make decisions based on other economic priorities.

Dakota skippers are sensitive to land management activities, but the vast majority of documented populations occur on private, county, state, and other lands not owned by the Service or federal agencies,. The listing of the Dakota skipper as a federally Threatened Species prohibits most forms of take of the species, but does not generally guarantee or require proactive measures to conserve species except by federal agencies. The long-term status of Dakota skipper populations is going to need a considerable amount of conservation effort outside of federal lands in the U.S., especially since only 17 of the 152 subpopulations in the U.S. occur on federal lands. When the Service listed the species in 2014, it included a special rule allowable under section 4(d) of the Endangered Species Act that exempted take of the Dakota skipper that occurred as part of routine livestock ranching activities on nonfederal lands. If the

status of the species changed to endangered, we would no longer be able to have such a rule in place and conservation of the species on non-federal lands could become more difficult due to decreased willingness to participate in the conservation process from private stakeholders. *Ex situ* management and reintroduction could be significant in keeping the species from becoming endangered and in maintaining our ability to recover it from its current threatened status.

### C. Threats

The greatest threat to the Dakota skipper has been loss of native high quality prairie habitat. However, it remains unclear why this species has vanished from more than 76% of the last known sites in the last few decades. Hypotheses include but are not limited to: further habitat loss and degradation, isolation due to fragmentation, small population size effects (i.e. Allee Effect), pesticide drift, invasive species, over- (or under-) use of prescribed fire and other habitat management methods, climate change and extreme weather events, and perhaps diseases or novel predators or parasitoids. It is assumed that these factors vary locally and interact with each other.

Among these threats, it is unlikely that only small population sizes and isolation alone could have been enough to cause the widespread disappearance of populations within such a short period of time. For example, formerly large populations of Dakota skippers appear to have disappeared from many sites across southwest Minnesota in just a few years. Surveys by the Minnesota DNR led by Robert Dana found Dakota skippers at eight localities in Hole-in-the-Mountain region, the Prairie Coteau Scientific and Natural Area, Terrace Wildlife Management Area, and private sites in the Chanarambie Creek Valley in 2006 through 2009. Populations in the Hole-in-the-Mountain region were particularly high in these years. Surveys did not resume at these sites until 2012 however, and at which time all southwest Minnesota Dakota skipper populations appeared to have been extirpated. Focused surveys from 2012 through 2016 at sites across this region have all failed to produce detection of the species. A synchronous region-wide extirpation event within just a few years likely suggests a common causal influence that acted on all populations across a wide geographic area, such as extreme weather event(s), widespread pesticides drift, etc., or some interaction(s) thereof. This period is also just after the apparent extinction of Poweshiek skipperling from the same region.

Pursuit of reintroduction is not often recommended when known causes for extirpation have not been mitigated. Due to the number potential of causal stressors identified above and serious data gaps (i.e. survey history, etc.) regarding Dakota skipper, it is difficult to extrapolate the exact cause for each local extirpation event, let alone predict how or what to mitigate. What is apparent, given the poor dispersal ability of this species (see Section VI.A), is that once a population is extirpated it is unlikely natural recolonization will occur. Our ability to restore corridors connecting extant sites is uncertain in most situations given the long distances between sites. To expand the current known range and ensure species persistence, reintroduction activities will be needed. While reintroduction efforts are being executed, activities studying reasons for the decline by the Service and Minnesota Zoo will continue, as will long-term efforts to restore prairie landscapes. Indeed, having stable or increasing populations of Dakota skipper and other imperiled prairie butterflies is identified as a key indicator of the success of prairie restoration and prairie connectivity efforts outlined in the multi-decadal Minnesota Prairie Conservation Plan (Minnesota Prairie Plan Working Group 2011).

Among the potential threats being studied is non-target pesticide drift from adjacent agricultural operations. The Minnesota Zoo and the Service have cooperated on a drift study at five prairie remnants in Minnesota and South Dakota since 2014. Grass samples were first collected within the HIM Preserve in August 2016 and analyzed by pesticide residues. As described below, residues of some insecticides

applied against the invasive soybean aphid, *Aphis glycines*) were found. Results will be compared to baseline data collected at other sites where Dakota skippers are still present and where they have become recently extirpated. These findings and their implications are presented in Runquist and Nordmeyer (2017) and in Runquist and Heimpel (2017). This work will continue annually.

#### D. Contributions to the Species' Recovery

If populations of Dakota skippers can be reestablished within their historic range, the species will be closer to recovery. Important lessons can also be learned that will inform the science of prairie skipper reintroductions and population management, even if Dakota skipper reintroduction efforts described below are not immediately successful. For example, dispersal patterns of adult butterflies away from the reintroduction site(s) along fixed transects that are surveyed on a regular basis will help inform models of metapopulation connectivity parameters. Monitoring behaviors of reintroduced adults may also elucidate key habitat characteristics that promote local residency vital to long-term population viability.

If we can reestablish a viable population of the Dakota skipper at HIM, it would make a tangible contribution to the species' recovery. Recovery of the Dakota skipper will rely on the existence of at least several healthy metapopulations within each of several ecoregions. Metapopulation health will rely on several factors intrinsic to the species' population dynamics, including the density and diversity of larval food plants and nectar plants and the extent of high quality habitat. It will also rely, however, on the consistent implementation of management practices that maintain or restore these essential habitat features and that minimize short-term adverse effects to population growth. The Nature Conservancy and the Minnesota DNR Division of Wildlife each manage a significant amount of native prairie at and in the vicinity of HIM. This is likely to provide the management consistency and quality that is not guaranteed at numerous sites occupied by the species.

#### E. Summary of CBSG Workshop– Dakota Skipper Working Group

In 2015, the Service, in collaboration with the Minnesota Zoo, invited the IUCN/SSC's Conservation Breeding Specialist Group (CBSG) to plan and facilitate a participatory workshop process designed to use the *Ex Situ* Guidelines (IUCN/SSC 2014) as an aid to evaluate the feasibility of incorporating an *ex situ* management element into the broader conservation activities for both Poweshiek skipperling and Dakota skipper. The workshop was hosted by the Minnesota Zoo on 20-22 October, 2015 and was supported by United States Fish and Wildlife Service and the Minnesota Zoo Foundation. The workshop was facilitated overall by Dr. Philip Miller of CBSG, with his colleague Dr. Kathy Traylor-Holzer leading the participants through the application of the *Ex Situ* Guidelines to the specific conservation issues facing the two focal species. Participants in the meeting included 20 experts on species biology and management, with a few individuals with expertise on conservation of closely related species participating by conference telecommunications.

The details regarding the participants, processes, and recommendations followed during the workshop are provided in Delphey et al. (2016). Below we summarize the approach adopted by the Dakota skipper group during the workshop:

**Reintroduction of Dakota skipper at sites within the species' historical range where it has been extirpated.** The specific objective for this management component is to establish at least one new population in the wild by 2021. Larvae for reintroduction will be produced primarily by headstarting – collecting eggs from wild females and rearing the eggs at the zoo to produce larvae

or pupae for release. Some larvae or pupae may be produced from mating of captive-reared adults at the Minnesota Zoo. This may consist largely of individuals that survive research projects (see below) and become adults at the zoo, but captive rearing and breeding to produce an F1 generation may also be used to generate a sufficient number of offspring to establish a reintroduced population.

**Provision of Dakota skippers for research projects that are integral to the species' conservation.**

The research program would focus on gaining a better understanding of the number of larvae/pupae that must be released to reestablish a viable population of the Dakota skipper. A viable population would be one with consistent evidence of recruitment. To accomplish both the research and restoration components of the overall program would require producing at least 800 post-diapause larvae and/or pupae. Approximately 175 larvae could be used in continued larval food plant studies at the Minnesota Zoo, while an additional 30 larvae could potentially be used in a pesticide study, also conducted by the Zoo. Upon completion of those studies, all larvae produced *ex situ* would be available for population restoration unless additional research needs are identified.

**Completion of a management protocol that could be used by zoos or other facilities to successfully house the Dakota skipper *ex situ*.** This would likely take the form of a comprehensive husbandry manual describing the procedures and methods necessary to achieve success in management *ex situ* populations of the Dakota skipper.

This plan focuses on the first of these points and, even more specifically, on *ex situ* rearing and reintroduction of the Dakota skipper to TNC's Hole-in-the-Mountain Prairie Preserve in Lincoln County, Minnesota.

## F. Reintroduction Justification

Due to the Dakota skipper's patchy extant range and fragmented available habitat, it is improbable that the species will immigrate to many of the suitable, otherwise unoccupied habitats without human aid in the foreseeable future. During the 2015 CBSG Workshop, the first recovery activity recommendation was the formation of a reintroduction program from zoo-reared individuals that are part of the Minnesota Zoo's insurance population. Population restoration via reintroduction was chosen as the conservation strategy for a number of reasons. First, reinforcement of extant populations through augmentation is not considered a worthwhile option at this time. Augmentation engenders certain risks and requires analyses that are not relevant or important for reintroductions – swamping of locally adapted genotypes, for example. If a local population appears to be experiencing rapid decline to the extent that genetic rescue may be necessary, we may initiate a reinforcement program. By only implementing a reintroduction strategy to a site where the species is extirpated, there is little risk to wild populations.

Conservation introductions are not being considered at this time for Dakota skipper recovery. Conservation introductions may take the form of ecological replacement, or assisted colonization to sites outside their indigenous range. Ecological replacement is not currently warranted for Dakota skippers, as the broader ecological impact of this species in its native prairie range is not well known and therefore a suitable substitute species cannot be identified. Assisted colonization is a risky and often controversial conservation strategy, and has a low likelihood of success. Given the poor understanding of Dakota skipper's broader ecological role, it is impossible to predict the effects Dakota skippers would have on the ecology of a site to which it was introduced to as a non-native species. Until a well-defined need is identified for conservation introductions, no such activities are being proposed at this time.



At this time, only reintroductions into remnant prairies are being considered, as opposed to restored prairies. We likely do not know enough about the species' ecological needs to identify and recreate those features within a restored site. Historically, translocations of imperiled butterflies into restored sites have had low levels of success. Theoretically, there could be an unknown element of the environment (the lack of a mutualist, etc.) that has not been incorporated into the restoration that was critical to the translocated species. Even for species that have been studied more robustly, this is the case. However, the number of remnant prairie sites apparently suitable for reintroduction are few. It is possible, if not likely, that restored prairie sites will need to be utilized for the recovery of this species at some point in the future. Establishing Dakota skippers within more sites will increase the species' overall resiliency. However, translocation to restored sites is currently outside the scope of this document.

Reintroductions to HIM will utilize Zoo-reared Dakota skippers. Acknowledging the risks of *ex situ* reared Lepidoptera (Lewis and Thomas 2001; Schultz and Dzurisin 2009), this strategy is being adopted in hopes that benefits from having a reduced impact on the extant populations will offset these risks. Many other Lepidopteran translocation and *ex situ* programs collect specimens as eggs or larvae to reduce population level impacts. Given the presumably low survivorship of early life stages, removal of relatively few eggs, or early instar larvae likely has a minimal impact on the population as a whole. Survival in the wild from egg to pupation of one rare butterfly, for example, was 3% based on a sample of 1,617 eggs (Lambert 2011, p. 110). In studies reviewed by Nail *et al.* (2015), the predicted survival rate of monarchs (*Danaus plexippus*) from egg to adult was ~4.2 to 9%, but this was conservative since the pupal stage was raised in captivity and not exposed to some important mortality factors. In the case of Dakota skippers, no technique or search image has been developed for identifying and finding eggs or larvae in the wild. The only life stage that can be located with any confidence is the adult stage. As part of the Minnesota Zoo's Dakota skipper collection protocol, adult females are collected from the field and held for no more than 72 hours. Any eggs laid in this time are integrated into the *ex situ* Zoo population. Once eggs are collected, the adult females are returned to the same GPS coordinates from which they were collected, to allow them to continue laying eggs and contribute to that local population. For more details about the Minnesota Zoo's collecting and husbandry techniques, the Hesperiid Husbandry Manual is available upon request.

An alternative approach to this reintroduction strategy would be to translocate gravid adult females from other *in situ* populations. This strategy was not adopted largely due to the above explanation of trying to mitigate negative impacts on removing specimens from the source populations. Removal of a fraction of a female's reproductive load is likely of much less impact than removing the female herself. Additionally, translocating adults may have added complications. Adult skippers often do not travel well and are prone to damaging themselves. By utilizing *ex situ*-reared specimens, we are able to translocate pupae, with little risk of injury.

At this time, reintroduction is only being considered for sites in Minnesota due to logistical, partnership, ecological, and financial benefits. The TNC HIM Preserve was chosen as the initial release location based on its ranking compared to other candidate sites within the Dakota skipper's historic range in Minnesota (see Selecting Release Sites, below). The long term goal of the project is for the TNC HIM Preserve as well as the adjacent Hole-in-the-Mountain and Altona Wildlife Management Areas (Minnesota Department of Natural Resources) to become occupied by Dakota skippers. We hope that the units will behave as a functional metapopulation. Collectively, we are referring to all of these units combined as the Greater HIM Complex.

## V. Goals, Objectives and Actions

We will use the following definitions for this plan (IUCN 2014:5):

A **Goal** is a statement of the intended result in terms of conservation benefit;

**Objectives** give clear and specific details for how the goal will be realized; and,

**Actions** are statements of what should be done to meet the objectives.

### Goal

The goal of this plan is to ensure continuity of a self-sustaining population of Dakota skipper at Hole-in-the-Mountain Prairie in Lincoln County, Minnesota. A self-sustaining population would be one in which the species can be reliably detected at the reintroduction site for at least five years after the cessation of any release of individuals produced partly or entirely *ex situ*.

### Objectives

The following are objectives - and underlying actions - of this plan. Note that for the specific actions addressed by this plan, parts or all of objectives 1-3 were completed before or during plan development.

1. Select one or more sites where it would be warranted to attempt the reintroduction of the Dakota skipper.
  - 1.1. Consult with species experts and review survey data to identify candidate sites.
  - 1.2. Evaluate candidate sites according to the criteria described in the section, Reintroduction Site Selection.
  - 1.3. Secure landowner permission to carry out the reintroduction. Ensure that owners of the reintroduction site are apprised of the contents of the Dakota Skipper Propagation and Reintroduction Plan.
2. Identify Dakota skipper populations that are healthy enough to sustain the removal of a limited number of eggs for captive rearing and that are ecologically similar to the reintroduction site.
  - 2.1. Consult with species experts and review survey data to determine which extant populations are likely to have populations sufficiently robust to allow for egg collection based on the protocols.
  - 2.2. Ensure that any potential collection sites are in the same Ecological Sections as the reintroduction site as described by Bailey *et al.* (1995).
  - 2.3. Ensure that all necessary approvals and permits are secured to allow for egg collection and transport to Minnesota Zoo.
3. Carry out egg collection at identified collection sites and rear eggs to pupal stage for release according to the best practices identified in the Minnesota Zoo's Hesperiid Husbandry Manual.
4. Develop site-specific release plans before releases occur.
  - 4.1. Site plans for reintroductions will consist of the following, at a minimum: (1) a map that delineates the limits of the site and the extent of Dakota skipper habitat at the site; (2) the results of any previous surveys for Dakota skipper conducted at the site; (3) a description of the individuals, organization or entities who will carry out release activities, manage habitats at the

site, and carry out surveys; (4) a description of previous and planned survey and habitat assessment methods; (5) a description of the land ownership and statements of approval or authorization from the landowner(s) for the area where releases will occur; (6) the precise methods of release, including a) the life-stage - or life-stages - at which immature Dakota skippers will be released; b) any structures to be used and how they will be used; c) the number and identity of personnel who will carry out each task; d) methods to be used to transport the animals to the release site; e) the methods that will be used to determine the time of release; f) the information that will be collected as each release is carried out, including fates of released individuals, timing of eclosion, etc.; g) the location within the reintroduction site where releases will occur; and, h) contingency plans for each aspect of the release, as appropriate.

**5.** Ensure that funding, facilities, and personnel are in place to carry out planned activities.

**5.1.** By the end of each calendar year, identify gaps in facilities, funding, and personnel needed to complete the planned activities for the following year.

**5.2** No later than April 1 of each calendar year, or as deadlines dictate, apply for funding as needed to fill forecast gaps in funding, facilities, and personnel while this plan remains in effect, to carry out the actions described in Section VII. Monitoring and continuing management are secured and in place to support those actions for the succeeding twelve months.

**5.3.** No later than April 1 of each calendar year while this plan remains in effect, ensure that personnel have been identified to fulfill all of the needed roles and responsibilities as described in Section IX. Monitoring and continuing management, as needed for the succeeding twelve months.

**6.** Ensure that planned activities are communicated to all stakeholders before any egg collection or releases.

**6.1.** Develop an outreach plan to inform stakeholders about planned activities.

**6.2.** No later than April 1 of each calendar year while this plan remains in effect, implement the recommended activities of the outreach plan to ensure that all identified stakeholders have been informed of the release plans.

**7.** Determine success or failure of captive rearing and releases and whether to continue reinforcement.

**7.1.** Monitor release sites to determine whether Dakota skipper adults are present and where they occur at release sites.

**7.1.1.** Develop and implement a monitoring plan that includes the following: (1) a description of the survey methods to be used; (2) a description of the qualifications of persons who will conduct surveys; (3) a map and description of the area(s) to be surveyed; (4) a description of the timing, frequency, and number of surveys to be conducted during each flight period; and, (5) a description of the manner in which results will be reported.

**7.1.2.** Evaluate adult survey data collected after releases to determine the abundance and distribution of the Dakota skipper.

**7.2.** If five years of releases have failed to establish the species at the reintroduction site, determine whether releases should continue. Continue releases until it is determined that additional releases are unlikely to maintain or further improve population trends. This determination may be made based on the trends in relative abundance – or another appropriate

metric – of the Dakota skipper at the reintroduction site(s); the extent of suitable habitat that the species occupies at the site; and/or, the likely trends in the quality and extent of habitat at the site. If suitable habitat remains unoccupied at the site or if management actions are likely to lead to significant improvements or expansion of suitable habitat at the site, continued releases may be prudent.

**7.3.** Annually evaluate survival from egg to release while in captivity to determine whether it is likely to exceed survival in the wild. Survival rates from egg to pupa or late-instar larva that are less than 3% may not exceed survival rates in the wild. If after three years of *ex situ* management, survival rates during the egg to release stage do not exceed 3-5%, the program will cease pending further review.

## VI. Basic Biological Knowledge

### A. Dispersal

Dakota skippers are not known to disperse widely; the species was evaluated among 291 butterfly species in Canada as having relatively low mobility. Experts estimated Dakota skipper to have a mean mobility of 3.5 (standard deviation = 0.7) on a scale of 0 (sedentary) to 10 (highly mobile) (Burke et al. 2011, p. 2279; Fitzsimmons 2012, pers. comm.). Dakota skippers may be incapable of moving more than 8 kilometers (km) (5 miles (mi)) between patches of prairie habitat separated by structurally similar habitats, but typical movements may be less than one km (Cochrane and Delphey 2002, p. 6, R. Westwood, University of Winnipeg, pers. comm., 1 Sep 2016). Royer and Marrone (1992a, p. 25) concluded that Dakota skippers are not inclined to disperse, although they did not describe individual ranges or dispersal distances. McCabe (1979, p. 9; 1981, p. 186) found that concentrated activity areas for Dakota skippers shift annually in response to local nectar sources and disturbance.

In a mark–recapture study, average adult movements of Dakota skipper were less than 300 meters (m) (984 feet (ft)) over 3–7 days; marked adults crossed less than 200 m (656 ft) of unsuitable habitat between two prairie patches and moved along ridges more frequently than across valleys (Dana 1991, pp. 38–40). Dana (1997, p. 5) later observed reduced movement rates across a small valley dominated by exotic grasses compared with movements in adjacent widespread prairie habitat. Roads and crop fields were suspected to be impediments for movement among prairie patches along two sites of the main valley (Dana 1997, p. 5), although movements beyond the study area were beyond the scope of the 1997 mark-recapture study (Dana pers. comm. 2013). Skadsen (1999, p. 2) reported possible movement of Dakota skippers in 1998 from a known population at least 800 m (2625 ft) away to a site with an unusually heavy growth of purple coneflower; he had not found Dakota skippers in three previous years when coneflower production was sparse. The two sites were connected by native vegetation of varying quality, interspersed by a few asphalt and gravel roads (Skadsen 2001, pers. comm.).

In summary, the best information we have suggests that dispersal of Dakota skipper is limited due in part to its short adult life span and single annual flight. The precise relationship between natural repopulation and the distance to the nearest extant population is unknown, but the species' extirpation from a site may be permanent unless it is close enough to a population that generates enough emigrants to repopulate the site or is the subject of a human-mediated reintroduction. Even sites greater than one km from another populated site likely face a reduced chance of recolonization.

## B. Dakota Skipper Habitat Descriptions

Core habitat patches are areas that contain the vegetation and physical features that provide nectar, sites for oviposition, larval food, and shelter required by Dakota skipper during its life cycle. Dakota skipper occurs in two general core habitat types. ‘Type A’ core habitats consist of low wet-mesic prairie with little topographic relief that occurs on near-shore glacial lake deposits (Royer et al. 2008, p. 14-16). The second core habitat type, referred to as ‘Type B’ by Royer *et al.* (2008, p. 14), occurs primarily on rolling terrain over gravelly glacial moraine deposits and is dominated by little bluestem (*Schizachyrium scoparium*), needle or porcupine grasses (*Hesperostipa spp.*), sideoats grama (*Bouteloua curtipendula*), and prairie dropseed (*Sporobolus heterolepis*). Typically, ‘Type B’ habitats have generally sustained larger populations of Dakota skippers than ‘Type A’ habitats.

### ‘Type A’ Habitats

In the United States, Dakota skipper occurs in two general habitat types. The first is a low wet-mesic prairie with little topographic relief that occurs on near-shore glacial lake deposits – Royer et al. (2008, p. 14-16) (Figure 5). In the United States, ‘Type A’ Dakota skipper habitat occurs primarily in North Dakota, but it may also comprise a small amount of the species’ habitat in northeastern South Dakota. ‘Type A’ habitat may be flooded in some years, but has “sufficient relief to provide segments of non-inundated habitat during the spring larval growth period within any single season” (Royer et al. 2008, p. 15; Royer et al. 2014, p. v). ‘Type A’ habitats are also found in the “Interlake” region of Manitoba, between Lakes Winnipeg and Manitoba.

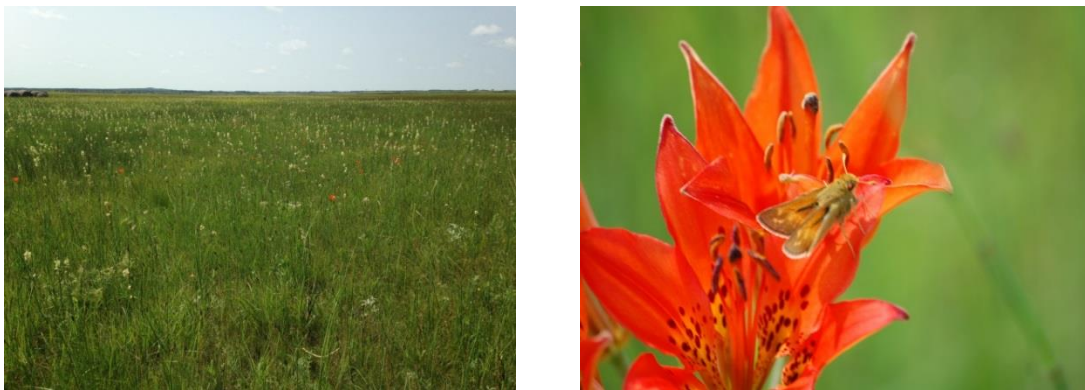


Figure 5 - ‘Type A’ Dakota skipper habitat in McHenry County, North Dakota (Royer et al. 2014). Note the abundant mountain deathcamas (white flowers) and the scattered prairie lilies (orange flowers). A male Dakota skipper perched on a prairie lily in ‘Type A’ (USFWS photo).

### ‘Type B’ Habitats

The second Dakota skipper habitat type, referred to as ‘Type B’ by Royer *et al.* (2008, p. 14), occurs primarily on rolling terrain over gravelly glacial moraine deposits and is dominated by big bluestem, little bluestem, and needle or porcupine grasses (6). As in ‘Type A’ habitats, bluebell bellflower and prairie lily are present in ‘Type B’ habitats, but ‘Type B’ habitats support more extensive stands of narrow-leaved purple coneflower, upright prairie coneflower (*Ratibida columnifera*), and common gaillardia (blanketflower; *Gaillardia aristata*) (Royer et al. 2014, p. 1-2). Each of these flowers is a documented



nectar source for the Dakota skipper in ‘Type B’ habitats (McCabe 1981; Dana 1991). Little bluestem and porcupine grass (*Hesperostipa spartea*) are the predominant grass species in South Dakota ‘Type B’ habitats, but side oats grama, needle-and-thread grass (*H. comata*), and prairie dropseed are also typical (Skadsen 2006, p. 1-2). In a variant of ‘Type B’ habitats found in western North Dakota (Figure 6), western wheatgrass (*Pascopyrum smithii*) is also typical (Royer et al. 2014, p. 1).

Dakota skipper ‘Type B’ habitats typically support a high diversity and abundance of native forbs, including purple coneflower, purple prairie clover (*Dalea purpurea*), white prairie clover (*D. candida*), yellow sundrops (*Calylophus serrulatus*), prairie groundsel (*Packera plattensis*), groundplum milkvetch (*Astragalus crassicaucus*), eastern pasqueflower (*Pulsatilla patens*), old man’s whiskers (prairie smoke, *Geum triflorum*), western silver aster (*Symphyotrichum sericeum*), dotted blazing star (*Liatris punctata*), tall blazing star (*L. aspera*), meadow zizia (heartleaf golden alexanders; *Zizia aptera*), blanket flower (*Gaillardia* sp.), prairie sagewort (*Artemisia frigida*), and leadplant (*Amorpha canescens*) (Skadsen 2006, p. 1-2). Prairie milkvetch (*Astragalus laxmannii* Jacq. var. *robustior*) also occurs in ‘Type B’ habitats in Minnesota (Dana 1997, p. 8).

In the rolling terrain of river valleys and the Missouri Coteau of North Dakota, on the western edge of the species’ known range, Dakota skippers inhabit a variant of ‘Type B’ habitats. These habitats typically contain an association of little bluestem, big bluestem, and needlegrasses that is often invaded by Kentucky bluegrass (*Poa pratensis*) (Royer and Marrone 1992, p. 22). These prairies, also typically contain prairie lily, bluebell bellflower, coneflowers, and other asters as nectar sources; in some areas, mountain deathcamas also occurs (Royer and Marrone 1992, p. 22). ‘Type B’ habitats also occur in far southwest Manitoba and southeast Saskatchewan.



Figure 6 - ‘Type B’ Dakota skipper habitats in southwest Minnesota (upper left), northeast South Dakota (upper right), and western North Dakota (bottom). The site at upper left is The Nature Conservancy’s Hole-in-the-Mountain Prairie Preserve, the reintroduction site addressed in this plan. Photos from USFWS and Royer et al. (2014).

### C. Habitat Needs by Life Stage

#### Adults

“Regular access to nectar is clearly important” for adult Dakota skippers, most critically as a source of water and secondarily as a source of carbohydrates to support survival and reproduction (Dana 1991, p. 47). Adult Dakota skippers nectar on flowers “regularly throughout the day” and do not obtain water from mud, pond margins, etc. as do other skippers (Dana 1991, pp. 21; 48).

In Minnesota, Dana (1991, p. 50) found that almost all nectaring occurred in dry-mesic habitat. Dakota skippers relied mostly on four plant species that have “concealed” nectar that is available only to species with a “slender trophic apparatus” (e.g., proboscis) that is 5 mm or longer (Dana 1991, p. 48; Table 1). North of the range of the purple coneflower in Minnesota at Lake Bronson State Park, Dakota skippers used oval-leaf milkweed (*Asclepias ovalifolia*) and prairie milkvetch (*Astragalus adsurgens*) for nectar.

*Table 1 - Four species used most as nectar sources by Dakota skippers in Minnesota ‘Type B’ habitats (Dana 1991). Number of nectaring observations by Dana: V = very common (many hundreds, not enumerated); C = common (about 35 visits); F = frequent (11-25); O = occasional (1-10); R = rare (2-4).*

Species	Males	Females
Narrow-leaved purple coneflower ( <i>Echinacea angustifolia</i> )	V	V
Prairie milkvetch ( <i>Astragalus laxmannii</i> Jacq. var. <i>robustior</i> )	C	F
Hoary vervain ( <i>Verbena stricta</i> )	O	F
Purple locoweed ( <i>Oxytropis lambertii</i> Pursh var. <i>lambertii</i> )	F	R

The “standing crop” of nectar in the species used commonly by the Dakota skipper may be greater than in species that may be used by a wide range of nectar feeders (Dana 1991, p. 48). When favored species of nectar are unavailable, Dakota skippers may switch to less favored species that may produce less nectar or are accessible to a large number of other insects (Dana 1991, p. 48).

Dakota skippers use vegetation that rises above the grass canopy for reproduction and for unobstructed flight. In Minnesota, males typically perch on *Echinacea angustifolia* flowers 0.3-0.5 meters “above the grass canopy” and chase butterflies from perches, in pursuit of potential mates (Dana 1991, p. 21). The need for unobstructed flight from perches and larval habits (see below) may explain why Dakota skipper habitat is comprised primarily of mid-height grasses, such as little bluestem (*Schizachyrium scoparium*) and prairie dropseed (*Sporobolus heterolepis*), and why it is generally absent from grassland dominated by taller species, such as big bluestem (*Andropogon gerardii*).

## Eggs

Habitat patches must be capable of supporting oviposition and must not be subject to intensive herbivory while unhatched eggs are present. Dana (1991, p. 50) found no evidence that oviposition occurred outside of the species' dry-mesic habitat in Minnesota. Females oviposited on plants "in the grass stratum" with little or no selectivity among plant species (Dana 1991, p. 14; 47). This lack of selectivity may be an adaptation to the ubiquity of the native grass species that function as larval food plants in high quality Dakota skipper habitat (see Larvae and Pupae, below). In Minnesota sites inhabited by Dakota skipper, Ottoe skipper (*H. ottoe*) larvae emerged from eggs laid on purple coneflower and dropped from the flowers into underlying grasses soon after hatching (Dana 1981, p. 77). The Minnesota Zoo has observed similar non-specific oviposition deposition in female Dakota skippers in open air mesh cages under *ex situ* conditions. Dakota skippers may behave similarly after hatching, although they may not oviposit frequently on purple coneflower (Dana 1991, p. 17). Removal of vegetation before oviposition or before hatching (e.g., by herbivory) may reduce or eliminate oviposition sites or destroy eggs (e.g., Lambert 2011, p. 97).

## Larvae and Pupae

Larvae construct a series of shelters as they grow that are built from with plant material at or near the soil-surface interface and they pupate in similar shelters (Dana 1991, p. 16). Larvae require ready access to non-senescent tissue of food plants to develop through at least four instars before entering diapause (Dana 1991, p. 46). The bunchgrasses, little bluestem, prairie dropseed, and sideoats grama, provide Dakota skipper larvae with a dense cluster of erect blades in close proximity to "an abundance" of edible leaf tissue (Dana 1991, p. 46). The shelter-building habit of Dakota skipper larvae may render the native grasses big bluestem and Indiangrass (*Sorghastrum nutans*) unsuitable as larval hosts after spring and early summer due to the distance that would have to be travelled between shelters and palatable tissue and hairiness of stems that may hinder travel of the larvae along the stem, respectively. The Minnesota Zoo is currently studying the performance of Dakota skippers reared on seven potential host grasses (prairie dropseed, little bluestem, side-oats grama, big bluestem, porcupine grass, Kentucky bluegrass, and smooth brome) through larval no-choice experiments. This experiment will continue through 2017.

## D. Climate

IUCN (2013:15) recommends that climate requirements of the focal species should be understood and matched to current and/or future climate at the destination site. This will be important for potential reintroductions for the species broadly throughout its historical range. Currently, this document only addresses the reintroduction to a single site. It is important to note that HIM is further south than any other known extant Dakota skipper site. This plan makes the assumption that climate change is not a contributing factor in the decline Dakota skippers. Climate change remains a poorly analyzed variable in Dakota skipper population trends and warrants further attention. In the next version of this document we will do the following, as adapted from IUCN (2013:15):

- Assess key climate parameters in the Dakota skipper's current and historical ranges, as appropriate, to estimate the breadth of climatic conditions potentially suitable for the species;
- Use the resulting bio-climate envelope in models of predicted climate change to assess how the Dakota skipper might respond to scenarios of future climate; Supplement the climate change modeling with a study of other factors that might determine habitat suitability and distribution, such as the presence of essential species and habitats, disease etc.; and,
- Determine whether the climate is predicted to remain suitable for the Dakota skipper for long enough to achieve the desired outcome for the species, in light of the uncertainties inherent in climate projections. Variables that will need to be addressed will include, but are not limited to, include: air temperature, microsite temperature and humidity in the duff layer and winter snowpack.

## VII. Feasibility and Design

### A. Selected Founder Populations and Genetic Considerations

The apparent extinction of Dakota skippers from all documented populations in southern Minnesota (including the Hole-in-the-Mountain complex) necessitates that any reintroduction efforts there must rely on populations from outside this historic metapopulation. Ideally, reintroduction programs should derive source individuals from populations as close geographically and ecologically to the extinct populations. Mixing contributions from multiple disparate source populations may result in reduction of fitness if genetically-mediated phenotypes are drawn away from locally-selected optima. Conversely, hybrid vigor may be produced if beneficial genetic variation that had been lost through genetic drift in small populations is reintroduced through deliberate mixing of lineages.

To date, the only published research on Dakota skipper population genetics and phylogeography is Britton and Glasford (2002). The researchers assayed allelic diversity at 21 isozyme loci from 278 individuals across nine populations from Minnesota, South Dakota, and Manitoba. Included in this study are populations that would likely serve as source ("Enemy Swim Lake", South Dakota) and destination (Hole-in-the-Mountain, Minnesota; now apparently extinct) for the reintroduction program discussed here. The Felton Prairie complex, which is perhaps the now only remaining viable Dakota skipper population in Minnesota and is also represented in the Minnesota Zoo's *ex situ* rearing and breeding program, was also included in the study. Low levels of genetic differentiation were observed globally, though there were statistically significant relationships of pairwise genetic isolation by distance between populations both globally and between the Minnesota and South Dakota populations. This pattern of increasing genetic differentiation with increasing distance between populations is consistent with expectations for species with historically large and continuous ranges (like prairie endemics). Due to modern habitat loss and the consequent interruption of historic gene flow between populations, genetic drift is likely the primary generator of modern differentiation between extant populations. The two Manitoba populations were moderately divergent from the seven studied U.S. populations, and some additional lower divergence was found between the southern Minnesota and South Dakota populations. Populations were also found to have low heterozygosity, suggesting inbreeding.

While the isozyme electrophoresis methods employed by Britton and Glasford were sound for their time, interpretation of these results requires some caution. Technological advances in molecular genetics in the years following publication of the study have dramatically improved analytical power,

particularly through “next generation” genomic sequencing. Modern DNA-based techniques provide significantly greater resolution than isozyme-based techniques. Isozymes are also more likely to be under selection than the presumably neutral genome-wide nucleotide polymorphisms revealed through modern DNA sequencing techniques. Therefore, patterns emerging from these two data sources can vary from each other. New research utilizing these modern next generation methods on Dakota skipper population genetic and phylogeographic are now underway, led by Dr. Emily Saarinen of the New College of Florida. Important to this work will be the incorporation of additional populations from across the range, including for the first time, populations from the western edge of the range in North Dakota.

Until this deeper understanding of the extant (and ideally historical) genetic diversity and divergence within and across populations can be developed (as well as other husbandry considerations), it is recommended that Dakota skipper reintroduction efforts to southwest Minnesota’s Hole-in-the-Mountain utilize the nearest known viable extant populations, in northeastern South Dakota. These South Dakota populations are found on tribal Sisseton Wahpeton Oyate lands and also constitute the large majority of the Minnesota Zoo’s existing rearing and breeding programs, and are also derived from ecologically comparable habitats to that of the Hole-in-the-Mountain Preserve.

## B. Animal welfare

The welfare of all individuals (handled or otherwise) is of paramount concern. The imperiled state of all known remaining Dakota skipper populations requires that significant care be undertaken. Any handling of individuals must be done for deliberate reasons by trained personnel under explicit authorizations. As much as possible, field censuses of Dakota skipper populations should be conducted by visual counts. Specific protocols for the recommended operation are discussed below in Section VII.B of this document and can be found in more depth in the Minnesota Zoo’s Hesperiid Husbandry Manual (available upon request).

## C. Disease and parasite considerations

Larvae reared by the Minnesota Zoo and other potential institutions are done so under controlled conditions that are designed to reduce the risk of disease and parasite transmission. The full history of the Minnesota Zoo’s rearing methods is outlined in annual reports. To date, no known diseases or parasites have been recorded in any of the Minnesota Zoo’s rearing efforts with any skipper species. Larvae are either reared individually or at low densities amongst siblings on potted host grasses that have been enclosed in a fine mesh cage. Clean conditions are maintained, and Dakota skipper operations are also quarantined from parallel husbandry operations with Poweshiek skipperling, Garita skipperlings (*Oarisma garita*), and other grass skippers through the establishment of multiple hoop houses exclusively dedicated to each species. All equipment used to handle Dakota skippers (forceps, paintbrushes, etc.) are disinfected with 20% bleach solution, or ethanol between specimens. No equipment is shared across species of butterflies. Protocols are also established so that, within a given day, Zoo staff care for Dakota skippers before other less endangered butterfly species to further minimize the risk of transmitting disease to threatened species.

Dakota skipper collection and rearing protocols mitigate the risk of unintentional introduction of parasitoids when individuals are released. At the Minnesota Zoo, all individuals are double contained at all times. Larvae and adults are housed inside fine nylon mesh cages that exclude parasitoids such as Tachinid flies, and Braconid and other small wasps. Eggs are obtained either through breeding at the Minnesota Zoo or from wild females temporarily held under controlled settings. These measures



eliminate potential parasitoid encounter. In the event that a zoo-reared Dakota skipper was found, or suspected to be parasitized, it would be excluded from any potential release and quarantined from other Dakota skippers.

#### D. Social feasibility

For the Dakota skipper reintroduction program to be successful, it must be socially feasible and take into account the priorities and agendas of various stakeholders. For this plan, we will use the following definition for stakeholder - one who is involved in or affected by a course of action.

The known or potential stakeholders that we have identified thus far are:

- U.S. Fish and Wildlife Service
- Minnesota Zoo
- Sisseton-Wahpeton Oyate Tribe
- South Dakota Department of Game, Fish, and Parks
- Minnesota Department of Natural Resources, Division of Wildlife
- Minnesota Department of Natural Resources, Division of Ecological and Water Resources
- The Nature Conservancy
- City of Lake Benton, Minnesota
- Lincoln County Parks
- Minnesota Department of Transportation
- Lincoln County Highway Department
- Lincoln-Pipestone Rural Water
- DM&E Railroad (owner of electrical transmission line) and, private landowners immediately adjacent the reintroduction site

We will ensure that each of these stakeholders has at least a general understanding of our plans and has access the plan's details and associated documents (e.g., permits). In addition, we will seek their comments on our plan and ask them to tell us of any concerns that they might have related to the plan. We will attempt to resolve any concerns, as feasible.

A local awareness campaign has already begun in the city of Lake Benton. Minnesota Zoo staff have been reaching out directly to local land managers that manage land immediately boarding HIM. Zoo staff have begun sharing reintroduction plans with Lake Benton city council members. The Minnesota Zoo is also planning multiple public presentations at the Lake Benton Public Library in 2017. The intent of these outreach activities is predominantly to generate local awareness about the plight of the Dakota skipper and inspire people to care. It is a goal to dispel/ mitigate any local misconceptions about the Dakota skipper listing and make ourselves available for questions. The purpose of this campaign is not to have local land managers change their agricultural practices to better accommodate Dakota skippers. Though some agricultural practices may be harmful for Dakota skippers, such as unintentional pesticide drift (see Section IV.C), sufficient data is lacking to recommend changes land management procedures in

agricultural spaces. At this time the Dakota skipper working group is pursuing a ‘knowing is caring’ approach.

According to IUCN guidelines, successful translocations must not only contribute to conservation of the intended species, but any gain from this conservation must be balanced against potential “collateral harm to other species, ecosystems or human interests” (IUCN 2013). Potential risks that may occur (biological, financial, socio-economic, and others) are discussed further in the Risk Assessment section of this propagation plan. However, at this time, we do not anticipate any negative consequences of *ex situ* management that would outweigh the conservation benefits for Dakota skipper.

## E. Regulatory compliance

### Federal Endangered Species Act Compliance

The Endangered Species Act, 1973, as amended (16USC 1531 et seq.) (ESA) makes it unlawful to take (includes harm, harass, pursue, hunt, shoot, wound, kill, trap, capture, or collect any wildlife within the United States), possess, ship, deliver, carry, transport, sell, or receive unlawfully taken wildlife. These prohibitions apply to live or dead animals, their progeny and parts or products derived from them. Some activities are allowed in accordance with permit provisions. For protected species, like the Dakota skipper, permits may be issued for scientific research, enhancement of propagation or survival, and taking that is incidental to an otherwise lawful activity.

The Minnesota Zoo holds a Section 10(a)(1)(A) Threatened and Endangered Species Recovery Permit (#TE64079B-1, expires on 12/31/2017) from the Service authorizing the handling and collection of a limited number of eggs from a limited number of temporarily held female Dakota skippers. We anticipate that this permit will be renewed and amended, as necessary to ensure that the goal of this plan is achieved.

On May 2, 2016, the U.S. Fish and Wildlife Service’s (Service) finalized a revised Intra-Service biological opinion (BO) on the effects of issuing section 10(a)(1)(A) scientific research permits to personnel conducting surveys for the Dakota skipper in Iowa, Minnesota, North Dakota, and South Dakota and for captive rearing efforts for the species. The biological opinion was prepared in accordance with section 7 of the ESA and replaces the original opinion for the subject actions, which was completed on June 16, 2015. The Service will update and revise this biological opinion, as needed, to ensure that the issuance of section 10(a)(1)(A) permits is carried out in compliance with ESA section 7.

### NEPA Compliance

The National Environmental Policy Act (NEPA) was enacted to facilitate national policies protecting the environment and ecological processes and provide means to carry out these policies. The captive rearing of the Dakota skipper is completely covered by a categorical exclusion contained in 516 DM 6, Appendix 1 (Federal Register 1997 62:2375-2382). The applicable categorical exclusion applies to the reintroduction or supplementation (e.g., stocking) of native, formerly native, or established species into suitable habitat within their historic or established range, where no or negligible environmental disturbances are anticipated. This categorical exclusion precludes the need to prepare an environmental assessment for this project.

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## USDA/APHIS Compliance

The Minnesota Zoo holds a required Interstate Movement Permit from the U.S. Department of Agriculture Animal and Plant Health Inspection Service for “Live Plant Pests, Noxious Weeds, and Soil”. All live phytophagous insects are classified as potential “plant pests” by the USDA, and intentional movement across of them between states is regulated, regardless of their Service or State listing status. This permit (P526P-15-02728) was issued June 11, 2015 and is valid through June 4, 2018. An additional USDA permit (P526P-17-01270; issued April 4, 2017, expired April 4, 2020) allows for the release of zoo-reared individuals originating from South Dakota to be released in Minnesota. Individuals derived from within state boundaries do not require additional USDA permitting. In the future, founders may be acquired from North Dakota or Manitoba, but an amendment to existing permitting would be required before releases of those individuals outside of their founder jurisdictions could be conducted.

## State Compliance

The Minnesota Department of Natural Resources issued the Minnesota Zoo a state permit in 2016 authorizing the collection and holding of Dakota skipper at their facility. This permit will need to be renewed and updated to allow for the Dakota skipper reintroduction program. All landowner permissions will be obtained prior to accessing lands. Additional permits from other agencies will also be secured as necessary.

### F. Resource availability

The Minnesota Zoo has established personnel and infrastructure capacity to perform the captive rearing and breeding program. A dedicated rearing chamber (termed “The Chrysalis”) and an attached greenhouse were constructed in fall 2015. These double-contained, clean, climate-controlled facilities are exclusively dedicated to the Prairie Butterfly Conservation Program. In addition to work tables, the chamber also houses a large laboratory hibernation freezer that safely mimics the sub-freezing conditions that wild hibernating caterpillars naturally experience under winter snow.

The Minnesota Zoo maintains three open air hoop houses with built-in containment capabilities for this program. Each of the three hoop houses is dedicated exclusively to a given species: 1) Dakota skippers and their host plants, 2) Poweshiek skipperlings and their host plants, and 3) Other surrogate skipper species (like Long Dash, *Polites mystic*) and their host plants. These lockable hoop houses are solely designated outdoor rearing and husbandry space for the Prairie Butterfly Conservation Program. The footprints of the hoop houses are wrapped in 3-foot high sheet metal to prevent access from mice and other small vertebrates that may eat plants and/or butterflies. The upper portions are wrapped in durable fine-mesh outdoor screening that excludes insect predators and parasitoids. Each hoop house contains work tables and a waterline, and is partially wrapped with clear plastic for protection from rain/hail. The screen for these hoop houses is not snow-bearing, so it is peeled back in late autumn prior to the first snow. All caterpillars kept in this facility are transferred to double containment hibernation containers prior to screen removal.

The Minnesota Zoo’s Prairie Butterfly Conservation Program has two full-time personnel. Dr. Erik Runquist (Butterfly Conservation Biologist) is the Program manager, and Cale Nordmeyer (Butterfly Conservation Specialist) coordinates and conducts much of the husbandry operations. The Zoo plans to hire additional seasonal staffing to assist in routine husbandry operations as necessary during the summer of 2017 and beyond as funding allows.

## G. Disaster preparedness

Equipment failures, human error, and other potential catastrophic events have the potential to cause the loss of some or all of the individuals being held or maintained in captivity. The maintenance of Dakota skipper at more than one facility would reduce the potential extent of adverse effects that could occur as a result of a catastrophic event at any single facility. At present though, no other facilities are prepared to maintain *ex-situ* populations of Dakota skipper. Limiting the number of facilities reduces the potential for human error and other issues which may result from the involvement of unqualified personnel. The Minnesota Zoo staff is trained and experienced in the care and handling of skippers. As discussed above, the Zoo maintains separate and dedicated facilities for Dakota skipper to prevent the spread of disease. Skippers are always maintained under at least double containment conditions in all facilities to prevent individuals from escaping confinement and to exclude enemies. All facilities where skippers may be held have been equipped with remote temperature and humidity monitors that automatically notify Zoo staff via cellular networks when conditions vary outside of predetermined tolerance thresholds so that appropriate remediation operations can be promptly undertaken. The Minnesota Zoo also possesses backup generators that may be used in the event of a power outage, but under most circumstances, a power outage represents minimal threat since the majority of larval rearing operations are likely to occur outdoors. Unauthorized disturbance of animals at these facilities is prevented by restricted and secured access.

In accordance with institutional and U.S. Fish and Wildlife Service policies, the Minnesota Zoo's Prairie Butterfly Conservation Program has developed a disaster preparedness plan (available upon request). It details critical activities that would take place and which staff would be responsible for those activities in the event of fire, high winds, severe weather, reduced workforce (e.g. pandemic or other personnel crises), and power outages. These plans are broken down by which portion of the Dakota skipper lifecycle may be affected when the emergencies might occur (two "Active Periods" = May through October, and "Diapause Period" = late October through April).

## VIII. Risk Assessment

### A. Risk to source populations

Removal of natural parental stock may result in an increased risk of extinction by reducing the abundance of wild individuals and reducing genetic variability within naturally occurring populations. To minimize this risk, protocols are in place to prevent over-collection at a site. As outlined in the Service Recovery Permit issued to the Minnesota Zoo, Dakota skipper adult females may be temporarily held for egg collection only after a minimum of 25 individuals are observed at a site within a 24-hour period during the yearly flight. This 25-individual minimum threshold was subjectively established in early permits issued to the Minnesota Zoo in 2013, and was designed to allow eggs to be collected only from relatively large populations. It is an estimated number based on survey data, in that at least 25 individuals can be regularly encountered within a day at the best and apparently most stable populations of Dakota skippers. Even if this threshold is met, however, only 10 females may then be used for egg collection from any single site. Each female may be held, using approved protocols, for up to 72 hours and those females must be cared for by trained staff. These parameters establish a minimum floor that excludes smaller and potentially less stable populations, and are meant to ensure that source populations are robust enough to not be substantively harmed by the removal of a limited number of eggs. When eggs from wild gravid females

are removed to controlled enemy-free *ex situ* conditions, eggs may be reared to larval or pupal stage at significantly higher survivorship rates than those expected in the wild.

The health of the temporarily held wild females is absolutely central to egg collection protocols. Female grass skippers (especially Dakota skippers) that have been returned to the habitats in which they were found within 48-72 hours of their removal have only very rarely shown signs of ill effects using current methods (Runquist, pers. comm.; Runquist 2012, Runquist 2013, Runquist and Nordmeyer 2014, Runquist and Nordmeyer 2015). Females are to be released under calm, cool weather conditions in the earlier morning and placed directly from their temporary holding vials onto a preferred nectar source (especially *Echinacea*, Table 1). This maximizes the likelihood that the females will resume normal behavior and “stay” in their original, and presumably preferred, habitat.

We expect egg removal from source sites to be minimal relative to the number of eggs that will be laid by females in the respective wild populations. The number of eggs removed from any single wild population of Dakota skipper may approach 300, but is likely to be less than 15% of all eggs that would be laid in the population. Female Dakota skippers may lay about 15-20 eggs per day (Runquist and Nordmeyer 2014, Runquist and Nordmeyer 2015) and maximum potential fecundity is “probably between 180 and 250 eggs” (Dana 1991). Female Dakota skippers held for a maximum of 72 hours may lay about 30 eggs for use in captive rearing – or about 16% of each female’s potential fecundity if we assume she might be able to produce 180 eggs under ideal conditions. As stated earlier, no females may be captured for egg collection unless at least 25 individuals are found within a 24-hour period. We assume that at least twelve females will be observed before any are captured if sex ratios are approximately 1:1. If we assume that ten females held for egg collection (as permitted), and that these ten are different from the 12 seen during the initial survey, there may be at least 22 females present at any site where egg collection takes place. If we conservatively assume an expected fecundity of 90 eggs per female– approximately half of the species’ assumed potential fecundity of 180 eggs – due to early death and other factors, total fecundity of these 22 females may be 1,980 eggs. If 300 eggs of these are removed for captive rearing (from the 10 held females), it would reduce total oviposition in the wild by about 15%. It is actually likely to be less than 15% because affected populations are likely to include more than 22 females and the number of females captured is likely to be lower than the maximum of ten that would be permitted – in 2014, for example, an average of six female Dakota skippers were captured for egg collection at five sites. If we alter the assumption that the ten females held for egg collection were different from the 12 observed during the initial survey and instead assume that all ten of the females held for egg collection were members of the initial 12 observed during the survey, then the total egg production of the population would be lowered to 1080 (12 females x 90 eggs/female), with a consequent change in the percentage of the population’s eggs collected rising to 27.8% (300/1080). Regardless of the total population size though, based on an estimated 3% survival from egg to adult in the wild (see below), each population would be reduced by about nine adults as a result of the permitted collection of 300 eggs.

Survival of *ex situ* reared Dakota skipper has been measured across four distinct stages: 1) neonate to larval diapause; 2) larvae during winter diapause; 3) larvae from end of diapause to pupation; and, 4) pupal stage to adult. In 2015, 82% of the 432 eggs collected in the wild developed and hatched. (Runquist and Nordmeyer 2015, p. 6). Combining wild-collected neonate caterpillars and those bred at the Zoo in 2015 (n=604), 40% eclosed as adults in 2016 (Table 2).



*Table 2- Survival of Dakota skippers during successive life stages at Minnesota Zoo, 2015-2016.*

Stage	Estimated Survival	Basis for Estimated Survival (Year/Period)	Cumulative Survival from Egg to End of Stage
Neonate to Larval Diapause	67%	2015	67%
Larval Diapause	77%	2015-2016	51%
Diapause to Pupation	80%	2016	41%
Pupation to adult	96%	2016	40%

Based on these results with the Dakota skipper, about 60% of the Dakota skippers that are collected as eggs may die before reaching adulthood. This level of mortality is likely much less than what Dakota skippers would likely experience in the wild. A wide variety of factors may kill butterflies during each life stage, including drowning or physical damage due to flooding; predation; ungulate herbivory; and, parasitoids (Benrey and Denno 1997; Borkin 2000; Severns *et al.* 2006, p. 368; Lambert 2011). Survival in the wild from egg to pupation of one rare butterfly, for example, was 3% based on a sample of 1,617 eggs (Lambert 2011, p. 110). Studies reviewed by Nail *et al.* (2015) predicted survival rate of monarchs (*Danaus plexippus*) from egg to adult was about 4.2 to 9%, but this is likely an overestimation of survivorship to adulthood since the pupal stage was raised in captivity and not exposed to some important mortality factors.

For the foreseeable future, we anticipate that no more than 900 Dakota skipper eggs will be collected in any single year; that is, 300 eggs/site from up to three sites per year. If the above mortality rates found for the Dakota skipper at the Minnesota Zoo occur, this would result in the production of about 360 Dakota skipper adults (but note, actual release is likely to occur during the pupal stage). In contrast, if we assume a 3% survival rate from egg to adult in the wild, only 27 Dakota skipper adults would be expected from these same eggs if left in the wild. Thus, if survivorship observed in other butterflies is transmissible to Dakota skippers, we anticipate our collection protocol to be minimally invasive while still having significantly higher survivorship than those in the wild.

### **Effects of Netting Wild Adults for *Ex Situ* Operations**

The act of hand-netting adults for egg collection incurs risks of sub-lethal, or lethal injuries (USFWS 2016). In 2015, 42 Dakota skippers were captured and no injuries were reported. The health of collected adults will continue be reported as outlined in USFWS permits.

It is unclear whether netting and releasing Dakota skippers could have significant adverse effects on post-release behavior and survival. In 2015 we began to collect information on behavior of Dakota skippers immediately after release. Data from 2015 is not conclusive, but do not suggest any significant effects to behavior of Dakota skippers related to netting and release (Table 3). It is assumed that post-release dispersal into atypical habitat (like into “Tall Shrubs or Trees”, below) or over long distances that prevent identification of perching substrate (“Flew Away” or “Unknown”, below) is detrimental in that individuals may land in areas that are not conducive to the health of the individual or the population. We

will continue to compile data on the initial post-release behavior of any Dakota skippers netted and released.

*Table 3 - Post release behavior of Dakota skippers captured and released in 2015. Surveyors were asked to report post-release behavior as: Flew to and perched on herbaceous vegetation, low shrubs, or to out-of-sight location in herbaceous vegetation.*

Source	Number Netted & Released	Post-Release Behavior					Comments
		Flew to Perch in Herbaceous Vegetation or Low Shrubs	Flew Into Tall Shrubs or Trees	Flew Away	Did Not Disperse	Unknown	
Stegeman (2016)	1	1	0	0	0	0	
Selby (2016)	13	2	0	11	0	0	Two that flew away first perched on the net and/or a finger.
E. Runquist, pers. comm. 2016	20	7	0	0	13	0	All individuals were released gently from vials directly onto <i>Echinacea</i> in the cool morning hours. Thirteen stayed directly on the <i>Echinacea</i> flower to nectar and did not fly away. The remaining 7 flew a short distance ( $\approx 10$ m) into grass or to another <i>Echinacea</i> .
C. Nordmeyer, Minnesota Zoo, pers. comm. 2016	7	0	0	2	3	1	All individuals were released gently from their tubes directly onto <i>Echinacea</i> . Three stayed on the <i>Echinacea</i> flowers; two flew away to an unknown location; one died before release that was "quite old" when captured, with faded ragged wings and a skinny abdomen. She did not lay any eggs in captivity and likely died of old age, not due to any causes directly related to handling.

## B. Ecological Risk

Ecological concerns associated with the Dakota skipper reintroduction program can be partitioned between 1) the source populations and 2) the site of reintroductions. First, as discussed above, removal of eggs from the source populations may diminish the health of the source populations if conducted in an unsustainable manner. The actual removal of the eggs (and therefore ultimately adults) from the source environment however is not thought to be substantially disruptive to general ecological process in the source environment. We will minimize the risk of diminished survival and reproduction by ensuring that state-of-the-art methods will be used throughout the *ex situ* process by the Minnesota Zoo.

Second, the ecological risk of reintroducing Dakota skippers into sites at which they are no longer present are also minimal. Dakota skippers presumably occupied the reintroduction site(s) for significant periods of time before their recent extirpation. Furthermore, stochastic events (such as large wildfires or

extreme weather events) likely extirpated Dakota skippers from historically occupied sites like the Greater HIM complex in the past, but the region could be re-colonized by dispersal from connected populations. The modern fragmentation of the suitable habitat precludes natural recolonization of the Greater HIM complex, and reintroduction is likely the only mechanism by which Dakota skippers will return to the area. The sites of origin and the reintroduction site also must necessarily be ecologically similar to each other for reintroduction efforts to be successful. Therefore, the likelihood that the individuals released or their progeny will have deleterious or undesirable effects on other species or ecosystem functions is likely discountable. However, reintroduction efforts may require some alterations to habitat management plans to promote the conditions Dakota skippers need, and those conditions may not necessarily be optimal for other species presently or potentially occupying the same habitat.

Bailey's Provinces reflect similarities in "vegetational macrofeatures" and climatic characteristics (Bailey 1995, p. 2). The vegetational macrofeatures used to distinguish the Provinces inhabited by the Dakota Skipper include the relative amounts of short-, mid-, and tallgrass prairie; and, the amount and relative dominance of forest and grassland. Climatic differences among provinces that are likely to be related to adaptations in the Dakota skipper include the degree of aridity; frequency of drought; and, variation in temperatures. Having similar ecological features with the sites of origin is likely to minimize the risk that survival and reproduction of released Dakota skippers will be lower due to their poor adaptation to the characteristics of the reintroduction site. The gg source and reintroduction sites are both in the same Bailey's Province (Figure 7).

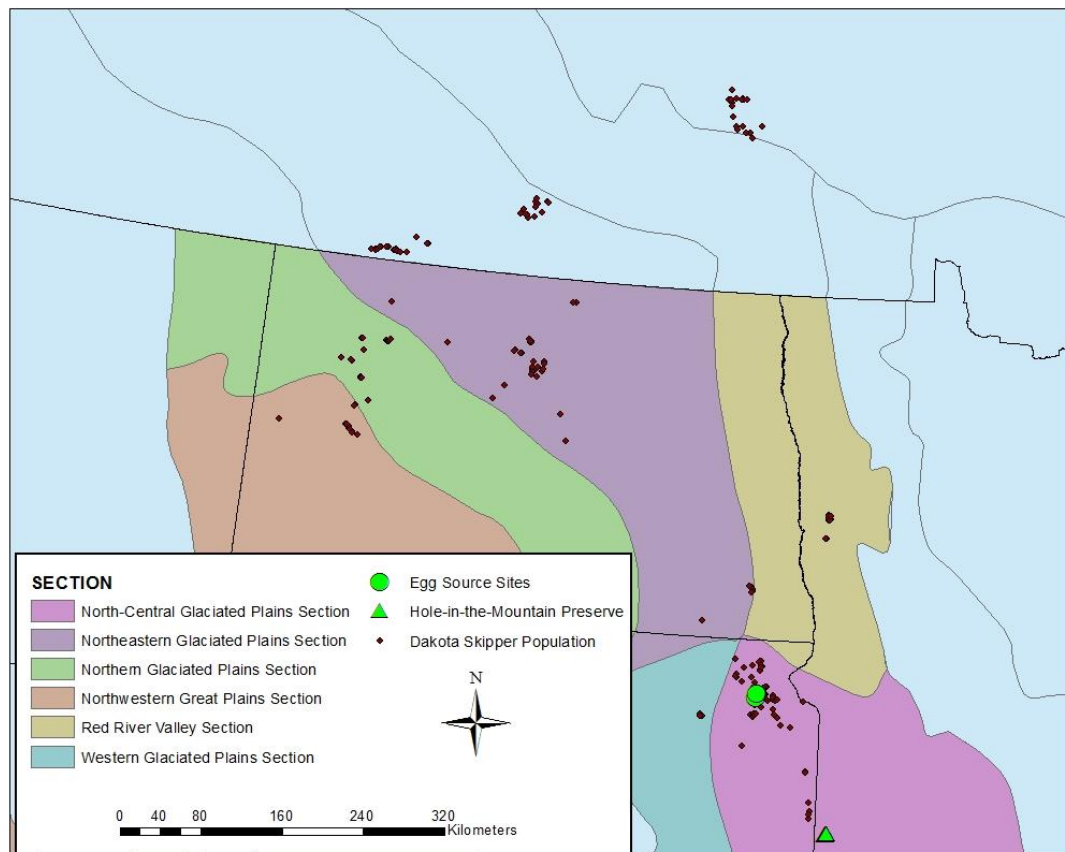


Figure 7 - The locations of the egg source sites (circle) and the reintroduction site (triangle), relative to Bailey's ecological Sections (Bailey 1995). The egg source sites and the reintroduction site are each in Bailey's North Central Glaciated Plains Section.

At an even finer level of resolution in the classification hierarchy, the source sites and reintroduction site may be separated into two subsections - the Outer Coteau des Prairie (northeast South Dakota) and the Northwest Iowa Plains (Hole-in-the-Mountain). Subsections are delineated primarily with the use of soil and surficial geology criteria (McNabb et al. 2007, p. 1). Primary nectar flowers and native grasses that skippers may use as larval foods appear similar between sites. Purple coneflower is the primary nectar species at both sites, where habitats fit the description of 'Type B' Dakota skipper habitat (Royer et al. 2008).

The Nature Conservancy owns and manages the reintroduction site and is an integral partner in the development of plans to carry out the proposed reintroduction. TNC has already provided key information to identify the portions of their Hole-in-the-Mountain Preserve where a primary nectar source, purple coneflower, is especially abundant. Moreover, TNC has prioritized the specific area where reintroduction is likely to occur for a burn in 2017 that would occur before the release and that is likely to further enhance its ability to support Dakota skippers. Prescribed burns are known to promote coneflower blooming (a known concentrator of Dakota skipper adults) and to reduce invasive plants.

TNC has indicated a willingness to cooperate on efforts to minimize stressors to the Dakota skipper. Fire management is likely to be a key issue. Partitioning the habitat into smaller areas so that only relatively small sections of habitat occupied by the skippers are burned at any one time, and rotating burn treatments across multiple years will likely be essential to ensure that the population is able to grow in spite of mortality in the burned areas. That is, that the level of mortality is offset by movement of Dakota skippers back into the burned area.

Another possible stressor to both source and reintroduced populations of the butterfly is the potential for drift of pesticides from nearby agricultural operations. Pesticides were detected in samples collected by the Minnesota Zoo at HIM in August 2016. This sampling occurred during the known aerial application season of insecticides to control soybean aphids, a severe invasive pest on adjacent agricultural fields. Grass and soil samples were collected from six points within the HIM preserve. Relatively low levels of the organophosphate insecticide, chlorpyrifos, were found at three of them (5.5, 9.2, and 13.5 parts per billion). These points were not clustered geographically within the preserve. No other insecticides were detected in any of the samples. This pattern of low levels of broadly scattered chlorpyrifos detection is comparable to concurrent observations at nearby Prairie Coteau SNA and other prairies farther north in August 2016 and also in prior years. Two pyrethroid insecticides, bifenthrin and lambda-cyhalothrin, that are also commonly applied against soybean aphids, have also been found in within federally designated Dakota skipper critical habitat in these surveys. Additional details are summarized in Runquist and Heimpel (2017). It is not known whether these levels - found on grass species used as larval food by the Dakota skipper - would harm the species. This uncertainty has resulted in recommendations to conduct insecticides exposure experiments with grass skipper larvae of common species to estimate the consequences of these exposures to wild skippers (Delphey *et al.* 2016, Runquist and Heimpel 2017). Agricultural land is nearby and the presence of the pesticides suggests the potential for drift to affect reintroduced Dakota skippers and any wild progeny. We may seek avenues to reduce the potential for drift by working cooperatively with nearby agricultural landowners. Minnesota Zoo staff will continue sampling and conducting pesticide residue analysis at the release site in both the early and late summer for the foreseeable future, with this data informing reintroduction plans and operations as appropriate. The initial release location within the Central Unit of HIM (Figure ) was selected partly on the basis of it being distant from agricultural edges and the presence of ridges that may act to shield specimen from pesticide drift on the prevailing winds.

### C. Disease risk

The motivation for the reintroduction program for Dakota skipper is to expand the global population of the species by reestablishing extirpated populations. Many factors have likely contributed to those extirpations, and those factors are expected to vary and interact differently at local levels. Habitat loss and fragmentation is likely the primary driver of population loss, but other intrinsic factors such as disease could have contributed. Viral, bacterial, or fungal diseases and parasites and parasitoids that are specific to Dakota skippers are not known. This lack of understanding of Lepidopteran pathogens is one of the key reasons it was decided to conduct releases at a known extirpated site. The risk of disease infection of Zoo-reared individuals cannot be fully precluded, but it can be minimized by through strict clean protocols and quarantine procedures. Any individual that appears to be in sub-optimal health will be removed from the release program and potentially euthanized if deemed necessary. Disease outbreaks in ex situ Lepidopteran programs often take the form of mass population mortality. In the event of unexplained mass population mortality of zoo-reared larvae the situation would be assessed and any releases would likely be forgone for that generation.

Beyond diseases associated with viral, bacterial, and fungal infections that may be mitigated by clean practices, infection from *Wolbachia* is a concern. It has been recommended that all Lepidopteran ex-situ programs consider *Wolbachia* (Hamm *et al.* 2014). This maternally-inherited intracellular bacteria is a common symbiont across insects (Hilgenboecker *et al.* 2008), including many imperiled Lepidoptera (Hamm *et al.* 2014). It can have significant impacts on population demographics if it is introduced to uninfected populations or if infected populations become infected with novel strains. These impacts can include killing of males, sterilization of males via cytoplasmic incompatibilities, feminization of males, parthenogenesis, or other effects (Werren *et al.* 2008).

As noted earlier, population genetics studies are underway by Dr. Emily Saarinen (New College of Florida) and Minnesota Zoo staff, and this work includes assays for the presence of *Wolbachia* in Dakota skippers from several key populations. If found to be present, a pattern of uniform infection within and across populations is expected for this formerly wide-ranging species. Such a pattern generally results from a historic infection that has stabilized and no longer presents a demographic risk to the population(s) (Hilgenboecker *et al.* 2008, Nice *et al.* 2009). *Wolbachia* infection status should not by itself be a constraint to translocate individuals or their genes between populations. For example, translocation is not considered problematic if all populations are uniformly infected with the same strain of *Wolbachia*. Ultimately, any *Wolbachia*-induced phenotypes in their host butterflies cannot be known without detailed experimental crosses. Until *Wolbachia* strain identification is completed with Dakota skipper egg collection sites, geographically distant populations will be treated as though they are incompatible. In the initial 2017 planned release at HIM, only specimens representing crosses or recently collected individuals from metapopulations in northeastern South Dakota will be released, to avoid these risks. If multiple *Wolbachia* strains are later identified across sites, rigorous, multiyear crosses would need to be conducted in the lab to determine if negative effects of those crosses exist. *Wolbachia* is also only one of several other microbes that are known to alter reproductive dynamics in arthropods (Duron *et al.* 2008). The status of these organisms in Dakota skippers is unknown, and protocols to isolate and identify them are not well established as they are with *Wolbachia*. Given the isolation of HIM from other known Dakota skipper sites, there is reduced risk of reintroduced Dakota skippers having a negative effect on known extant populations if *Wolbachia* infection status or strains were to differ.

#### D. Associated invasion risk

With any reintroduction, care should be taken to ensure that potentially invasive species are not accidentally released, along with the focal species. The small number of Dakota skipper larvae or pupae that may be released requires that only small containers holding each individual be brought into the field. Any live plant material associated with releases would be only be native to the site, so that even if some were to be accidentally introduced to a site it would already be a constituent species of the site.

#### E. Gene escape and population genetic consequences

“Gene escape” refers to the potentially negative consequences of mixing historically isolated populations, or of hybridization with closely related species or subspecies. There are other grass skipper species that would be sympatric and synchronic with Dakota skippers at HIM. Long Dash (*Polites mystic*) and tawny-edged skipper (*P. themistocles*) are likely two of the closest living relatives of Dakota skipper that still occur at the site and have overlapping flight periods. The congeneric Ottoo skipper (*Hesperia ottoo*), once occurred at HIM but is now likely extirpated as well. There is no evidence that Dakota skippers can hybridize with any other skipper species. It should also be noted that Dakota skippers only became extirpated from the site relatively recently. Reintroducing Dakota skippers back to HIM is expected to have no negative genetic impacts on related species.

Other population genetic consequences, however, may be relevant to this planned Dakota skipper reintroduction. A central consideration of any *ex situ* program in which partial or complete generations are maintained under artificial conditions is the selection of phenotypes that are maladaptive under *in situ* conditions. This can have significantly negative consequences for any augmentation or translocation program by reducing the viability of the destination populations (e.g. Nichols and Pullin 2000; Crone *et al.* 2007). Captivity may also reduce the apparency of the accumulation of these negative effects, and these effects compound the longer individuals and generations are reared under captive conditions (Joron and Brakefield 2003). Rearing practices at the Minnesota Zoo have been developed to mitigate artificial selection of captive Dakota skipper stock. Larvae are reared *ex situ* using methods that mimic “wild” conditions to the greatest extent as is possible (i.e. outside under regular temperature ranges, on potted host grasses), while still protecting them from most dangers. Once releases begin, no lineage of Dakota skippers will be kept in captivity for more than three generations as adopted from the Oregon Zoo’s Taylor’s Checkerspot protocol (Lewis, 2014 pers. comm.). Releases will comprise both Zoo-bred individuals and head-started individuals (collected as eggs the year before). Zoo-reared adults are measured (under anesthesia, while being individual marked for breeding cages) and their morphometrics are compared to wild-collected museum specimens (wing length and width). If wing aspect ratio, or other physical characteristics appear distorted among a particular lineage at the Zoo, those lines would be barred from release.

#### F. Socio-economic risks

The reintroduction of Dakota skippers back to suitable habitat is unlikely to have any direct effects on people and livelihoods, as there are no currently known direct negative impacts. However, there may be some perceived danger of increased regulations by releasing a threatened species back into the wild, particularly if we begin reintroductions to sites where the Dakota skipper is currently extirpated. Dakota skippers do not persist outside of high quality native prairie habitat, and are not expected to disperse into suboptimal habitat. For example, Dakota skippers would not inhabit cropland or non-native hayfields (e.g., alfalfa fields) and a special rule exempts any take of the Dakota skipper that would occur as part of



routine livestock ranching activities. The current reintroduction would directly affect only a single landowner - The Nature Conservancy – which has expressed support for the species’ conservation on the site. Additionally, we do not anticipate any indirect harm (e.g., actions that could threaten ecosystem services) through our work at these Dakota skipper sites. The only indirect ecological effect that we anticipate is some light trampling of habitat while capturing and releasing Dakota skippers. Care will be used to minimize damage by training all individuals conducting field work.

In addition to direct and indirect effects of the reintroduction itself, there may be some persons who disagree with the conservation benefits of removing Dakota skippers from source sites for *ex situ* management. The current source site landowners have been part of ongoing discussions regarding the *ex situ* programs and have so far been supportive of conservation efforts. Landowners of areas that may be considered in future years will be engaged early in future discussions. In order to ensure continued support and to address any future concerns of interested parties, we will put into place the communication and outreach plans highlighted in the “Social feasibility” section of this document. These efforts will also improve our understanding of public perceptions, and provide a venue to address concerns (see Section X.F).

## G. Financial risks

The Minnesota Zoo’s Prairie Butterfly Conservation Program is currently exclusively supported by a collection of short-term grants from various federal, state, nonprofit, and private sources that provide all of the Program’s routine staff payroll and operational costs. The primary funding source has been Minnesota’s Environment and Natural Resources Trust Fund (ENRTF), as recommended by the Legislative-Citizen Commission on Minnesota Resources. Key support has been also provided through grants to the Zoo from the Minnesota’s Legacy Amendment Arts and Cultural Heritage Fund, and through interagency Cooperative Agreement Grants with the U.S. Fish and Wildlife Service. The Minnesota Zoo provides office and facilities space, and covers administrative, maintenance, and utilities costs. This relative independence from the Zoo’s general operating budget provides a buffer against fluctuations in the Zoo’s budget, but also provides uncertainty in the long-term. The grants currently held have varying expiration dates between 2017 and 2019. Institutionally, the Minnesota Zoo administration is supportive of the Program as it matches the Zoo’s mission “to connect people, animals, and the natural world to save wildlife”. Perhaps the biggest hurdle to the long term expansion of the Prairie Butterfly Conservation Program is sufficiently trained full-time staffing, particularly during the high-intensity summer months when husbandry operations at the Minnesota Zoo are simultaneous with the flights of Dakota skippers, Poweshiek skipperlings, and other species of interest. The ENRTF, Service, and Legacy funds have and will continue (at least in the short-term) to pay for summer seasonal staff.

The U.S. Fish and Wildlife Service’s Twin Cities Ecological Services Field Office (TCFO)<sup>1</sup> allocated funds that are used to support salaries of Service personnel to plan and coordinate captive rearing activities; ensure regulatory compliance with provisions of the Endangered Species Act and with Service policies; and, to assist with field activities, as needed. If the use of TCFO-allocated funds to support staff time on this project no longer occurs, it would be difficult to carry out the program in a manner necessary to meet project objectives. The amount of funds allocated to TCFO may vary from year to year and their use is at the discretion of the TCFO project leader. Therefore, a significant reduction in funds allocated to TCFO or a change in priorities of the project leader could have a significant adverse effect on the likelihood of project success. Neither of these, however, seems likely at this time.

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<sup>1</sup> Recently renamed the Minnesota/Wisconsin Ecological Services Field Office.

A critical component of the plan is routine and standardized quantitative surveys for adult Dakota skippers at the reintroduction site (section X.A), both the summer(s) of release(s), and in the years following cessation of any reintroductions. Evaluation of program success depends on rigorously collected data over multiple years. Unfortunately, there are few trained personnel with the necessary skills to accurately identify Dakota skippers in the wild. This personnel deficit poses an annual risk that surveyors cannot be secured during the flight. Contracted surveys for Dakota skippers are often costly, particularly given the current competition for the same surveyors from fossil fuel companies in North Dakota. Agencies like the Service, Minnesota DNR, and the Minnesota Zoo that are charged with successful implementation and monitoring of the Dakota reintroduction program almost exclusively bear this financial and personnel burden.

## H. Risks of inaction

Given the poor dispersal ability of Dakota skippers (Dana, 1991), emigration to an extirpated site from any of the extant sites is improbable. Even if all anthropomorphic causes for a site's extirpation have been mediated, local natural disasters still risk the remaining small populations. If no action is taken, we risk the continued loss of Dakota skipper metapopulations with no ability to reestablish the species in suitable habitats. In short, we would be foregoing the benefits of the proposed program that are described in the section, Reintroduction Justification, above. There are also risks of waiting too long to attempt *ex situ* operations. If wild populations fall to critically low levels, as is currently the case with Poweshiek skipperling for example, there may be too few individuals remaining to launch effective *ex situ* conservation programs. Acting now with Dakota skippers will help buffer that risk, and will also build institutional knowledge of how *ex situ* and reintroduction programs should be conducted.

## IX. Release and Implementation

### A. Selecting Collection Sites

As stated above, Dakota skipper populations on Sisseton Wahpeton Oyate lands in northeast South Dakota are best suited for reintroductions to the Hole-in-the-Mountain Preserve. They are the current source of the majority of the Minnesota Zoo's current Dakota skipper *ex situ* insurance population, are from ecologically similar habitats, and are most likely least genetically divergent from the now extinct populations in the Hole-in-the-Mountain region. Collection protocols have been set in place to be as minimally invasive as possible. Only sites that appear to have robust Dakota skipper populations have been targeted for egg collection to date, and this is reflected in the permitted egg collection protocols (see section VII.A above.). Ongoing genetic analysis will help identify genetically distinct populations. In the future, these distinct populations may warrant higher priority for collection site selection. Collection sites are also determined based on landowner permissions and other project logistics.

### B. Collections and *Ex situ* Rearing

The collection of eggs from wild Dakota skipper females and the consequent rearing of progeny at the Minnesota Zoo (sometimes for a generation or more) until reintroduction will be performed in accordance with all permitted protocols and in a manner that prioritizes the welfare of each individual. Full protocols are discussed in the Minnesota Zoo's Hesperiid Husbandry Manual and in prior annual reports to the USFWS (available upon request).

## C. Selecting Release Sites

### Site identification

Only Minnesota sites are being considered for reintroduction at this time. Although the source populations for this reintroduction effort are from within the Lake Traverse Reservation in northeastern South Dakota, reintroductions back into extirpated locations in Minnesota are prioritized, for several reasons. First, Dakota skippers formerly occurred in dozens of prairies across Minnesota, but only one predictable population is currently known statewide. Re-establishing populations in Minnesota will advance recovery of the species by expanding the range of extant populations to buffer against losses in regionally clustered populations and metapopulations that are impacted by common phenomena. For example, a local drought in northeast South Dakota may negatively impact the entire cluster of Dakota skipper populations in that region, but may not occur in Minnesota.

Second, prairies in Minnesota are prioritized at this time because they have generally have better recent survey history, which has produced a better understanding of the current status of Dakota skipper occupancy. Outside of Minnesota, the best surveyed areas are in northeastern South Dakota, but the prevalence of extant subpopulations in this area reduce conservation needs and potential gains. Indeed, a central consideration is the potential for extant Dakota skippers at or within dispersal distance of a site. If there is not a history of multiple negative surveys at a site and at adjacent suitable habitat, it remains possible that Dakota skippers are not actually extirpated from that site and/or from adjacent suitable habitat. Sites where Dakota skipper extirpation is highly likely are much stronger candidates for reintroduction, at least in the near term, so that the gene pools of any extant are not altered by the introduction of non-natal genotypes (assuming doing so would be detrimental, see Sections VII.A. and VIII.C.).

Third, sites where Dakota skippers were once common but have apparently been extirpated from in North Dakota and Iowa are located in different ecoregions than where Dakota skippers in the Minnesota Zoo's current *ex situ* population have been derived from. These individuals may be less adapted to conditions in other ecoregions (as well as the 'Type A' vs. 'Type B' habitats discussed earlier).

Finally, logistical and financial operations are situated in Minnesota. The majority of the Minnesota Zoo's Prairie Butterfly Conservation Program operational budget is funded by grants from the State of Minnesota, and those resources need to be expended in Minnesota. Minnesota also possesses a strong network of partners at federal, state, and local levels that are prepared to support this reintroduction effort, and these have not been as well established in other states.

We drafted seven criteria and a scoring system to rank candidate reintroduction sites in Minnesota that could begin as early as 2017. All of these sites historically had Dakota skippers (Appendix A). These criteria are designed to incorporate biological needs and social necessities, and include the following:

1. The status of the Dakota skipper at the site and in suitable habitat within two kilometers of the site
2. The extent of landowner approval for the reintroduction effort
3. The potential for public controversy from adjacent landowners
4. The extent of unplowed prairie
5. The quality of habitat
6. Assurance of appropriate habitat management at the site
7. Distance from row crop agriculture

Based on these metrics, The Nature Conservancy's Hole-in-the-Mountain Preserve in southwest Minnesota ranks most highly (Table 4). Sites like Glacial Lakes State Park, Chippewa Prairie, and Bluestem Prairie where Dakota skippers may still be present, either within those sites or nearby, are weaker candidates for releases until concerted surveys indicate that Dakota skippers are likely extinct in those areas. A significant additional positive to performing the first reintroductions in the TNC Hole-in-the-Mountain Preserve is the possibility for colonization of bordering suitable habitats managed by the Minnesota DNR: the Hole-in-the-Mountain Wildlife Management Area (WMA) and the Altona WMA. Both of these WMAs had historically significant Dakota skipper populations, and the colonization of these WMAs by reintroduced individuals could eventually re-establish a functional metapopulation in the Greater Hole-in-the-Mountain Complex.

*Table 4 - Rankings of six candidate prairie remnants for Dakota skipper reintroduction. Scoring schema are described in Appendix A. Higher scores indicate higher suitability for reintroduction efforts. Scoring was completed by Erik Runquist (Minnesota Zoo) and Robert Dana (Minnesota DNR).*

	Hole in the Mountain TNC	Glacial Lakes State Park	Prairie Coteau SNA	Tympanuchus WMA	Chippewa Prairie TNC	Bluestem Prairie SNA
Dakota skipper status within 2km	1	-1	1	1	-1	-1
Habitat extent	1	2	0	0	2	0
Habitat quality	2	1	2	1	1	1
Landowner approval	1	0	-1	0	0	-1
Potential for public controversy	0	0	0	0	0	0
Assurance of appropriate management	1	0	-1	-1	-1	-1
Distance from row-crop ag	-1	0	-1	-1	-1	-1
Totals:	5	2	0	0	0	-3

### Release site selection within the TNC Hole-in-the-Mountain Preserve

The Nature Conservancy's Hole-in-the-Mountain preserve is divided into multiple management units with varying sections of habitat quality and historic Dakota skipper occupancy (Cross Unit, Triangle Unit, Central Unit, East Unit, South Unit and Southwest Unit). Additionally, adjacent to the HIM TNC owned land are two DNR Wildlife Management Areas, Hole-in-the-Mountain WMA and Altona WMA. It is the goal of this program that all high quality habitat patches within the above described locations are eventually occupied by Dakota skippers as a functional metapopulation. Given the current number of

Dakota skipper larvae at the Minnesota Zoo (Section IX.E.), only a single release location within TNC's HIM preserve will initially be utilized.

In order to facilitate contact between eclosing adult Dakota skippers, all pupa releases will be in a condensed central area (< 50m<sup>2</sup>). Initial releases within the HIM preserve will take place in the TNC-designated Central Unit (Figure ). This release area was chosen based on its high habitat quality designation, density of purple coneflowers and proximity to other high quality patches. Other criteria for this location included its proximate distance from the nearest agricultural borders. The topography of the site may act as a barrier from pesticide drift, as well as cater to Dakota skipper's propensity for 'hill topping.' Initially, a location in the northwestern border had been identified. It was believed that the forest edge may also act a barrier from pesticide drift while simultaneously corralling adults together to facilitate 'stay time.' The northwestern portion was later rejected as the initial reintroduction location due to at least one known past spraying for periodic population outbreaks of forest tent caterpillars (*Malacosoma disstria*) in the mid-2000s. The chosen location is also removed from planned 2017 controlled burns, but close enough to expect released individuals to possibly disperse into them and benefit from the burn effects.

Future releases will also aim to be in small condensed areas, but the location within the Central Unit may change. Survey efforts will inform where these releases take place and may shift to locations with greater adult skipper abundance. Releases into the other TNC units and adjacent WMAs will be evaluated annually. Criteria will be based on post-release dispersal data, habitat quality and captive breeding success.

#### D. Release strategy

##### Life stage – Pupa

Generally, only Dakota skipper pupae will be released during reintroduction efforts. Releasing adults involves more risk due to their fragile bodies and short reproductive lives, particularly given the long 3+ hour drive from the Minnesota Zoo to the HIM. Additionally, critical timing of life history events may be missed by waiting to transport and conduct releases after individuals become adults. Evidence from zoo-reared individuals at the Minnesota Zoo suggest that there is a short critical period for females to mate after eclosing. The likelihood of a female accepting male advances has shown to decrease over time and females typically begin laying eggs after 3 days whether they've mated or not. Typically, females become unreceptive to male mating advances once egg laying begins. It is unknown if this same behavior is also exhibited *in situ*, but barring more field data, raises a serious concerns as to risk any delay in getting eclosed skippers in to the field.

Releasing pupae allows for 1) the Minnesota Zoo to maintain individuals under safe *ex situ* conditions for as long as possible to maximize survivorship, 2) transportation to the release site with negligible stress to the individual, 3) placement of individuals into the best possible locations in the reintroduction habitat for those individuals (adults may disperse erratically if released in a stressful manner), 4) the determination of the sex of every individual released, and 5) the phenological and circadian timing adjustment of individuals to key biological and microclimatic triggers at the reintroduction site for optimal adult skipper emergence. Releasing larvae would generally be avoided due to 1) an incomplete understanding of larval host plants, and 2) increased *in situ* risks to the survivorship of the individual due to exposure to predators and parasitoids and/or extreme weather events.



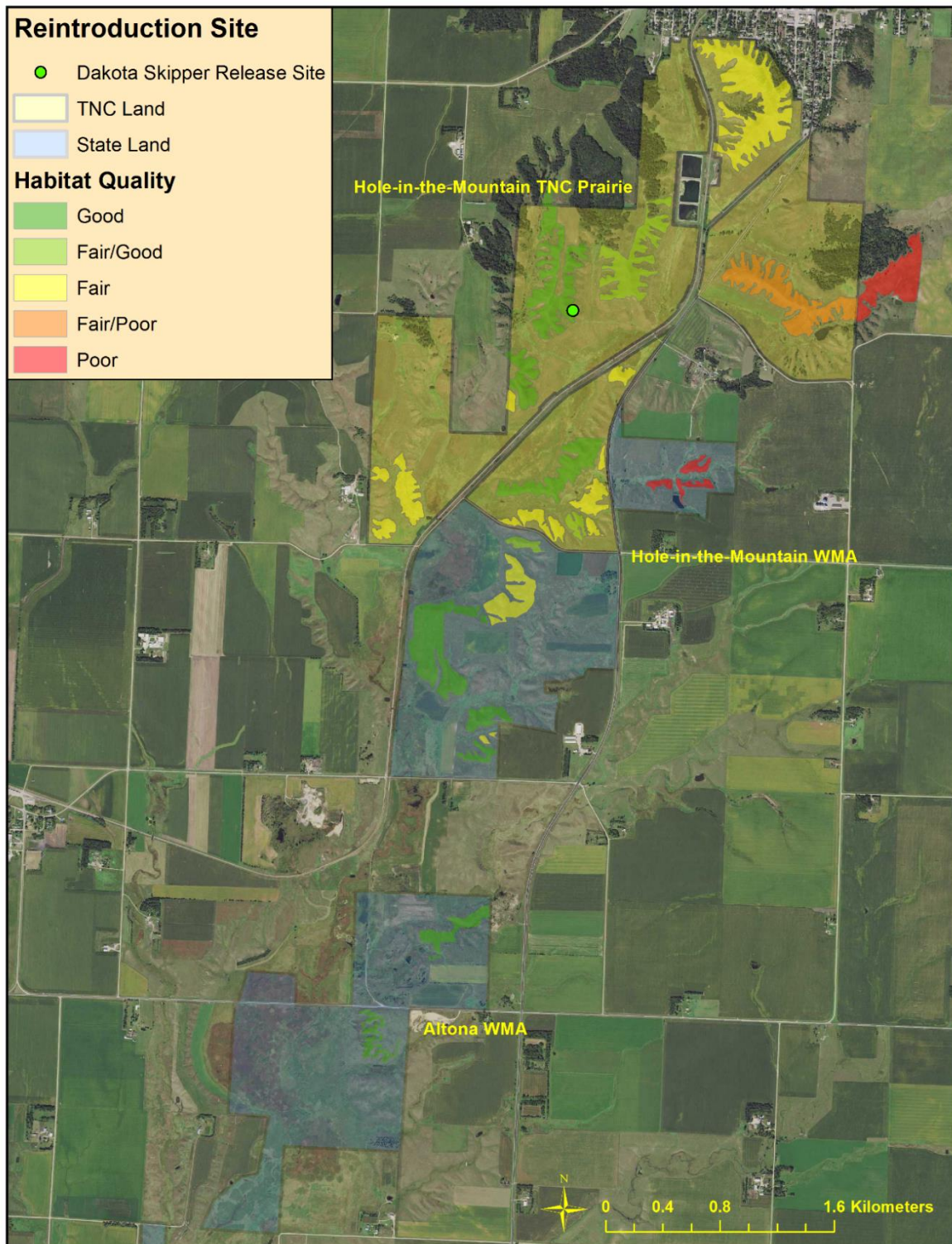


Figure 8— The greater Hole-in-the-Mountain Complex in Lincoln and Pipestone Counties, Minnesota, with habitat quality assessments from Dana (2015, unpublished) overlaid by TNC Preserve and Wildlife Management Areas (WMA) boundaries. The identified initial release site within the 'Central Unit' of the TNC Preserve is indicated by a green dot.



## Release Technique

We have identified four different potential release techniques (Table 5). Each technique has pros and cons and the decisions regarding which technique to implement will be largely contingent on available survey staff. Currently, the Dakota skipper working group has identified utilizing a “closed box” which should offer the greatest amount of security to pupa brought to HIM. For the closed box technique, pupa will be housed in a sealed closed box in the center of the release site (Figure 8). The box will be checked multiple times per day to release eclosed adults beginning no later than 8:00 am. A concern with the closed box is that the box itself may be an attractant and utilized as a perch; artificially attracting or concentrating local birds. The box itself would exclude predation of pupae, or newly eclosed adults prior to releasing them. However, there is a high probability that released Dakota skippers will concentrate around the release box. It is not our goal to eliminate all the potential predatory threats, but we do want to maximize success of the released individuals. After the release box is installed, but before the first skippers eclose, we will evaluate whether the box is being heavily utilized as a perch and decide if some kind of deterrent (i.e. scarecrow) is warranted.

Annual reports will include descriptions of the implemented release methods used and any logistical modifications (Section X.G). If release strategies change, the relevant sites plans will also be revised.

*Table 5 - Potential Release Strategies*

Release technique	Description	Pros	Cons
<b>Closed box</b>	Pupae are kept in a hopper-esque box on a post that is stationed at the release site. The hopper-esque box would offer full protection from predators/parasitoids and be shielded from rain. The sides are constructed with fine mesh to allow airflow, but prevent escape of the butterflies.	-Offers full protection until release -Allows us to obtain complete census data	-Requires producing a specialized box. -Requires daily (+) monitoring. - Could become a perch for prairie birds
<b>Open box</b>	Pupae are kept in a hopper-esque box on a post that is stationed at the release site. The hopper-esque box would offer some protection from ground predators and shielded from rain. The sides are constructed with wire mesh with gauge so that adult butterflies can escape once they have eclosed (~1”).	-Requires less monitoring than a closed box -Offers limited protection -Allows us to census exuviae	-Requires producing a specialized box -Would not completely shield pupa from predators -Could become a perch for prairie birds
<b>Direct release with open barrier</b>	Pupae are placed directly into the base of host bunchgrass. The grass itself would be surrounded by mesh cylinder of Lumite screen that is open on top.	-Offers more protection from predators or extreme weather than direct release -Requires no additional personnel post-release -More ‘natural’ condition than either box strategy	-Only mitigates predation by ground predators like mice. Could allow avian predators to form a search image. -May not allow us to accurately census exuviae if they degrade
<b>Direct release</b>	Pupae are placed directly into the base of host bunchgrass.	-Requires no additional hardware or personnel post-release -May provide the most ‘natural’ condition experienced	-Offers no protection for released pupa -Least opportunity to accurately census exuviae

## E. Disposition of excess progeny

Only a portion of the Minnesota Zoo's standing *ex situ* Dakota skipper population would be used for the reintroduction each year. Roughly 150 individuals will be retained each year as part of the Minnesota Zoo's breeding stock. Any and all remaining individuals could be used for release, unless otherwise determined by the working group. As described in Section IX.E, no individuals will be retained at the Minnesota Zoo's breeding colony for more than three generations. These individuals would be prioritized for release, unless those individuals display atypical characteristics (morphological, behavioral, etc.) that may be maladaptive in wild populations, in which case they would be phased out of the Zoo-breeding and reintroduction programs.

Other individuals would be excluded from the Zoo-rearing program and the reintroduction program if they were suspected to be carrying a disease or parasite/parasitoid. Any such individuals would be either destroyed to prevent pathogen transfer or preserved for additional study, in accordance with protocols outlined in the Minnesota Zoo's Section 10(A)(1)(a) permit.

We anticipate some pupation time variance within the Zoo's population. Some of this variance may be due to individual genetic differences and/or developmental responses to different husbandry techniques. On average, within past Minnesota Zoo-reared Dakota skippers, females pupate 3-4 days later than males. This phenomenon was also observed by Dana (1991). To ensure the released population is diverse and captures both males and females, at least two separate release events to HIM will take place one week apart. All individuals will be confidently sexed prior to release through examination of pupal abdominal morphology under a dissecting microscope using established protocols.

We will strive to represent at least 20 distinct lineages during each year of releases, with no one lineage representing > 10% of the released population. Both multi-generational Zoo-bred lineages and newly collected individuals will be released. The longest Zoo-bred lineages at the Minnesota Zoo will be prioritized for release. The purpose of this is to mitigate the possibility of artificial selection while in Zoo care.

### Release Size

No minimum number of individuals for release at a single site has been identified. Persistence at the release site is unlikely if there are too few individuals to come in contact with each other and mate, or the released population is not genetically diverse enough. Currently, a target of 150-250+ individuals for the initial release would be ideal and within the scope of the Minnesota Zoo's breeding program. This metric is derived from the successful reintroduction of the large blue, *Maculinea arion*, into the UK (Thomas 2009).

## X. Monitoring and continuing management

### A. Demographic performance

Each reintroduction site should be monitored yearly during the adult flight period following reintroduction. Several methods for monitoring rare butterflies exist, but biological and financial tradeoffs exist between methods (Haddad et al 2008). For example, mark-recapture methods are powerful, providing detailed information on both population size and demographic parameters, but mark-recapture may be harmful to rare butterflies (particularly small, muscular species like skippers) if not done with extreme care. Mark-recapture is also significantly more time-intensive to conduct than Pollard-Yates

transects. The occurrence and distribution of adult Dakota skippers are the primary parameters of interest for the Dakota skipper reintroduction. Therefore, transect-based methods will be employed, at least initially. Distance sampling (Brown and Boyce 1998, Buckland *et al.* 2000) would allow for estimates of population density and detection probability. For example, models developed by Zonneveld *et al.* (2003) can describe peak counts as low as five individuals. INsect Count Analyzer (INCA), is a freely available user-friendly software program analyze transect counts using the Zonneveld model (Bruggeman and Zonneveld 2002; Longcore *et al.* 2003).

Observers will visit extant sites in the weeks leading up to the predicted adult flight to determine the start of the flight period. This will involve surveys starting approximately in mid- to late June through mid-July, depending on initial flight date.

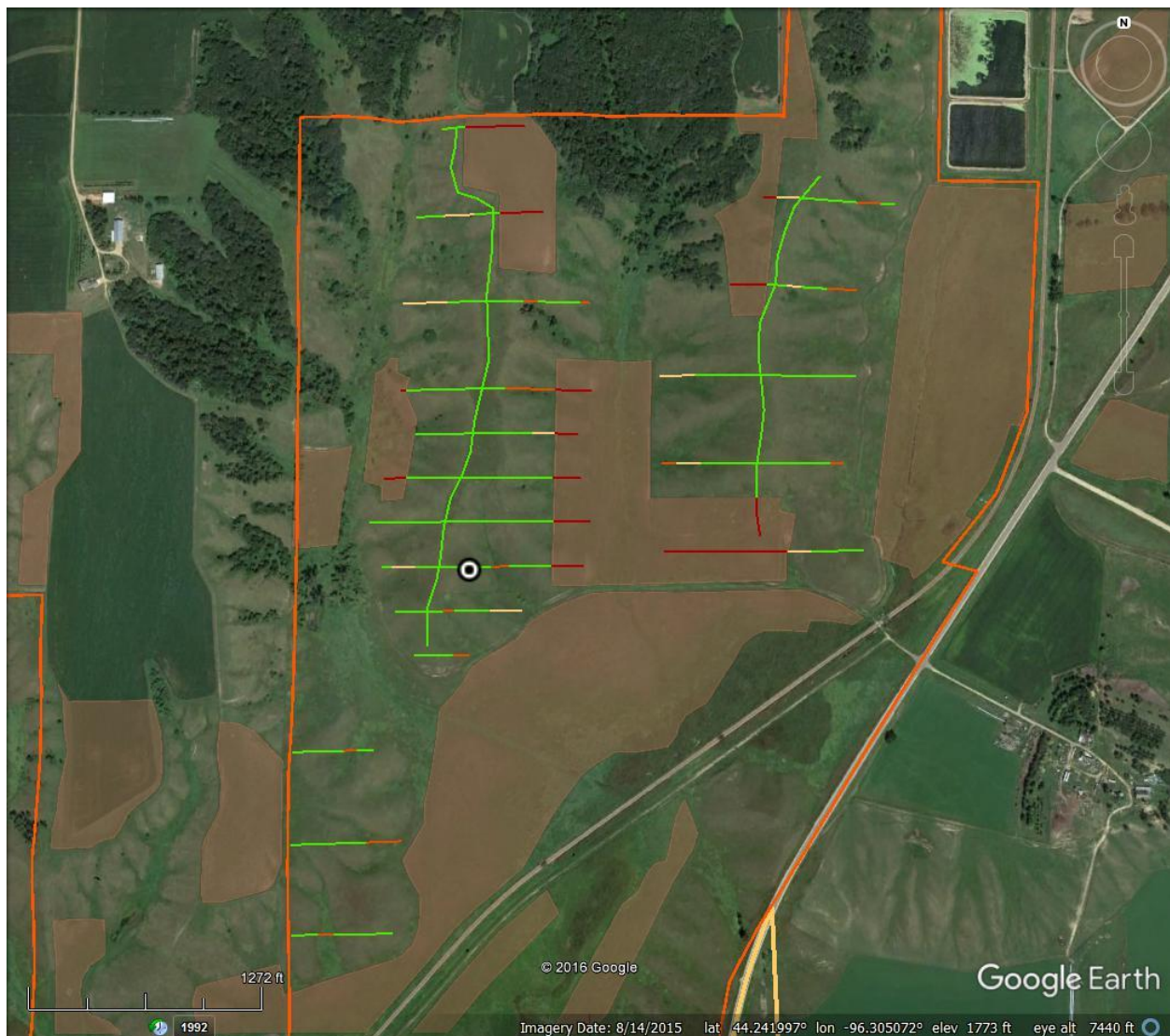
#### **Adult Monitoring Study Design:**

The proposed 2017 release site(s) is located at the southern end of the northwestern-most ridge of the Central Unit of TNC's HIM Preserve (Figure 8). We delineated 'available habitat' in the Central Unit based on uplands approximated from satellite imagery (Google Earth) and cross-checked with Robert Dana's habitat characterizations. We buffered these upland regions by 25 m (upslope) to eliminate areas of less suitable habitat near the bottomlands.

We hypothesized that Dakota skippers have a very low dispersal ability (rarely more than a few hundred meters). Thus, to more efficiently allocate sampling effort, we stratified the Central Unit into high- and low-density sampling zones based on proximity to the release site. The high-density zone encompasses available habitat within ~250 m of the release site, and the low-density strata includes all remaining available habitat in the sampling habitat.

In the Central Unit, most sampling for Dakota skippers will be conducted along fixed transects oriented in a general east-west direction (Figure 9). Transects in the high- and low-density strata are systematically spaced at 75 m and 150 m intervals, respectively. In Figure 9, the upland transects that had been estimated through aerial imagery are color-coded based on likely habitat quality an incorporation historic land use patterns (e.g. tilling) In addition, we will sample from a single, ad hoc transect along the primary ridgeline of each delineated upland. These complementary transects will improve our understanding of dispersal and inform future monitoring efforts. East-west transects in the Central Unit total ~5.0 km, and ridge transects total ~1.5 km. The exact positions of each transect will not be determined until ground-truthing can be completed in late spring 2017 to maximize sampling efficiency.

Similar delineation will be made of available habitat in several peripheral sites (the Cross Unit, South Unit, and West Unit in TNC's HIM property and the southern unit of the HIM WMA). Although we do not anticipate that Dakota skippers released in the Central Unit will disperse to these sites, these surveys will serve to provide baseline data to inform future monitoring efforts and assess current species richness. These transects may be less formal, potentially consisting of semi-fixed meandering routes.



*Figure 9 – Monitoring transects in the Central Unit of the TNC Hole-in-the-Mountain Preserve. Transects are coded by habitat quality (green = good; yellow = poor; orange = non-habitat; red = formerly cultivated land). Formerly cultivated land under restoration is indicated with brown polygons, and is presumed to not be suitable habitat. Habitat quality assessments and cultivation history is provided by Robert Dana (unpublished). The approximate location of the proposed release site is indicated by a white and black dot. All transect locations are approximate and will be refined in 2017 prior to the reintroduction.*

Monitoring of adult abundance and dispersal will commence on the first day after pupae are established on site and continue for two to three weeks after the second wave of pupae are established to encompass as much of the flight as possible. Surveys will be conducted daily in the Central Unit during hours of peak butterfly activity. Sampling at the peripheral sites identified above will be completed on a rotational basis, such that one peripheral site is visited per day. This schedule will ensure that peripheral sites are revisited once every four days (conditions permitting), while enabling us to focus our efforts in the Central Unit release site. However, we anticipate that sampling will actually occur less frequently than planned due to inclement weather.

Surveyors will sample from transects at a slow, consistent pace. All Dakota skippers sighted in front of the observer will be recorded while on-transect, unless the observer is confident that an individual was sighted previously. Surveyors may deviate from transects to verify identity and to GPS observed Dakota skipper locations. Surveyors must be able to rapidly identify Dakota skippers visually from up to 10 - 15 meters. The ability to differentiate Dakota skippers from sympatric skippers is critical. Surveyors need to be physically fit and able to spend long hours hiking in hilly, uneven terrain in potentially difficult weather conditions for multiple consecutive days.

After at least five years of stable or increasing Dakota skipper relative abundance or abundance at a particular location, we will suspend augmentations at HIM and consider the population to be contingently self-sustaining. Annual monitoring to track trends will continue for at least five more years. If annual monitoring indicates that the species is not establishing self-sustaining populations at HIM, we will review the potential causes and consider the resumption of augmentations. Short of marking all individuals that are released each year or only releasing mated females (both of which would require a shift in methods to release adults and not pupae), there is no definitive means of identifying whether or not an adult Dakota skipper observed at HIM is the product of *in situ* breeding from individuals reintroduced the prior year or if it was an individual released that year. Presumably though, individuals that are observed in areas where they were not reintroduced to (at least separated by large swaths of unsuitable habitat, or the persistence of individuals in areas where reintroductions had occurred but had been ceased, would be indications of successful reintroduction efforts. The intensive transect monitoring scheme that has been developed will help determine dispersal patterns away from the reintroduction point, and therefore produce a landscape model of where individuals may disperse into in future years. Assays of genomic relatedness of both released and wild adults could also conceivably be conducted, but personnel and financial shortfalls, a lack of known informative genetic markers, and increased risk of severe harm to individuals preclude this technique.

## B. Behavioral monitoring

While monitoring the behavior of reintroduced animals is important, its value depends on comparative data from other natural populations (IUCN/SSC 2013). This comparison would be difficult, given the present lack of data. Every effort will be made to assess adult behaviors at extant sites. This may include recording numbers of adults nectaring, perching, flying, chasing, ovipositing, and mating (e.g., Monfils and Cuthrell, 2014). This data set can be used as baseline information to help determine what set of behavioral characteristics should be represented in the reintroduced population and if there are any impacts to source populations from the egg collection efforts. However, since many of these behaviors are weather and micro-climate influenced, departures from the “norm” will need to be interpreted carefully.

## C. Ecological monitoring

We currently do not foresee any negative ecological impacts due to the implementation of this plan. After the initial reintroduction in 2017, we plan annual releases under this plan. The intended demographic targets for augmentations are not expected to increase the abundance or densities of local populations of the species past its historical levels.



## D. Genetic monitoring

In addition to the population genetics research described above (Sections VI.A., VII.C., and VII.E.), and in the release strategy (Section VIII.D.), detailed lineage data of the Minnesota Zoo's entire population (and therefore all individuals ultimately selected for the reintroduction program), will be closely maintained. Explicit genetic comparisons between individuals in the Zoo's population are not currently possible until microsatellite or other next generation genetic data is extracted from representative individuals in the Zoo's population. As such, lineages at the Zoo are ultimately tied back to the wild founder female(s) from which eggs were first collected from (which can range from one to three generations removed). Each of these wild maternal lineages are presumed to be distinct from each other. As stated previously, morphometric characters of Zoo-reared adults will be compared to historic museum specimens to test for deviations away from wild type characters that may indicate potentially maladaptive effects of rearing under controlled conditions.

## E. Health and mortality monitoring

Individualistic and quarantined rearing of immature Dakota skippers provides the opportunity to monitor the health of every individual under *ex situ* care. However, short lifespans of Dakota skipper adults, and the inability to find eggs, larvae, and pupae under natural conditions prevents monitoring of the health status wild populations. Diseases, predators, and/or parasitoids that may be specific to Dakota skippers are also completely unknown, and therefore also cannot be directly monitored. Year-to-year fluctuations in population sizes may or may not be attributable to diseases or other factors that mediate population health. Weather may be a more direct influence on population sizes.

## F. Socio-economic monitoring

To better understand the socio-economic impacts and perceptions of our work with Dakota skippers, we will maintain conversations with stakeholders on these subjects throughout the timeline of this plan. We will not have time to conduct a thorough survey before reintroductions begin in 2017, but we will instead conduct socio-economic and financial impact discussions after the first round of Dakota skipper releases in 2017. This will not prevent us from soliciting and responding to concerns and questions raised by stakeholders during our initial outreach attempts. As we continue to implement Dakota skipper releases at HIM (and similarly at other potential reintroduction locations), we may also ask stakeholders if their opinions towards Dakota skipper conservation have changed since *ex situ* work and outreach efforts began.

If there appears to be a sharp decline in support from landowners and other interested parties, or if the results show severe negative perception of our conservation efforts, outreach will be focused on specific issues of concern and targeted communication will be had with relevant stakeholders. If perceptions continue to decline or remain negative, we will discuss this with the appropriate agencies and individuals and determine possible reasons for these negative perceptions and potential ways to address concerns. Possible solutions may include but are not limited to modifying and increasing outreach, hosting meetings for interested stakeholders to share and discuss their concerns, and modifying the propagation plan to take into account stakeholder concerns.



## G. Continuing Management

As stated in IUCN (2013, p. 21), some translocations require management over many years and monitoring results provide the basis for either continuing or changing management regimes and the justification for any change in translocation objectives or time schedules. We have already stated above in the Goals, Objectives, and Actions Section of this document how we plan to assess the effects of reintroduction and will not repeat that in detail here.

Much of the year-to-year analysis and reevaluation of the program will be expressed in updates to this plan. The team will review and revise the plan annually. Release plans will be drafted for any site where reintroduction will take place. Included in annual release plan revisions, as needed, will be an update to maps and survey results; detailed plans for the upcoming year, including any updates or revisions proposed for the upcoming year to survey, egg collection, transport, rearing, or release techniques; any changes in personnel; and, any modifications to contingency plans.

In addition to release plan revisions and updates, each year the team will draft an annual report of activities. The Minnesota Zoo may include the majority of the relevant information in its own annual reports, but the team will prepare a supplementary report, if needed. Annual reports will be completed by March 1<sup>st</sup> and will include detailed descriptions of the egg collection, transport, and rearing activities conducted over the previous year; the precise locations where each activity was carried out; the proportion of collected eggs that are released at later life stages; and, a description of the extent and quality of Dakota skipper habitat at reinforcement or reintroduction sites. The results of Dakota skipper adult surveys, including the locations where the species was recorded during surveys, will also be summarized and appended to the annual report. The report will include a description of the extent of habitat that the species occupies at the site and the trends in the quality and extent of the habitat. This information will be essential for determining whether reinforcement or reintroduction activities should proceed at a site and whether habitat management activities are needed.

Information that will be critical for determining whether – and when – to cease reinforcement at any individual site or generally will include adult survey data collected in a manner that will allow us to estimate relative abundance - or to assess another appropriate metric for population dynamics - and the proportion of collected eggs that survive to release. These are also addressed in the Goals, Objectives, and Actions section of this plan, above.

Activities associated with captive rearing of the Dakota skipper require authorization by the U.S. Fish and Wildlife Service under section 10(a)(1)(A) of the ESA. In addition, the Service's issuance of each permit requires that it conduct an internal consultation under section 7(a)(2) of the Act to ensure permitted activities will not reduce appreciably the likelihood of the species' survival and recovery in the wild. These regulatory requirements will provide an additional means by which the activities conducted under this plan are assessed and will take into account any significant new information.

## H. Habitat management

The first and only site under consideration for reintroduction currently is TNC's Hole-in-the-Mountain Preserve, which will be subject to habitat management, as specified in an endangered species recovery permit that USFWS issued to TNC in March 2016. The permit allows TNC to carry out habitat management with a primary intent of conserving Dakota skippers on several preserves, including HIM.

The TNC permit application contains details regarding its proposed approach to habitat management, including how adverse impacts to the Dakota skipper will be minimized. To subdivide

potential Dakota skipper subpopulation areas, TNC has divided Hole-in-the-Mountain into 6 “sub-sites,” 5 of which occur on TNC property, based on input from Dr. Robert Dana, Minnesota Biological Survey (TNC 2016). TNC proposes to plan separately prescribed fire and monitoring activities within each of these sub-sites following the general parameters described below.

TNC’s prescribed burns will be conducted in the spring, fall, or a combination. Burns will be conducted in such a way as to minimize impact to Dakota skipper populations and individuals. TNC’s proposed prescribed fire treatments take a conservative approach by following best practices identified in the literature and guidelines to the full extent possible, while also taking into account site-specific constraints and logistical challenges inherent to prescribed fire management. Using the best information available for each site, including historical occurrence records, recent surveys, Dakota skipper habitat suitability assessments, and expert knowledge, TNC will identify the areas where the larvae are most likely to be present.

TNC will minimize the possibility of fire-related injury or death to individuals within a given burn unit to the extent possible. For example, prescriptions may be designed specifically to encourage patchiness of the burn. Burn supervisors may also choose to reduce fuel loads prior to the burn. From the perspective of emerging Dakota skipper larvae, early spring and fall are the most desirable times for burns, to avoid the timeframe when larvae are above the litter layer (Dana 1991; USFWS Conservation Guidelines 2015). Seasonality of the burn will be factored into burn plans accordingly, weighing desired outcomes for Dakota skipper habitat and reducing the risk of injury or death to individuals. For example, a fall burn may be required to increase the availability of nectar plants the following spring, or a late spring burn may be needed if cool-season, non-native grasses are degrading Dakota skipper habitat. TNC will take an adaptive approach to burning with prescriptions that are informed by Dakota skipper and habitat monitoring conducted as part of this research. There is significant topographic relief at the site that precludes some other management techniques, such as haying

The prescribed burn framework for this project emphasizes spatiotemporal factors that are compatible with sustaining and recovery of Dakota skipper populations. The identified breeding habitat will be divided as well as possible into units for burning—striving for at least three, and ideally four burn units, of which only one would be burned in any given year (USFWS Conservation Guidelines 2015). The minimum fire return interval for each burn unit as described above will be 4-to-6 years (Panzer 1988; Panzer 2002; USFWS Conservation Guidelines 2015, Robert Dana, pers. comm. December 8, 2015). Care will be taken to reduce the impacts of prescribed burns on Dakota skipper populations. TNC will coordinate with adjacent ownerships that have documented occurrences of Dakota skipper and/or mapped likely breeding habitat (e.g., Bluestem and Blazing Star) to ensure that these spatiotemporal parameters are maintained consistently over time.

TNC will coordinate with the US Fish and Wildlife Service as they make plans for annual prescribed fire on the 6 sites identified in this proposal, offering an opportunity for review of these plans. For context, annual burn plans may be submitted with relevant spatial information about management history, in particular prescribed fire—conducted in the year preceding the study period and cumulative histories over the course of the project.

## XI. Exit strategy

The monitoring discussed in the previous sections will help managers assess whether the objectives are being met and can be used to determine when to end the program under seven potential scenarios:

*Scenario 1 - Recovery of the species has been achieved.* A recovery plan for the species will require development of numerical targets to measure recovery and inform any decision to down-list or remove the species from the Threatened species list. Developing such targets is outside the scope of this plan and is in progress by the Service. This plan has largely addressed the means by which reestablishment of extirpated Dakota skipper populations might be achieved, and the risks that might put at risk such efforts. As the objectives of this plan are achieved, additional objectives and actions may be considered to further the conservation of the species. It is possible that additional *ex situ* actions, in combination with other *in situ* actions (e.g., habitat management) will need to be successful for the species to be considered fully recovered.

*Scenario 2- Objectives of the plan are achieved and the species has established self-sustaining, stable or growing and genetically viable populations in the Greater HIM complex such that the ex situ programs are no longer necessary in that area, but recovery of the species is needed elsewhere. Resources could be shifted from recovery efforts at HIM to other regions.*

*Scenario 3- Objectives of the plan cannot be achieved due to lack of observations of Dakota skippers near the release site and on the fixed monitoring routes throughout the Greater HIM Complex, despite repeated releases of hundreds of individuals per year over at least a five years.* This would indicate that releases are not successful (for many potential reasons), and that Dakota skippers are not re-establishing in the Complex despite concerted efforts.

*Scenario 4 – Failed Zoo-based rearing program –* Survivorship of Zoo-reared eggs to release stage is at zero or nearly so (<3%) for three consecutive years, or source populations reach such low numbers (for two or more years) that collection of adult females for eggs is no longer feasible. Annual evaluations of the program will help assess the options under this scenario.

*Scenario 5- Habitat becomes no longer suitable.* Releases should halt if habitat quality in the Complex becomes no longer suitable for Dakota skippers, or there are increased extrinsic threats in the greater landscape that increase risks to skipper safety beyond an acceptable threshold (e.g. dangerous pesticides drift, etc). Current estimations of risk and agreements of habitat management are discussed above in VIII.B and X.H.

*Scenario 6- Objectives of the plan can no longer be achieved due to the total loss of capacity (e.g., funding) to continue the program in the foreseeable future.* The financial assurances and risks are discussed in Section VI.G of this document.

*Scenario 7 - Objectives of the plan cannot be achieved due to species extinction.*

Under each identified scenario, the Service will engage with relevant partners to discuss the exit strategy, before a final course of action is taken.

## XII. Dissemination of Information

Annual reports described in the section, Continuing Management, above, will be distributed and made available to ensure that all stakeholders and any other interested parties may stay abreast of progress and activities implemented under this plan.

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## XIV. Appendix A- Criteria for Reintroduction and Founder Site Selection

The following are the criteria and associated scoring system to weigh candidate sites against each other for Dakota skipper reintroduction suitability. These factors attempt to weigh biological factors with social feasibility. The most appropriate answer that applies to the Hole-in-the-Mountain TNC preserve for each criteria is indicated in bold type. The scores of six candidate sites are provided in the main text.

### 1) Status of the Dakota skipper at the site and in suitable habitat within two kilometers of the site:

a. **The site and all suitable habitat patches within two kilometers of the site have had at least three consecutive negative survey years. This indicates that Dakota skippers are likely extirpated from the site and adjacent areas.** 1 point

b. The site and all suitable habitat patches within two kilometers of the site have had less than three consecutive negative survey years. This indicates that Dakota skippers may still be present at the site or in adjacent areas. -1 point

The intent of this factor is to ensure that the Dakota skipper is not present at the potential reintroduction site or at sites from which it could emigrate readily. If it were present, we would not release the species at the site. Instead, we would focus on whatever might contribute to the health of the population.

### 2) Extent of unplowed prairie

a. The extent of unplowed prairie at the site exceeds 140 ha. 2 points

**b. The extent of unplowed prairie at the site exceeds 140 ha, but it is fragmented.** 1 points.

b. The area of unplowed prairie at the site is between 30 and 139 ha. 0 point

c. The extent of unplowed prairie at the site is less than 30 ha. -1 point

Swengel and Swengel (1999) found that relative abundance of Dakota skippers was highest in prairies that exceeded 140 ha in extent and was intermediate in prairies in their “medium” (30-130 ha) size category. Robert Dana, Minnesota Department of Natural Resources, has conducted Dakota skipper research and monitoring at HIM for thirty years or more and in 2015 qualitatively assessed the Dakota skipper habitat conditions there (Dana, 1991; Dana 1997; Figure ). There are over 140 ha of unplowed prairie in areas where the Dakota skipper has been previously recorded at HIM and there is additional prairie without previous records for the species immediately adjacent.

### 3) Habitat quality

a. The methods described in Ahlering and Narem (2015) – or methods substantively similar – were used to assess habitat quality at the site and overall habitat quality was ranked as A or A-. 2 points

**b. The methods described in Ahlering and Narem (2015) – or methods substantively similar – were used to assess habitat quality at the site and overall habitat quality was ranked as B.** 1 point

c. The methods described in Ahlering and Narem (2015) – or methods substantively similar – were used to assess habitat quality at the site and overall habitat quality was ranked as B-. 0 point

d. The methods described in Ahlering and Narem (2015) – or methods substantively similar – were used to assess habitat quality at the site and overall habitat quality was ranked as C or C-. -2 points

Our ranking of habitat quality is currently based on a combination of qualitative assessments provided by Robert Dana (Minnesota DNR) and quantitative data collected by the Minnesota Zoo. The qualitative assessments by Dana follow the Condition Ranking Guidelines for Upland Prairie Systems (Minnesota DNR 2014) that incorporate estimations of the prevalence and extent of native plant diversity associated with high quality Dakota skipper habitat, the extent of non-native plant invasion, topography (Dakota skippers are generally concentrated along higher ridgelines in 'Type B' habitats), and management history (e.g. some areas may have been degraded by overgrazing). These rankings were also influenced by historic abundance records for Dakota skippers observed by Dana and others (i.e. some locations historically had higher concentrations of Dakota skippers than others, and therefore were considered better quality). The quantitative data on the prevalence of narrow-leaved purple coneflower collected by the Minnesota Zoo (see below) also contributed to the overall assessments of Dakota skipper habitat quality across sites. The ranking is not strictly transferable to the letter ranking scheme devised by Ahlering and Narem (2015). If we convert Dana's rankings to a letter ranking and arrive at an overall score for habitat quality by weighing habitat scoring based on the relative proportion of the total HIM area, the ranking would be somewhere between B and A- (Table 6).

*Table 6 – Extent and relative quality of Dakota skipper habitat at Hole-in-the-Mountain in areas that contain historical records for the Dakota skipper, as determined by Robert Dana, Minnesota Department of Natural Resources in 2015., and the resulting combined scoring of the HIM Preserve using the Ahlering and Narem method.*

Habitat Quality (Dana 2015, unpublished)	Habitat Quality Letter Ranking	Habitat Quality Numeric (1-6)	Hectares	Proportion of Site	Weighted Score
Poor	C	1.2	16	0.10	0.116788321
Fair/Poor	B-	2.4	19	0.11	0.268613139
Fair	B	3.6	56	0.34	1.217518248
Fair/Good	A-	4.8	17	0.10	0.502189781
Good	A-	6	58	0.35	2.087591241
Total/Overall Score			166		<b>4.19270073</b>

As stated previously, narrow-leaved purple coneflower (*Echinacea angustifolia*) is the primary nectar source for Dakota skippers in the 'Type B' habitats of northeast South Dakota and southern/central Minnesota, and adults are almost exclusively found congregating on the flowers in areas of high density purple coneflower (Table 1). Therefore, coneflower density is a key characteristic of habitat quality that must be assessed across candidate reintroduction sites. To advance this indexing, the Minnesota Zoo's Cale Nordmeyer and Seth Stapleton conducted density surveys of flowering purple coneflowers at three historic Dakota skipper locations in August 2016 to inform the Dakota skipper reintroduction site selection. Strip transect sampling of all 2016 flowering purple coneflowers within an approximately 10

meter half width (and assumed detection probability of 1.0 within that strip) was conducted at TNC's Hole-in-the-Mountain preserve (Central Unit), Glacial Lakes State Park (Pope County, MN), and Felton Bicentennial Prairie (Clay Co, MN). Like Hole-in-the-Mountain, Dakota skippers are believed to be extirpated from Glacial Lakes State Park (despite historically large populations). The Felton Bicentennial Prairie is thought to be the only viable Dakota skipper population remaining in Minnesota. Surveys were only performed in the northwest quadrant of Felton Bicentennial because this is the area of the property with the highest Dakota skipper densities. Glacial Lakes State Park possesses extensive native prairie acreage, contained historically large Dakota skipper populations, and appears to be relatively well buffered from pesticides drift (Minnesota Zoo and USFWS unpublished data).

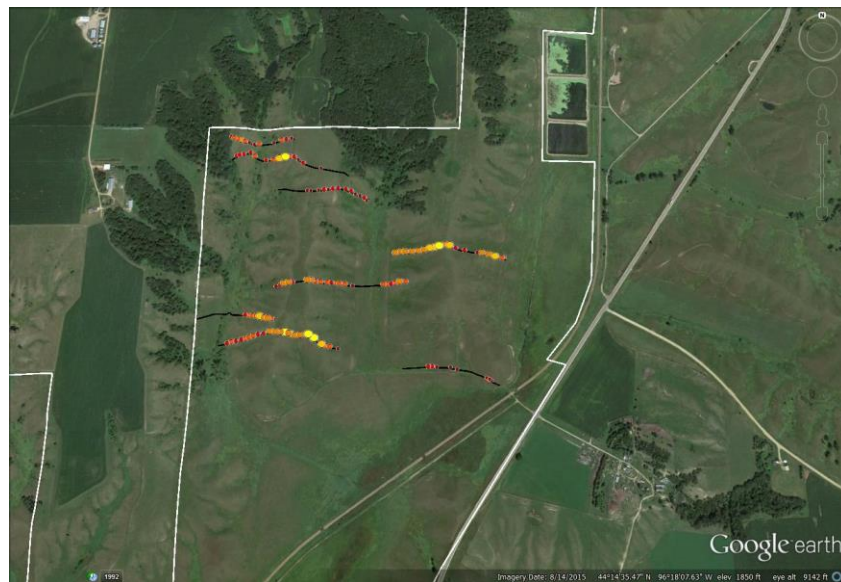
These surveys found that although coneflower densities at Hole-in-the-Mountain are somewhat more variable than at Felton Bicentennial, the best coneflower sites surveyed at Hole-in-the-Mountain were comparable with those at Felton Bicentennial where Dakota skippers maintain an apparently viable population. The densities were markedly lower Glacial Lakes State Park, at least in the areas sampled. It should be noted though that coneflower density surveys did not occur in the properties directly east of the Park where Dakota skippers historically had the highest densities, due to lack of landowner permissions (Table 7, Figure 10Figure 11Figure 12). Additional predictors of habitat utilization should be identified through additional research.

*Table 7 - Summary statistics of purple coneflower densities along transects at three historic Dakota skipper populations in Minnesota, August 2016. Minnesota Zoo data.*

	<b>Dakota skipper status</b>	<b>Transects (n)</b>	<b>Mean (plants/10 m)</b>	<b>SD</b>	<b>Range</b>
<b>Felton Bicentennial</b>	Present	4	8.96	50.4	5.50 - 16.89
<b>Hole-in-the-Mountain</b>	Presumed Extirpated	8	7.35	50.7	0.7 - 16.11
<b>Glacial Lakes</b>	Presumed Extirpated	6	0.13	0.08	0.02 - 0.28



*Figure 10- Densities of purple coneflowers along transects at Felton Bicentennial prairie in the quadrant where most Dakota skippers occur, August 2016. Small, dark red dots indicate 1 – 4 plants at the point (within the strip width). Large, bright yellow dots indicate to >60 flowering plants per point. Different shades of red, orange and yellow and different sized dots follow along this color / size continuum. White border is the Felton Bicentennial boundary.*



*Figure 11 - Densities of purple coneflowers along transects in the central unit of TNC's Hole-in-the-Mountain Preserve, August 2016. Small, dark red dots indicate 1 – 4 plants at the point (within the strip width). Large, bright yellow dots indicate to >60 flowering plants per point. Different shades of red, orange and yellow and different sized dots follow along this color / size continuum. White border is the Preserve boundary.*



*Figure 12 - Densities of purple coneflowers along transects at Glacial Lakes State Park, August 2016. Small, dark red dots indicate 1 – 4 plants at the point (within the strip width). No points had more than 8 observed coneflowers, unlike at the sites above. White border is the State Park boundary. Red border is the area of highest quality habitat in the center of the State Park where random transects were placed.*

#### 4) Land manager approval:

If more than one land manager owns land within the site, points will be weighed according to the proportion of land owned.

- a. The land managers (s) has agreed in writing to the reintroduction of the Dakota skipper on their property      2 point
- b. The land manager(s) has agreed verbally to the reintroduction of the Dakota skipper on their property.      1 point**
- c. The land manger has expressed informal interest in the possibility of the reintroduction of the Dakota skipper on their property.      0 points.
- c. The land manager’s position on the reintroduction of the species is unknown.      -1 point
- d. The land manager has expressed opposition to the species’ reintroduction.      - 2 points

Additional conversations with other land managers are warranted, particularly to develop habitat management plans than would increase the pool of candidate sites for future reintroductions beyond those planned in the near team, as well as to raise the suitability scores of those sites already considered.

#### 5) Potential for public controversy

- a. There is no reason to think that the reintroduction will be controversial with adjacent landowners whose lands contain potentially suitable habitat or the state conservation agency. Each landowner with potentially suitable habitat and the state conservation agency has been polled on the question and has expressed no opposition to the reintroduction.      1 point

**b. There is no significant reason to think that the reintroduction will be controversial with adjacent landowners or the state conservation agency, but some of their opinions remain unknown. 0 point**

c. One or more adjacent landowners or the state conservation agency has expressed opposition to the reintroduction. -1 point

Minnesota Zoo staff met with landowners adjacent to the HIM Preserve in March 2017, and also presented the proposed work to the Lake Benton City Council. Reactions ranged from neutral to positive, so we do not expect significant initial controversy with the proposed reintroduction. Our consideration of this criterion for HIM brings to mind a few faults with the way the criteria approach the potential for public controversy. First, we should consider the potential for controversy among potentially affected stakeholders, which may include persons or entities with a basis for interest other than land ownership. Second, there will probably be few situations when reintroduction of a threatened or endangered species will not be controversial with at least one stakeholder.

For the proposed reintroduction of the Dakota skipper to HIM, it is reasonable to assume that at least one of the stakeholders listed in Section F. (Social feasibility) above, may have reservation and concerns. In the end, we do not expect opposition to be significant for the following reasons:

1. We will reach out directly to each stakeholder to explain our plans and their potential implications and will attempt to address each of their concerns and questions promptly. Initial conversation with landowners near the Hole-in-the-Mountain reintroduction site have been beneficial;
2. For issues raised by stakeholders that may be complex, may not be addressed quickly, or both, we will work to resolve them with minimal delay;
3. The Dakota skipper has specific habitat requirements and is only likely to inhabit high-quality, unplowed native prairie; and,
4. The Service may exercise its authority to permit activities that would otherwise be prohibited as take under section 9 of the Endangered Species Act; and,
5. A special rule published concurrent with the species' listing as threatened in 2014 allows take of the Dakota skipper that occurs as a result of routine livestock operations on non-federal lands.

We anticipate that the most significant concerns may be raised by persons involved with farming of agricultural row crops near HIM. In the section, Ecological Risk, above, we describe briefly the potential threat that pesticide drift may pose to the Dakota skipper at HIM. When we address this threat, we will deal, directly or indirectly, with private landowners near HIM. We are uncertain how receptive the landowners will be on this topic, but may engage with University of Minnesota Extension for assistance.

From the other landowners, we expect interest, but not significant opposition. We do not expect opposition because we expect the Dakota skippers to inhabit only high-quality native prairie; we are committed to dealing with stakeholders openly and cooperatively; and, we expect that we will be able to identify acceptable solutions to any potential conflicts that arise with the identified stakeholders.

## **6) Assurance of appropriate management**

If more than one landowner owns land that contains unplowed prairie within the site, points will be weighed according to the proportion of land owned.

a. The landowner(s) has agreed in writing to implement land management practices in a manner conducive to the conservation of Dakota skippers for at least ten years on the species' habitat at the site. 2 points



**b. The landowner(s) has agreed in writing to implement land management practices in a manner conducive to the conservation of Dakota skippers for at least five years on the species' habitat at the site. 1 point**

c. The landowner(s) has agreed verbally to implement land management practices in a manner conducive to the conservation of Dakota skippers for the foreseeable future on the species' habitat at the site. 0 point

d. The landowner has not agreed verbally or in writing to implement land management practices in a manner conducive to the conservation of Dakota skippers on the species' habitat at the site. -1 point

e. The landowner has expressed opposition to the species' reintroduction and has not agreed verbally or in writing to implement land management practices in a manner conducive to the conservation of Dakota skippers on the species' habitat at the site. - 2 points

At this stage, TNC has expressed support for the reintroduction and is cooperating with the Service and Minnesota Zoo to select the site where reintroduced Dakota skippers may be most likely to thrive, based on high relative density of purple coneflower; is planning to burn the reintroduction area to further enhance habitat quality; and, has expressed informally its implicit support to reestablish the species on its property at HIM. In addition, TNC has proposed a Dakota skipper habitat management study that would last at least five years at HIM and at other sites where the species may be present in Minnesota, North Dakota and South Dakota. They have applied to the Service for an endangered species permit that would cover any take of the Dakota skipper that could occur as a result of their habitat management in these areas. Prescribed fire intended to enhance habitat for the Dakota skipper, for example, could result in take of the species. TNC has proposed to manage lands where the Dakota skipper may be present, including HIM after its release, in a manner that is presumed to maximize the likelihood that the populations present will persist. TNC's permit application is evidence that it will engage with the Service to cooperatively manage their lands in a way that will conserve Dakota skipper populations.

#### 7) Distance to row-crop agriculture

a. There is no row-crop agriculture within two miles of the site. 2 points

b. There is no row-crop agriculture within one mile of the site. 1 point

c. There is row-crop agriculture within 0.5-1 mile of the site. 0 point

**d. There is row-crop agriculture within one-half mile of the site. -1 point**

This ranking factor is an index to the threat posed potentially by drift of pesticides from row-crop areas. This potential threat is recognized above, in the section, Ecological Risk. A preliminary assessment of pesticide residues at HIM carried out by Minnesota Zoo in 2016, showed that there is some pesticide drift into HIM (Section VII.B.). Similar, if not higher levels have been observed at other candidate sites considered for reintroduction in this plan (Prairie Coteau and Glacial Lakes State Parks).

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## XV. Acknowledgements

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