Poweshiek Skipperling
Dakota Skipper

Ex Situ Feasibility Assessment and Planning Workshop

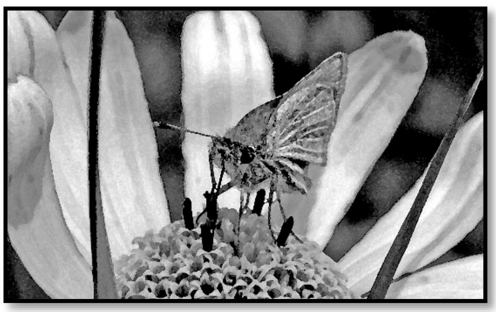
October, 2015

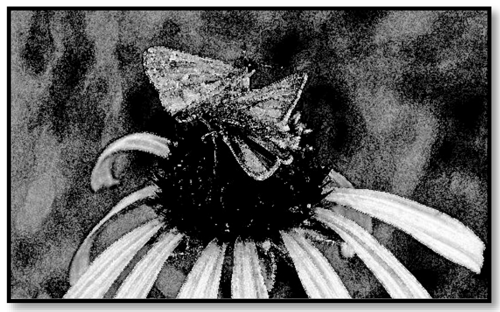
Poweshiek Skipperling and Dakota Skipper: *Ex Situ* Assessment and Planning Workshop

20 – 22 October, 2015
Apple Valley, Minnesota

WORKSHOP REPORT

Editors:
Phil Delphey, Erik Runquist, Tara Harris, Cale Nordmeyer,
Tamara Smith, Kathy Traylor-Holzer, and Philip S. Miller





Workshop Organization:
Minnesota Zoo

Workshop Design and Facilitation:
IUCN/SSC Conservation Breeding Specialist Group

Workshop Support:
United States Fish and Wildlife Service
Minnesota Zoo Foundation

A contribution of the IUCN/SSC Conservation Breeding Specialist Group, in collaboration with the Minnesota Zoo, United States Fish and Wildlife Service, and workshop participants.

Workshop support provided by United States Fish and Wildlife Service and the Minnesota Zoo Foundation.

IUCN encourage meetings, workshops and other forums for the consideration and analysis of issues related to conservation, and believe that reports of these meetings are most useful when broadly disseminated. The opinions and recommendations expressed in this report reflect the issues discussed and ideas expressed by the participants in the workshop and do not necessarily reflect the formal policies IUCN, its Commissions, its Secretariat or its members.

© Copyright CBSG 2016

Suggested Citation:
Delphey, P., E. Runquist, T. Harris, C. Nordmeyer, T. Smith, K. Traylor-Holzer, and P.S. Miller (eds.) 2016. *Poweshiek Skipperling and Dakota Skipper:* Ex Situ *Feasibility Assessment and Planning Workshop.* Apple Valley, MN: IUCN/SSC Conservation Breeding Specialist Group.

The CBSG Conservation Council

These generous contributors make the work of CBSG possible

$25,000 and above

Copenhagen Zoo*
Minnesota Zoological Garden
  -Office Sponsor
Omaha's Henry Doorly Zoo
George Rabb*
Saint Louis Zoo
SeaWorld Parks & Entertainment*

$20,000 and above

Toronto Zoo
World Association of Zoos and Aquariums (WAZA)
Zoological Society of London

$15,000 and above

Chester Zoo*
Chicago Zoological Society*
Columbus Zoo & Aquarium - The WILDS
Disney's Animal Kingdom
Zoo Zürich*

$10,000 and above

Alice Andrews*
Auckland Zoological Park
Dallas World Aquarium*
Houston Zoo*
San Diego Zoo Global
Taronga Conservation Society Australia
Zoo Leipzig*

$5,000 and above

Al Ain Wildlife Park & Resort
Allwetterzoo Münster
Association of Zoos & Aquariums (AZA)
Anne Baker & Robert Lacy
British and Irish Association of Zoos and Aquariums (BIAZA)
Detroit Zoological Society
Lincoln Park Zoo
Nordens Ark*
Ocean Park Conservation Foundation, Hong Kong*
Perth Zoo*
Point Defiance Zoo & Aquarium
Schönbrunner Tiergarten – Zoo Vienna*
Smithsonian National Zoological Park

$2,000 and above

Borås Djurpark*
Bristol Zoo Gardens
Cincinnati Zoo & Botanical Garden
Cleveland Metroparks Zoo
Dallas Zoo
Dickerson Park Zoo
Dublin Zoo
European Association of Zoos & Aquaria (EAZA)
Fundación Parques Reunidos
Givskud Zoo
Gladys Porter Zoo
Japanese Association of Zoos & Aquariums (JAZA)
Laurie Bingaman Lackey
The Living Desert
Linda Malek
Milwaukee County Zoo
North Carolina Zoological Park
Oregon Zoo
Paignton Zoo
Royal Zoological Society of Antwerp
Royal Zoological Society of Scotland
San Francisco Zoo
Sedgwick County Zoo
Seoul Zoo
Swedish Association of Zoological Parks & Aquaria (SAZA)
Thrigby Hall Wildlife Gardens
Twycross Zoo
Union of German Zoo Directors (VDZ)
Wilhelma Zoo
Woodland Park Zoo
Zoo Frankfurt
Zoologischer Garten Köln
Zoologischer Garten Rostock

$1,000 and above

Aalborg Zoo
Akron Zoological Park
Audubon Zoo
Cameron Park Zoo
Central Zoo Authority, India
Everland Zoological Gardens
Fort Wayne Children's Zoo
Fota Wildlife Park
Fundación Temaikèn
Kansas City Zoo
Los Angeles Zoo
Odense Zoo
Palm Beach Zoo at Dreher Park
Prudence P. Perry
Philadelphia Zoo
Phoenix Zoo
Riverbanks Zoo & Garden
Rotterdam Zoo
San Antonio Zoo
Skansen Akvariet
Taipei Zoo
Toledo Zoo
Utah's Hogle Zoo
Wassenaar Wildlife Breeding Centre
Zoo and Aquarium Association (ZAA)
Zoological Society of Wales – Welsh Mountain Zoo
Zoo Miami
Zoos South Australia

$500 and above

Abilene Zoological Gardens
Apenheul Primate Park
Ed Asper
Banham Zoo
Mark Barone
Bramble Park Zoo
Chris Byers & Kathy Vila
Cotswold Wildlife Park
David Traylor Zoo of Emporia
Friends of the Rosamond Gifford Zoo
GaiaPark – Kerkrade Zoo
Jacksonville Zoo & Gardens
Knuthenborg Safaripark
Lisbon Zoo
Little Rock Zoo
Katey & Mike Pelican
Racine Zoological Society
Tokyo Zoological Park Society
Topeka Zoo
Wellington Zoo
Wildlife World Zoo & Aquarium
Zoo de la Palmyre

$250 and above

African Safari – France
Arizona-Sonora Desert Museum
Susie Byers & Kurt Schwarzkopf
Lee Richardson Zoo
Lion Country Safari
Roger Williams Park Zoo
Rolling Hills Wildlife Adventure
Sacramento Zoo
Safari de Peaugres
Steinhart Aquarium
Tautphaus Park Zoo
Jacqueline Vlietstra

$100 and above

Alameda Park Zoo
Aquarium of the Bay
Elias Sadalla Filho
Lincoln Children's Zoo
Steven J. Olson
Zoo Heidelberg

$10 and above

Heiko Janssen

**Denotes CBSG Chair sponsor*

CBSG Regional Network Hosts

AMACZOOA & FUNDAZOO
Auckland Zoo
Copenhagen Zoo
Royal Zoological Society of Scotland
Saint Louis Zoo
Taman Safari Indonesia
Zoo Outreach Organisation & WILD
Zoofari Mexico

Thank you for your support!
31 October 2015

CONSERVATION BREEDING SPECIALIST GROUP
Planning a Future for Wildlife

Poweshiek Skipperling and Dakota Skipper: *Ex Situ* Assessment and Planning Workshop

20 – 22 October, 2015
Apple Valley, Minnesota

WORKSHOP REPORT

Table of Contents

Poweshiek Skipperling and Dakota Skipper: *Ex Situ* Assessment and Planning Workshop

Executive Summary

Introduction

The invertebrate fauna of the upper Midwest is increasingly threatened by a wide array of anthropogenic activities and processes, ranging from habitat conversion to pesticide use to climate change. The Poweshiek skipperling (*Oarisma poweshiek*) and Dakota skipper (*Hesperia dacotae*) are important examples of this worrisome trend. Both species are native to mixed-grass to dry tallgrass prairie, moist meadow, and prairie fen ecosystems of the north-central United States and south-central Canada. The destruction of tallgrass prairie in this region began in the early 1800s, and by the mid-1990s nearly all of this habitat had been converted to agricultural lands in Minnesota, Iowa, North and South Dakota, Illinois, Indiana, Wisconsin and Manitoba. Mixed-grass prairies suffered the same fate during this period. As a result, the Poweshiek skipperling may now be extirpated from Minnesota, the Dakotas, Iowa and Illinois and is restricted to a single site in southern Manitoba, a single prairie site in south-central Wisconsin, and four isolated prairie fen sites in eastern Michigan. While more widely distributed, the Dakota skipper has been lost from Illinois and Iowa and is now found only in isolated sites in Minnesota, the Dakotas and southern Canada. Recent surveys at many of these isolated sites reveal only a few adults.

In addition to implementing active habitat and population management efforts on the ground, experts managing both the Poweshiek skipperling and the Dakota skipper are now exploring options for intensive *ex situ* population management to improve the long-term status of these species in their native habitats. The range of *ex situ* scenarios and tools currently available to the species conservation community is diverse and can target different conservation needs and roles. In order to be successful, *ex situ* programs need to be carefully assessed, planned and implemented in a way that provides conservation benefit. In addition, as conservation challenges become more complex and urgent, the need to further develop scientifically based and innovative approaches to *ex situ* conservation will increase. To assist in this planning and implementation process, the IUCN's Species Survival Commission has created a document, titled *Guidelines on the Use of* Ex Situ *Management for Species Conservation* (IUCN/SSC 2014). This document provides practical guidance on evaluating the suitability and requirements of an *ex situ* component for achieving species conservation objectives.

The Workshop Process

United States Fish and Wildlife 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 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 generously 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.

Detailed workshop objectives were as follows:

- Review the status of species (threats, current conservation activities, and key data gaps) to set the proper context for the workshop activities.
- Define the role(s) that *ex situ* management could play in the overall conservation of the species.
- Determine the characteristics and dimensions of the *ex situ* population needed to fulfil the potential conservation role(s).
- Define the resources and expertise needed for the *ex situ* management program to meet its role(s) and appraise the feasibility and risks.
- Make a decision for each species that is informed and transparent (i.e. demonstrates how and why the decision was taken).
- Develop an *ex situ* Action Plan for each species based on the decision. Create explicit timelines for activities that make up the Plan.

The workshop began with a set of background presentations on the status of the two species, followed by a review of the early *ex situ* work currently underway targeting both species at the Minnesota Zoo. Presentation of the Guidelines included a discussion of the various *ex situ* management options that could be implemented to advance conservation of endangered species. These options range from creating a long-term *ex situ* breeding program aimed at preventing species extinction, to a head-start program featuring removal of individuals from the wild so that survival of a given life-stage can be improved with later release of individuals back into the wild, to the creation of an *ex situ* research population designed to improve *in situ* species conservation. Additionally, a set of *in situ* population management roles were discussed, including various forms of *in situ* intensive protection schemes and translocation of individuals among wild populations, and how these relate to the IUCN *Guidelines for Reintroduction and Other Conservation Translocations* (IUCN/SSC 2013).

Following these presentations, the workshop participants began the process of identifying threats to long-term viability for each of the two species. Two working groups were then formed, corresponding to each of the two species of interest, and each group then amplified the basic threat analysis as appropriate for their focal species. For each threat, the working groups identified the demographic rates that would likely be impacted, as well as the more general population characteristics (abundance, degree of population fragmentation) that would be affected by the threats.

With the above information in hand, the groups identified which of the various *ex situ* and *in situ* population management options could potentially be beneficial to the long-term conservation of their species. Each option was then evaluated in a thorough analysis, including a detailed characterization of each option, the requirements for their proper implementation, and the relative risks and benefits of their adoption. Using the findings from this analysis, each working group concluded their activities by making a recommendation on whether to adopt an *ex situ* program as part of a larger species conservation strategy and, if adopted, creating an Action Plan for implementing the program.

Summary of Workshop Findings

The Poweshiek skipperling group adopted an *ex situ* program based on a mixed approach of concurrent and consecutive activities. Key features of this approach are:

1. Establish a <u>head-start program</u> to augment extant locations through reinforcement (intra-site). Eggs from females will be collected on-site from a proportion of the individuals observed during a given flight period. Females will be released back to the site of capture within 72 hours (egg-laying time of approximately 48 hours). Eggs will be reared at the Minnesota Zoo and will be released post-overwintering as late-instar larvae or pupae. The program would begin in 2016 and will utilize two wild founder source populations from Michigan (Brandt Road and Long Lake

Fen). It is recommended that the Assiniboine Park Zoo or another Canadian partner start a similar head-start program utilizing founders from two separate sites within the Tall Grass Prairie Preserve (8 and J67) starting in 2017.
2. Conduct research on a surrogate species population. Research will be conducted concurrently – primarily on breeding and husbandry techniques – using a closely related species. Additional research (e.g., habitat) will occur at extant sites and potential reintroduction sites to determine suitability for reintroductions.
3. Consider establishment of an insurance population to enhance long-term survival of the species. If the surrogate husbandry research is successful, an insurance population may be created using captive-reared (F1 generation) individuals. The *ex situ* population would be maintained to maximize genetic and demographic stability.
4. Reintroductions to locations with historical records of the species (inter-site), but where the species is thought to be extirpated (long term). If the head-start program is successful and produces large numbers of healthy larvae, a decision point can be triggered regarding whether to reintroduce those larvae to previously extirpated sites (inter-site).

The Minnesota Zoo would take the lead in developing the *ex situ* rearing and husbandry methods, with other candidate institutions in both the US and Canada providing collaborative capacity as required. US Fish and Wildlife Service would coordinate data collection and assembly on current and future site characteristics, prioritize research needs, and assist with organizing releases of individuals from the head-start program back to the wild. The head-start program would be initiated by summer 2016, with release of late-instar larvae beginning in spring 2017.

Challenges to successfully implementing the proposed program include the difficulty in collecting the required number of adults to initiate a head-start program, a limitation in funding and staffing that is required to keep the program viable, and the presence of considerable uncertainty in our knowledge of proper husbandry techniques and infectious disease dynamics. The issue of disease may be especially serious, given the potential threats posed by infection by the *Wolbachia* bacterium and its many diverse strains.

The Dakota skipper group also adopted a mixed approach, featuring the following components:

1. Restoration 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
2. 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. A minimum of 175 larvae would be used in a larval food plant study at the Minnesota Zoo, while an additional 30 larvae would be used in a pesticide study, also conducted at the Zoo. Upon completion of those studies, all larvae produced *ex situ* would be available for population restoration unless additional research needs are identified.

3. 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.

US Fish and Wildlife Service will consult with species and subject matter experts to help develop a process for selecting and ranking potential reintroduction sites within the historic range of the Dakota skipper. The Service will also convene a team of species experts to determine the most appropriate developmental stage when head-started or captive bred larvae or pupae will be released. Larvae may be ready for release from the Minnesota Zoo in the summer of 2016, although a systematic review of potential reintroduction sites may not be complete before then. Therefore, this release site may best be described as a trial release.

A number of challenges may stand in the way of successfully implementing the proposed *ex situ* program for the Dakota skipper. For example, there are only a few Dakota skipper populations that are large enough to safely remove eggs while avoiding effects to their viability. This may be a primary factor limiting the number of larvae that can be produced for restoration and research projects. Additionally, the number of suitable sites where reintroduction may have a high probability of success may be limiting. Finally, as with the proposed *ex situ* program for the Poweshiek skipperling, there are real limitations to the amount of funding and staff available for proper program implementation and management. These shortcomings could seriously impede progress towards reaching program goals.

Overall, this workshop was seen by all participants as a valuable contribution to the collaborative efforts directed towards effective conservation of these two natives of the central North American prairie. The integration of both *in situ* and *ex situ* approaches to conservation, as practiced in this workshop, represents an increasingly important strategic step in the evolution of effective conservation management of endangered species (Traylor-Holzer et al. 2013). Moreover, the design of this workshop is a clear example of the Conservation Breeding Specialist Group's One Plan Approach philosophy (Byers et al. 2013), which considers all populations of an endangered species, both inside and outside of their natural range, and under all conditions of management, while engaging all responsible stakeholders and all available resources in the planning and implementation of any species conservation initiative.

References

Byers, O., C. Lees, J. Wilcken, and C. Schwitzer. 2013. The One Plan Approach: The philosophy and implementation of CBSG's approach to integrated species conservation planning. *WAZA Magazine* 14: 2-5.

IUCN/SSC. 2013. *Guidelines for Reintroductions and Other Conservation Translocations*. Version 1.0. Gland, Switzerland: IUCN Species Survival Commission.

IUCN/SSC. 2014. *Guidelines on the Use of* Ex Situ *Management for Species Conservation*. Version 2.0. Gland, Switzerland: IUCN Species Survival Commission.

Traylor-Holzer, K., K. Leus, and P. McGowan. 2013. Integrating assessment of *ex situ* management options into species conservation planning. *WAZA Magazine* 14: 6-9.

Threat Assessment for Poweshiek Skipperling and Dakota Skipper

As a preamble to discussing the potential roles that *ex situ* management can play in conservation of the Poweshiek skipperling and the Dakota skipper, workshop participants were asked to brainstorm and categorize threats to each of the species, and the aspects of the species' life history and/or population status that are targeted by those threats. The threats were not yet categorized by their impact on a given species, but were instead considered at the more broad level of currently impacting either species. The identification of species-specific threats was considered as an early task in the species-based working groups, whose reports are to be found later in this report.

The threats are defined here in terms of their impact on specific life-history stages that define the biology of these two species. Specifically, we define the following stages:

- Egg survival
- Pre-hibernation larval survival
- Overwinter (hibernation) larval survival
- Post-hibernation larval survival
- Adult survival
- Adult reproductive success (fecundity)

The early life-stages were separated out as above because many different threats operate only on specific stages comprising the early phases of the species' life-cycle. In addition, the group considered higher-order, population-level characteristics that are impacted by threats, namely the abundance of individuals in small populations and the degree of population fragmentation.

Note that the threat assessment here is neither exhaustive in its scope nor detailed in its treatment of specific mechanisms. The goal here was to provide a rather high-level overview of the threats to the species, particular in the context of their impact on the species' life-history and how *ex situ* options can help to ameliorate those threats.

The threat assessment is summarized below in Table 1.

Table 1. Summary of threat assessment for wild populations of Poweshiek skipperling and Dakota skipper.

Potential Threat	Demographic Rates Impacted by Threats						Population Status Resulting from Threats	
	Egg survival	**Larval Survival (Pre-Hibernation)**	**Larval survival (Overwinter)**	**Larval survival (Post-Hibernation)**	**Adult survival**	**Adult reproduction**	**Small population**	**Population fragmentation**
(Extreme) weather events	X	X	X	X	X			
Climate change								X
Wetter springs	X		X					
Drought and high temperatures		X	X					
Snow fall/snow cover			X					
Flooding		X	X	X				
Temp effects (direct and indirect)			X					
Freeze/thaw cycles			X					
Disease	X	X	X	X	X	X		
Parasites	X	X	X	X	X			
Habitat fragmentation					X	X		
Number of sites							X	
Patch size							X	
Habitat quality							X	
Lack of floral resources					X			
Nectar plant availability and survival						X		
Lack of potential future habitat								X
Vegetative structure, including host plant survival	X	X	X	X				
Limited food resources		X		X	X	X		

Potential Threat	Demographic Rates Impacted by Threats						Population Status Resulting from Threats	
	Egg survival	**Larval Survival (Pre-Hibernation)**	**Larval survival (Overwinter)**	**Larval survival (Post-Hibernation)**	**Adult survival**	**Adult reproduction**	**Small population**	**Population fragmentation**
Reduced source for dispersal or detection							X	
Lack of habitat diversity					X			
Lack of shelter					X			
Invasive species		X			X	X		X
Inbreeding?						X	X	X
Adult fitness	X							
Allee Effect (too few individuals)						X	X	
Extinction Vortex?							X	
Stochastic demographic impacts							X	
Overhandling of too high % of adults					X	X	X	
Long-term changes in habitat						X		
Lack of on-site monitoring of butterflies							X	
Land management factors (fire, simultaneous whole site treatment, haying frequency)	X	X	X	X	X	X	X	
Undermanagement of sites (correction use of fire, invasive species control)	X	X	X	X	X	X	X	X
Site management conflicting interests						X		

Potential Threat	Demographic Rates Impacted by Threats						Population Status Resulting from Threats	
	Egg survival	**Larval Survival (Pre-Hibernation)**	**Larval survival (Overwinter)**	**Larval survival (Post-Hibernation)**	**Adult survival**	**Adult reproduction**	**Small population**	**Population fragmentation**
Burn vs graze?			X					
When to hay, when to burn?				X				
Overgrazing	X	X		X	X	X		
Overburning	X	X	X	X	X	X	X	X
Ineffective/too much brush control								X
Groundwater alteration?	X	X		X	X			
Nitrogen run-off, eutrophication (vegetative structure)		X						
Pesticides?	X	X		X	X	X		
Knowledge gaps of causes		X	X					
Loss of historical knowledge of long-term changes in habitat and context						X		

Definitions of Potential Population Management Conservation Roles

Following the examples set forth in the *IUCN/SSC Guidelines on the Use of* Ex Situ *Management for Species Conservation*, the workshop participants identified and defined a diverse set of potential roles that an *ex situ* program could play as a component of a long-term conservation strategy for either the Poweshiek skipperling or the Dakota skipper. These specific alternatives are tailored for their application to the two butterfly species of interest to workshop participants.

Insurance Population
Maintain a long-term, genetically diverse *ex situ* breeding population of the species to prevent regional or global species extinction and preserve options for future conservation strategies

Source for Population Restoration
Maintain a (long-term) *ex situ* population as a source of individuals to re-establish the species into part of its former range from which it has disappeared (reintroduction) and/or to reinforce an existing population (reinforcement); can be for demographic and/or genetic reasons

Head-start Program
Remove individuals from the wild into captivity to increase survival during a specific life stage(s) and then subsequently return these individuals to the wild

Maternity Ward
Remove gravid wild females from the wild into captivity to lay eggs, releasing offspring to the wild at some life stage

Temporary Rescue (Salvage)
Temporary removal of individuals from the wild to protect them from predicted imminent threat(s) (e.g., extreme weather, fire)

Research Population
Research on *ex situ* population that will directly benefit conservation of the species in the wild (e.g., life history, plant/habitat requirements, pesticide impacts, parasites, potential inbreeding or outcrossing effects, developmental thresholds)

In addition to the *ex situ* roles identified above, the participants considered a trio of potential *in situ* population management conservation roles, listed below.

Protected in the Wild
Provide some level of buffer from threats as a modified *ex situ* condition in the field (e.g., larvae rearing pens in the field)

Wild-to-Wild Translocation
Remove individuals from one wild location and release into another wild location (occupied or unoccupied by conspecifics); can be for demographic and/or genetic reasons

Wild-to-Wild Rescue (Salvage)
Similar to Wild-to-Wild Translocation, but in response to imminent threat(s) in original location

Figure 1 below shows where the various *ex situ* and *in situ* population management conservation roles are best implemented in the context of a diagrammatic representation of the process of species endangerment and extinction. The "extinction vortex" refers to the heuristic model of population decline brought about by demographic and genetic instability in small, declining populations. This diagram provided by Conservation Breeding Specialist Group staff was helpful in identifying the appropriate choice of population management options as a function of the degree of endangerment of a given species.

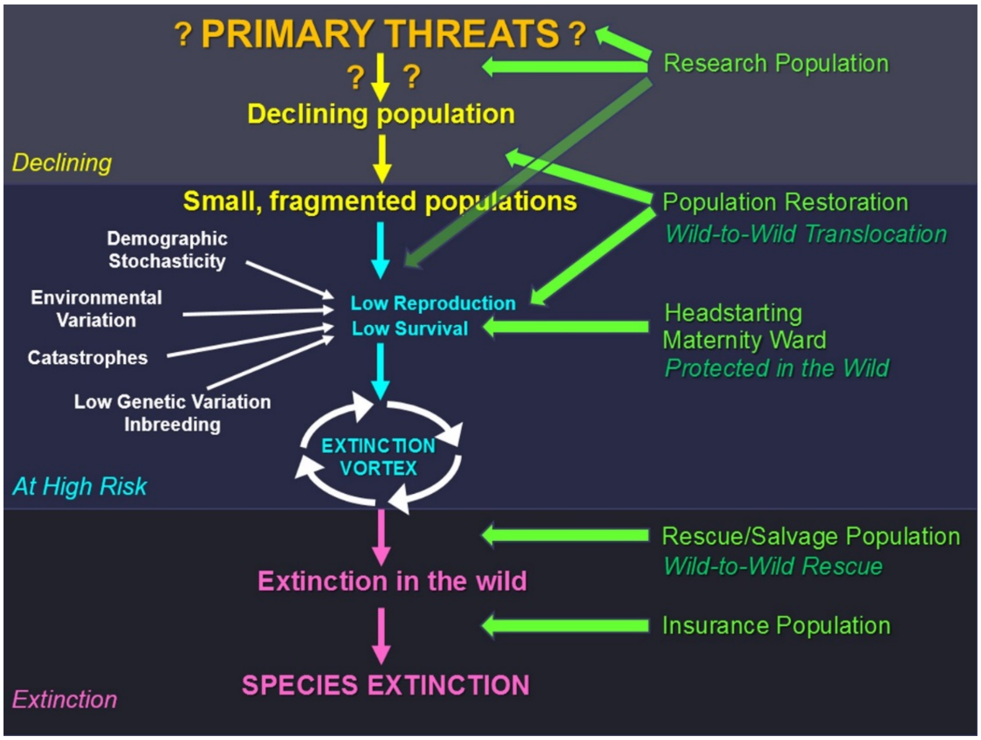


Figure 1. Diagram relating the optimal application of population management options to the extent of extinction risk for a given endangered wildlife species. Management options are on the right side of the diagram; un-italicized options refer to programs focused on *ex situ* activities, while italicized options refer to programs focused on *in situ* activities. See accompanying text for more information on each of these management options.

Species-Specific Identification of Potential Population Management Options

Following the discussion on alternative population management conservation roles presented in the last section, the workshop participants divided themselves into two working groups corresponding to the two butterfly species of interest in this analysis. The two groups then combined the information on species threats to long-term demographic and population stability (Table 1) with the list of potential population management conservation roles and their effective application to endangered populations (Figure 1) to derive a matrix of applicable population management conservation roles for each species. The combined information is presented in Table 2.

Note that the Poweshiek skipperling working group took a much more inclusive approach to identifying potential population management roles. This is likely a result of the higher risk of extinction this species faces as it is reduced to only a few remnant populations with a very small number of individuals in each. It may therefore be wise to consider each of the population management options in greater detail to determine how effective they may be in reducing the risk of losing the species in the wild.

It is also perhaps worth noting that the Dakota skipper working group identified four population management options with the greatest potential to contribute to effective conservation across the life-cycle of the species: Population Restoration Source, Head-Start Program, Research Population, and Protected in the Wild. This is in line with the information presented in Figure 1, where the risk of imminent extinction for the Dakota skipper – while still threatened with continued population fragmentation and decline due to existing and future threats – is not as high as that for the Poweshiek skipperling.

The following sections of this report feature detailed reports from each of the two species-specific working groups. The reports outline a more detailed threat assessment, discuss at length the characteristics of each potential population management conservation role laid out in Table 2, and ultimately present the groups' recommendations for developing an intensive population management program as a component of the general species conservation strategy.

Table 2. Identification of potential population management conservation roles for Poweshiek skipperling (P) and Dakota skipper (D), organized by the presumed ability of each option to ameliorate threats to one or more demographic rates and impacted population status characteristics. See accompanying text for more information on data presented in the table.

Population Management Role	Demographic Rates Impacted by Threats						Population Status Resulting from Threats	
	Egg survival	Larval survival (pre-hibernation)	Larval survival (overwinter)	Larval survival (post-hibernation)	Adult survival	Adult reproduction	Small population	Population fragmentation
***Ex Situ* Population Management Options**								
Insurance Population	P	P	P	P	P	P	P	
Source for Population Restoration	P	P, D	P	P, D	P, D	P, D	P, D	P, D
Head-start Program	P, D	P, D	P, D	P, D	P	P	P, D	D
Maternity Ward	P, D	P	P	P, D	P		P, D	D
Temporary Rescue (Salvage)	P				P	P	P, D	D
Research Population	P	P, D	P, D	P, D	P, D	P, D	P, D	P, D
***In Situ* Population Management Options**								
Protected in the Wild (*Ex situ* in the field)	P, D	P	P, D	P, D	P, D	P, D	P, D	D
Wild-to-Wild Translocation	P	P	P	P	D	P,D	P, D	P, D
Wild-to-Wild Rescue (Salvage)	P	P	P	P, D	P, D	P, D	P	P

Poweshiek Skipperling: *Ex Situ* Program Assessment and Planning

Working Group participants:

Su Borkin, Milwaukee Public Museum
Dave Cuthrell, Michigan Natural Features Inventory
Melissa Grantham, Nature Conservancy of Canada
Tara Harris, Minnesota Zoo
Kelly Nail, US Fish and Wildlife Service
Cale Nordmeyer, Minnesota Zoo
Laura Ragan, US Fish and Wildlife Service
Ron Royer, Minot State University (retired)
Tamara Smith, US Fish and Wildlife Service
Scott Swengel, independent researcher
Sarah Warner, US Fish and Wildlife Service

Threat Assessment

The working group referred to the threat assessment table (Table 1) produced in plenary on the first morning of the workshop and then prioritized which of the components/population characteristics (e.g., life stage) was most influential in determining long-term viability of the Poweshiek skipperling. Where desired, additional stressors were added to the threats originally defined in plenary. Each stressor under each component was then evaluated to see what contributes to each component. We estimated which aspects of the life history are under the greatest threat to ensure long-term viability. The results are presented below in priority of main categories, with the group score in parentheses (scoring done by each group member through a process of assigning points to those threat components they believed were of greatest concern).

1. <u>Small population size (8)</u>
    a. Extinction vortex – stochastic instability in demography and genetics that increase rate of decline in small populations
    b. Reduced source for dispersal/reduced detection
    c. Higher rates of inbreeding
    d. Allee effects (difficulty finding mates in low-density populations)
    e. Small number of sites
    f. Lack of onsite monitoring
    g. Lack of appropriate onsite management
    h. Excessive handling of individuals in the field

2. <u>Larval survival – pre-hibernation, overwinter, post-hibernation (8)</u>
    a. Overgrazing
    b. Disease
    c. Parasites
    d. Pesticides
    e. Invasive species
    f. Weather events
    g. Climate change
    h. Over-burning
    i. Eutrophication
    j. Limited food resources
    k. Groundwater alteration
    l. Larval host plant survival
    m. Snow cover (under climate change)

n. Ignorance of causes
o. Flooding
p. Direct/indirect temperature effects
q. Land management
r. Habitat fragmentation

3. Population fragmentation (6)
    a. Habitat deterioration
        i. Intrusion of invasive plant species
        ii. Woody invasion – ineffective brush control
    b. Climate change
    c. Inbreeding among fragmented populations
    d. Future loss of habitat

4. Adult reproduction (5)
    a. Demographic instability – too few individuals
    b. Inbreeding
    c. Low population abundance
    d. Habitat quality (not overgrazed, long-term changes, invasive species, land management)
    e. Disease
    f. Parasites
    g. Site management – conflicting objectives
    h. Limited food resources
    i. Excessive handling of individuals in the field

5. Adult survival (0)
    a. Overgrazing
    b. Over-handling of individuals in the field
    c. Limited food resources
    d. Pesticides
    e. Disease
    f. Parasites
    g. Lack of appropriate shelter – refugia & buffer areas (moisture gradient, etc.)
    h. Weather events
    i. Flooding
    j. Land management
    k. Groundwater alteration
    l. Over-burning

6. Egg survival (0)
    a. Overgrazing
    b. Pesticides
    c. Climate change
    d. Disease
    e. Parasites
    f. Weather events
    g. Availability of plants on which to lay eggs (structure)
    h. Groundwater alteration
    i. Habitat quality
    j. Management of habitat – (e.g., burning)
    k. Predators
    l. Adult fitness – effect on egg survival?

Notes from the discussion accompanying the threat evaluation:

- In much of our discussion for the three larval stages, the threats were almost identical. For this reason, we lumped the three stages into one category, while also recognizing that *ex situ* management techniques may not apply to all three stages.
- There is a lot of uncertainty around these threats and which life stages are most important, but the proposed *ex situ* management alternatives cut across many of these problems.
- Patch size relates more to *in situ* management and can have a positive and/or negative effect (Allee effect or stochastic effect).
- Egg survival – was considered to be a lower priority because the larval stage is of the longest duration.
- It may be very valuable to weigh the stressors within a given threat, but that is outside the scope of this workshop and could be done at a later date if desired.
- The Dakota skipper group also talked about threats initially. They prioritized pre-and post-diapause and pupal stages. Pre-hibernation larval stage was highest priority, small population size, population fragmentation, larval survival, adult survival and egg survival was the last priority. Lots of repetition of *ex situ* and *in situ* techniques for the various categories. Combination of lab and field – pots in field – protected conditions in the wild – post hibernation larval survival. Adult reproduction – need a lot more research on how to prioritize these things. Overwinter and egg survival ended up at the bottom of the prioritization list.

Identification of Potential Population Management Roles to Address Threats

With the threat assessment for Poweshiek skipperling in hand, and the set of potential *ex situ* and *in situ* management options available to us, we identified which option(s) would be effective in addressing each of the identified species threats. This information is summarized in Table 3 below.

Table 3. Applicability of population management alternatives to conservation of the Poweshiek skipperling.

	Threat					
Population Management Option	Small Population size	Habitat Fragmentation	Reduced Larval Survival	Reduced Fecundity	Reduced Adult Survival	Reduced Egg Survival
Ex situ						
Insurance Population	Y	N	Y	Y	Y	Y
Source Population for Reintroduction / Reinforcement	Y	Y	Y	Y	Y	Y
Head-start Program	Y	N	Y	Y	Y	Y
Maternity Ward	Y	N	Y	N	Y	Y
Temporary Rescue	Y	N	N	Y	Y	Y
Research Population	Y	Y	Y	Y	Y	Y
In situ						
Ex Situ Protected Conditions in the Field	Y	N	Y	Y*	Y**	Y
Wild-to-Wild Translocation	Y	Y	Y	Y	N	Y
Wild-to-Wild Rescue (salvage)	Y	Y	Y	Y	Y	Y

* may increase encounter frequency among adults
** erect fence to exclude cattle

Notes from the discussion accompanying the creation of the above table:

- Remember that the Maternity Ward option involves bringing females into an *ex situ* facility and allowing them to lay their full complement of eggs. This option could potentially be a component of a head-start program – the only difference may be the number of eggs retained. Someone commented that we do not know exactly what they need to increase survival. We defined a maternity ward as a type of head-start program for purposes of this exercise. There is a subtle difference between the two.
- Both *ex situ* and *in situ* options could be applied in many cases, so we voted Yes for many of the *ex situ* and *in situ* techniques for each of the threats (columns).
- In general, there were many Yes votes for each category – i.e., many of these *ex situ* or *in situ* techniques could be appropriate. There were caveats to many of the places where we wrote "Yes".
- There were several "No" votes in the habitat fragmentation category because we saw it more as a habitat issue, rather than an issue of individual survivorship or reproduction. Those *ex situ* methods would not address habitat.

A Deliberative Analysis of Each Population Management Alternative

A more detailed study of all the options relevant for Poweshiek skipperling appears below. This study includes an examination of the pros and cons of each program alternative. Where feasible, specific "fixes" were identified that could alleviate any one of the weaknesses ("cons") of a given program management alternative.

The working group decided to focus their attention on the *ex situ* program(s) that would be most valuable because of the high extinction risk facing the species. This meant that the three in situ management options – *Ex Situ* Protected Conditions in the Field, Wild-to-Wild Translocation, and Wild-to-Wild Rescue (Salvage) – were not considered for Poweshiek skipperling in this workshop. It is imperative that species management is implemented in a way to bring the species out of the extinction vortex. After examining the threats and management options that were presented to workshop participants in plenary, the working group concluded that the most appropriate management alternatives to consider would be (1) creation of an insurance population, (2) developing a head-start program, and (3) the temporary rescue (salvage) option.

Insurance Population

Goal and Purpose: Prevent the Poweshiek skipperling from becoming extinct.

Discussion notes: When initiating a captive population, the amount of genetic variation (heterozygosity) captured from the wild population is approximately $H_c = 1\text{-}(1/2N_F)$ where N_F is the number of founders (i.e. unrelated individuals that produce surviving offspring). We may not have to collect 20 all at once, instead we can collect a smaller number (e.g., 5 per year) to maintain genetics. We may have to supplement a population every other year. Can we change the slope of the line? Need to equalize family sizes by good genetic management. N_F = number of founders unrelated must contribute equally to offspring generation.

Assumption that we would only breed animals within the same population or those with known *Wolbachia* strains. We assume that we will have genetic structure of *Wolbachia* known to us after this winter.

Structure:

1. Rearing and breeding program. Build insurance population over time. Take the highest viable number of wild individuals (exactly which population(s) will be determined based on known information (genetics, *Wolbachia*) and assumptions). Supplement yearly as viable.
2. Population size to be maintained, life stage, types of facilities needed, etc.
    a. *Life Stage:* All
    b. *Type of Management:* Maintain population at all life stages. Collect adults.
    c. *Facilities:* Multiple rearing facility locations to diversify.

Table 4: Needs, risks, and feasibility of an insurance population program for the Poweshiek skipperling.

	Yes/No	Pros	Cons	Fix	Assumptions/ Notes
Biological Feasibility	Yes	1. Removing individuals from potential threat 2. Maintain a population 3. Potential to ramp up numbers quickly with breeding 4. Source stock 5. May maintain a higher genetic diversity 6. Disease may be controlled through protocol– e.g., not releasing diseased individuals back into wild	1. Can't guarantee we can breed – unknown breeding success 2. Artificial selection to captive conditions 3. May not be able to reach the number of founders. 4. Fragile insect, difficult to handle 5. Potential negative impacts on wild population – from	1. Learning from experience and adaptive management 2. Surrogate species research 3. Morphological monitoring (measure historic populations in museum collections) 4. Supplement from wild (potentially difficult fix if	Removal of a few individuals may not be a big effect, if that is so, then the population is already doomed.

	Yes/No	Pros	Cons	Fix	Assumptions/ Notes
			removal of individuals 6. Higher probability of disease transmission between individuals	populations continue to decline) 5. Heterozygosity model – start small and supplement 6. The pros can control the cons. Multiple facilities will help.	
Social Feasibility		1. Lots of state or government owned land; NCC/partners in Canada 2. Generates public interest	1. Unknown cooperation of landowners 2. Unknown social feasibility of program in Manitoba	1. Establish strong partnerships with stakeholders 2. Engage MB Zoo and other stakeholders	
Regulatory		1. ESA Federal and state protections 2. Potential funding	1. International regulations? 2. Potential conflict between state/federal 3. Timing of state and federal permit	2. Establish trust and strong partner engagement 3. Apply for/renew permits early. Some permits already in place.	
Resource			Increased cost – long term commitment		
Likelihood of Success		1. Easier to measure success. 2. Potential source population for other *ex situ* / *in situ* programs	Could remove several individuals		Low for one year because of unknown breeding success. Success will improve in later years.
Risk Assessment					

Knowledge gaps identified during the discussion of an insurance population program (may apply to multiple programs)

1. The consequences of crossing individuals from different populations is unknown – regarding genetics, disease, etc.
2. Uncertainty in appropriate breeding protocols for this species. Rearing protocols, capture/release/transport protocols.
3. Potential need for preliminary research on surrogates before programs are attempted for Poweshiek skipperlings.
    a. Suggested surrogates included *Oarisma garita*, *Oarisma edwardsii* or a *Copaeodes* species due to close phylogenetic relationships.

Source for Population Restoration

Goal: To re-establish extirpated populations via reintroduction and/or increase the viability of existing population via reinforcement to avoid the destabilizing forces of an extinction vortex.

Discussion notes: Many similarities here to the insurance population; summary below primarily points out major differences in the two programs

Structure:

1. Restoration via reintroductions (inter-site) or restoration via reinforcement (intra-site)
2. Need much larger number of individuals for the reintroduction program than that for an insurance population. A commitment to mitigating the threats at reintroduction sites is required for this – need for habitat management and monitoring.

Table 5: Needs, risks, and feasibility of a source for population restoration program for the Poweshiek skipperling.

	Yes/No	Pros	Cons	Fix	Assumptions/ Notes
Biological Feasibility	Yes	1. Benefit to wild population size and numbers (reintroduction and reinforcement). 2. Success is very measurable at reintroduction sites. 3. Less disease risk for reintroduction	1. Need more individuals to put out into the wild (for reintroduction and reinforcement) 2. For reintroduction - identification and mitigation of stressors to the population. 3. For reinforcements, issue is disease risk	2. (Ongoing) research (habitat) (e.g., retrospective land management analysis) 3. Protocol to reduce disease risk	Need to identify places to release
Social Feasibility	Yes	See Table 4	See Table 4		
Regulatory	Yes	See Table 4	See Table 4		
Resource	Yes	1. Long term cost may be less/similar because of limited number of time	1. More costly (initially) 2. More staffing needs	1. Fundraising and partnerships	
Likelihood of Success					
Risk Assessment					

Knowledge gaps identified during the discussion of developing a source for population restoration program (may apply to multiple programs)

1. There is a need for better understanding of habitat needs and threats to habitats, before decisions could be made in regards to where Poweshiek skipperlings may be reintroduced.
2. Do we need a retrospective analysis of land management and past Poweshiek records, to help determine appropriate management for this species? Need compatible site management and monitoring protocols for Poweshiek skipperlings.

Head-Start Program

Goal and purpose: Increase population size and recruitment in the wild. Increase survivorship during the most sensitive life stages, bypassing presumed high mortality in the early life stages.

Discussion notes: Because larvae are essentially impossible to detect in the field, we do not know at what stage *O. poweshiek* experiences the greatest amount of mortality under natural conditions.

Structure:

1. Remove *x* adult females from the *y* wild populations to get *z* individuals released into the wild the following year after egg collection (with egg collection occurring within a 48-hour period). Knowledge gaps: We don't know how many adults we would need. We also restricted our discussion to releasing individuals back into the source population.
2. Population size to be maintained, life stage, types of facilities needed, etc.
    a. *Life stage*: Adult females for collection, release stage is uncertain – to be determined (likely late-stage larvae or pupae)
    b. *Capture/release techniques*: Hold animals in favorable conditions, avoiding extremes such as high temperature; avoid desiccation; use an expert handler during the process. It is vital to develop a protocol for capturing, handling, transport, etc. based on prior experience.
    c. *Facilities*: Will likely depend on the number of animals that are used.
3. Collect females during the flight period for egg collection.
    a. Females are only to be netted and handled by identified, permitted, handlers. Protocols should be followed to prevent harm by following best management practices and protocols (currently being developed). Females are only held for up to 48 hours while they oviposit.
    b. Females are released back at the location they were collected from within 48 hours of being collected.
4. Eggs are brought back to a designated rearing facility (Minnesota Zoo, or other identified location/partner).
5. Larvae are reared to mimic natural conditions a close as possible following best management practices and protocols (currently being developed).
6. Collected offspring are returned to the site their mother was collected either as late instar larvae, or pupa (TBD).

Knowledge gaps: We don't yet know the desired target number of founders.

Table 6: Needs, risks, and feasibility of a head-start program for the Poweshiek skipperling.

	Yes/No	Pros	Cons	Fix	Assumptions/ Notes
Biological Feasibility	Yes - Founder source in Michigan (or Manitoba?) Yes- we have expertise for collection.	1. Potential increase in number of individuals in population. 2. Flexibility of stage of release.	1. Potential negative impact on the source wild population (drop in population number, reduced fitness – is this true?, introduction of disease) 2. Unknown success rate (survival rates) in captive rearing vs. wild. 3. Cost of handling (Experimental & never been done) 4. Difficult to monitor success of program.	1. Population numbers - Numbers gained will offset taken (success) Fitness – surrogate research; Intro of disease – use best management practices, implement different *ex situ* program (reintroduction) 2. Fix for knowledge gap – research, assumption that it is greater than in survivorship. 3. Develop & use best practices, training & expertise 4. Monitor populations, mark individuals for immediate success.	Assuming that 3% survivorship in the wild, assuming that captive rearing will have a greater survivorship. To avoid sink.
Social Feasibility	Yes	Same as Table 4	Same as Table 4	Same as Table 4	
Regulatory	Yes	Same as Table 4	Same as Table 4	Same as Table 4	Does Federal government take precedence over state?
Resources	Yes, MN Zoo & Nature Conservancy of Canada have potential accommodations	1. MN Zoo more than willing to take this on in US 2. Potential research, facility, access, funding, etc. from Nature Conservancy	1. Limited expertise 2. Limited funding 3. Proximity (MN Zoo is not close to any of the existing sites)	1. Training 2. Grants 3. Partnerships with additional zoos – maybe specializing on areas of expertise (release life stage)	

	Yes/No	Pros	Cons	Fix	Assumptions/ Notes
		of Canada in Manitoba			
Likelihood of Success	Need to define success. Low to Medium – general gut feelings of the group, varies depending on the circumstance. methods, etc.	1. Avoiding inbreeding depression 2. Avoiding *Wolbachia*	1. Difficult to measure success – how to define success 2. Limited number of populations/sites 3. Small population sizes - # of individuals to start with 4. Low numbers that will be returned to the environment	1. Develop criteria to measure success (and to start the program). 2. Develop criteria 3. Develop criteria or decision matrix – (e.g., to determine the appropriate number of individuals to use and the recipient population) 4. Do a mixed program strategy – (complimented by a breeding program) 5. Use surrogates to help us determine unknowns (rate of survivorship)	Notes: Probability of success that head-start program will be able to provide and increased number of larvae vs. survival in the wild vs. no head-start & possibility of introduction of disease to wild population.
Risk Assessment		(a lot of this was captured above)	(a lot of this was captured above)		

Notes and discussion points

- We should consider bringing eggs to a facility closer to the collection location.
- MN Zoo has estimates of egg hatching rate for Poweshiek skipperling in captivity.
  - Michigan, 2012: 86.7% hatch (sample size = 255 eggs)
  - Wisconsin, 2012: 88.2% (sample size = 51 eggs)
  - Manitoba, 2013: 72.8% (sample size = 11 eggs)
- *Facilities*: Types of facilities needed for holding the female: Generally females are kept in oviposition chambers or in a hotel room, shaded and cool, with short transport period. Desiccation can be an issue, so it is important to have an experienced person handling the female during collection and identification of female reproductive stage. Put females in a vial, in a cooler, moisture is an issue so keep them cool until in the oviposition chamber (9 oz. cup). Females are temporarily held near the site and released back to the same site.
- Need natural environmental conditions, removal of threats from predators, removal of threats of extreme environmental conditions.
- *Life stage*: Adult females
- Clarification – A head-start program involves rearing early life stages and releasing them into the wild later to increase survival. The group questioned at which stage that release should occur. It likely doesn't make sense to release eggs or early larvae; instead, it may be best to protect the individuals through diapause and release late-stage larvae, pupae or adults. At what stage is the margin of success the highest compared to success in the wild?
- How many individuals would we bring into captivity? Example - Need to find 25 Dakota skippers for within 24 hours to remove a certain number of individuals.

Knowledge gaps identified during the discussion of head-starting (may apply to multiple programs)

1. A lack of understanding of the strains of *Wolbachia* in the positive samples from Michigan, Wisconsin, and Manitoba.
   a. Do these strains cause sterility in males?
   b. Are there cross-infectivity issues emerging from a consideration of genetic mixing among populations?
2. The mortality/survivorship rates for all life stages in the wild are unknown.
3. We do not have a good understanding of the thresholds relating to numbers of individuals that could reasonably and feasibly be removed from wild populations.
4. There is a need for decision-making criteria.
5. The current state of knowledge on captive breeding programs at the Minnesota Zoo on Poweshiek is not informative for a head-starting program at this time.
6. The success rate of any type of *ex situ* or *in situ* program is unpredictable, and at this stage, any adopted program would be experimental on Poweshiek. Therefore, there is an unknown likelihood of success.
7. We do not have a good understanding of the underlying factors that are affecting population declines.
8. We currently have an inability to directly measure the success of a head-starting program.
9. The cost of handling individuals is unknown, although some observations suggest that adult handling may affect behavior, potentially negatively affecting reproduction and population size.
10. There is a need for a decision-making matrix that applies to populations/habitats/sites on the receiving end of any adopted *ex situ* program.

Plenary discussion notes

- Robert Dana: Unless we can establish a success rate that is higher than that in the wild – to avoid a sink – this might not work. We didn't decide whether we would be doing this program – yet to be determined.
- We need to develop criteria or decision matrix – (e.g., to determine the appropriate number of individuals to use and the effect on the recipient population).
- Scott Swengel: Impacts of handling individuals in the field:
    - 2.1% recapture but 21% recapture rate that the butterfly was marked while it was asleep (didn't know when they've been handled). Butterflies never handled (not knowing) vs. handled (comparing legs vs wings may not mean much – both handled)
    - Extreme decline since 2012 may be due to handling stressor added to extreme heat and other stressors. Be careful when handling. Big Valley, Brandt Road/Holly, Long Lake sites – handled and decline; Halstead Lake site – not handled, no decline, slight increase; Scuppernong site – handled, 100% decline; Puchyan Prairie site – not handled, no decline.
    - Robert Dana's reply – 50+ sites for Poweshiek in Minnesota, no individuals handled, all populations disappeared. So Scott's comment may be circumstantial evidence.
    - Take home message - the species is under a lot of stressors, so we need to be extremely careful when handling. Training is strongly advised.

Maternity Ward

Goal: Increase population size and recruitment in the wild. Increase survivorship during the most sensitive life stages, bypassing presumed high mortality in the early life stages.

Structure:

1. Remove adults and release offspring. Retain females to get all the eggs.

Discussion notes: We thought we did not need to discuss this program much because it is very similar to the head-start program and the only difference is retention of the female adults. However, then the group decided it was worth discussion because if some of the circumstances (below) occur, then we can consider this program as an option. Maternity ward programs may be a subset of the head-start program – we may want to have a decision tree to help decide when we would want to use maternity ward program.
A maternity ward program may not be the preferred program on its own, but it may be best used in conjunction with head-start program. Maternity ward programs may be appropriate to use under certain circumstances (e.g., older females, unhealthy females, failure to oviposit, etc.)

Table 7: Needs, risks, and feasibility of a source for maternity ward program for the Poweshiek skipperling.

	Yes/No	Pros	Cons	Fix	Assumptions/ Notes
Biological Feasibility		1. Potential increase in number of individuals in population. 2. Flexibility of stage of release.	Potential for less genetic diversity in the wild derived from a smaller number of reproductive females.		
Social Feasibility		1. Lots of state or government owned land; Nature Conservancy of Canada / partners in Canada. 2. Generates public interest	Release of females is better from public relations angle.		
Regulatory		1. ESA Federal and state protections 2. Potential funding	Potential regulatory difficulties - regulatory aspects may be different		

			than head-start because we are not releasing females		
Resources		1. MN Zoo more than willing to take this on in US 2. Potential research, facility, access, funding, etc. from Nature Conservancy of Canada in Manitoba			
Likelihood of Success					
Risk Assessment					

<u>Knowledge gaps identified during maternity ward discussion</u>

An assessment of what’s already been done on other species should be carried out to help inform any programs that may be adopted or developed for Poweshiek

Temporary Rescue (Salvage)

Goal: Prevent extirpation or high mortality of Poweshiek skipperlings – temporarily - due to predictable imminent threats.

Discussion notes: What threats would be ameliorated by rescue? What are we rescuing from? Two weeks of extreme heat. Wildfire? Flood? We were hard pressed to think of another type of imminent threat.
Could we mitigate any imminent threat? A decision tree is needed here.
Permits - Emergency Section 7 consultation (conducted after the emergency, not during) or Section 10 permit.

Structure:

1. Enactment of rescue removal of all adults (males and females), if removal will occur during the flight.
2. Population size to be maintained, life stage, types of facilities needed, etc. - depends

Table 8: Needs, risks, and feasibility of a source for temporary rescue program for the Poweshiek skipperling.

	Yes/No	**Pros**	**Cons**	**Fix**	**Assumptions/ Notes**
Biological Feasibility		Availability of ESA permits	1. Limited window of opportunity 2. Intervention may not be better (assuming we know better than the species) 3. If plan to respond to adverse management may encourage bad management	2. May still be some individuals left in the population 3. ESA protections – purposeful take is prohibited	
Social Feasibility					
Regulatory					
Resource					
Likelihood of Success					
Risk Assessment					

Research Population

<u>Goals:</u> Conduct research on a surrogate species to inform *ex situ* programs and also to inform land management decisions for Poweshiek skipperling.

<u>Discussion notes</u>: The group agreed that this is not feasible for Poweshiek right now but may be feasible after success with other programs. We may want to bring in partners to conduct some of this work (e.g., other zoo facilities may be better equipped to work with surrogates for a variety of reasons).

<u>Structure</u>:

1. Research not on Poweshiek skipperling itself, but instead using a surrogate species (e.g., *O. edwardsii*, *O. garita*) for research.
2. The structure of the program will be dependent on research question.
3. Population size to be maintained, life stage, types of facilities needed, etc. – Depends on research questions
4. Types of facilities

Instead of going through pros and cons of the research program, we identified some important research questions for Poweshiek skipperling:

1. *Wolbachia* crosses – the effect that the various strains may have on Poweshiek skipperling
2. Pesticides – toxicity, thresholds, etc.
3. Host plant and structure preferences
4. Life history and demographics (e.g., mortality and survivorship of life history stages)
5. Factors influencing breeding success
6. Overwintering conditions (e.g., effects of snowpack or lack thereof)
7. Environmental thresholds (physiological)
8. Rearing protocols – develop protocols for Poweshiek
9. Release protocols and variations (e.g., soft release)
10. Experimental release to understand if the surrogate can survive at selected locations
11. Vulnerabilities – parasites, fungal, other diseases
12. Dispersal between sites/populations
13. Hydrologic questions
14. Flooding survival
15. Fire survival & response (Manitoba studies – are they completed?)
16. Genetics
17. Adult nectar preferences
18. Research on relatedness of *Oarisma poweshiek*, *Oarisma garita*, and *Oarisma edwardsii* – which one of the two would be the most appropriate surrogate.

Beginning of the Decision Process

The working group started a preliminary assessment of the likelihood of success of various programs.

Ex-situ Program	**Likelihood of Success (Immediate)**	**Degree of Uncertainty**	**Notes**
Insurance	Low		
Restoration Source	Medium		
Head Start (Maternity Ward)	High		
Temporary Rescue			
Research			

Summary/discussion notes:

- Decision Tree - If number is *x*, then insurance. If number is *y*, then release into the wild. Adaptive on program based on numbers and lessons learned. Insurance program needed but not sure how successful we will be the first iteration of the program. For example, if the result of the insurance program was only a few individuals, all one sex, etc. then those individuals may be used differently, e.g, released.
- Where is the best site for collecting founders? How many individuals would be appropriate to collect?
- Head-starting, retaining some for restoration, considering insurance if enough individuals in the long-term goal.
- “Policy” level decision on where to grab sites – those with “robust” structure or from a site like Puchyan Prairie– to do this without being confident in our ability. Risks and Benefits – risk of population extirpation currently (may not be causing a change in their trajectory if already 95% chance of extirpation at the site) vs. benefit. Ann commented that it will likely be very difficult to collect any adults at Puchyan Prairie, and we were not likely to get them all – it is a difficult site in which to work.
- Should we implement one program with different sub-components and goals? Or several programs with different goals? For example, establish an insurance population that could also serve as a source population. Need to be explicit about each goal. For reintroduction – how did the Dakota skipper group overcome the number games with the numbers needed (or best) for reintroduction? Answer – they will tie this question into research.
- Resiliency in the wild vs. insurance?
- Adult or larvae – which strategy to go to given the number of larvae you reared.
- NOTE: Compare existing programs to see what they are doing – for example, the Oregon Zoo is using a mixed-program approach for Taylor’s checkerspot (*Euphydryas editha taylori*).

A Recommendation for Population Management of Poweshiek Skipperling

The goal and purpose of several *ex situ* programs were identified and the needs, risks, assumptions, and feasibility of each potential program were assessed. Based on this detailed analysis, this working group recommends short- and long-term plans with mixed *ex situ* strategies. The short-term plan focuses on head-starting for reinforcement of extant sites and surrogate research, while a long-term plan includes an insurance program and reintroductions to extirpated sites. Both the short- and long-term plans may act concurrently – certain decision points will trigger movement between programs (see Figure 2). The strategies will require cooperation between FWS and the state of Michigan, Michigan Natural Features Inventory, the Minnesota Zoo, the Nature Conservancy of Canada, Michigan landowners, and other partners and zoos (Table 9).

Goals of the Mixed-Programs Approach:

1. Establish a head-start program to augment extant locations for reinforcement (intra-site).
2. Conduct research on a surrogate population.
3. Establish an insurance population (long term).
4. Reintroductions to locations with historical records (inter-site), but are thought to be extirpated (long term).

Head-Start Program

Head-start Program Vision – An increased population size and recruitment of the Poweshiek skipperling in the wild.

Head-start Program: A head-start program for the Poweshiek skipperling is recommended, beginning in 2016, utilizing two wild founder source populations from Michigan (Brandt Road and Long Lake Fen). Propagules will be used to reinforce the populations where the collections were made (intra-site). It is recommended that the Assiniboine Park Zoo or other Canadian partner start a similar head-start program utilizing founders from two separate sites within the Tall Grass Prairie Preserve (8 and J67) starting in 2017, using time in 2016 to obtain permits, prepare facilities, and obtain training (from MN Zoo). 2016 Methods - Eggs from females will be collected on-site from a proportion of the individuals observed during the flight period. Females will be released back to the site of capture within 48 hours. Eggs will be reared at the MN Zoo and will be released post-overwintering as late-instar larvae or pupae.

Short-Term Head-Start Program Goal:

- Reinforcement of x/14 extant locations of Poweshiek skipperling – potentially 4 sites (2 Michigan sites, 2 sites in MB – see Table 9)
    - Temporarily remove *x*% of the population from wild into captivity (~20-25%)
    - Return females back to the wild to continue laying eggs at the collection site
    - Return offspring back to the wild in the following year (intra-site reinforcement)

Measureable Outcomes:

- For goal of increasing population: Monitor the results in 2017. Measure the positive trend in population size.
    - Examine both per effort (observations per minute) and daily high count.
    - Create an expected trend line – and compare if the trends stay the same or above trend line (using standard survey protocol that has been used since 2009, or something with comparable results).
    - *Monitoring discussion notes* – Dave Cuthrell will send out the standard protocol to the group for review.

Table 9: Potential collection, reinforcement, and reintroduction sites for Poweshiek skipperling management.

State/Province	Sites with extant populations in 2015	Collection Sites	Reinforcement Sites (short term)	Reintroduction Sites (long term)
Wisconsin	1	0 sites	Puchyan Prairie?	TBA – perhaps Scuppernong?
Michigan	4	2 sites (Brandt Road, Long Lake)	2 sites (Brandt Road, Long Lake)	TBA – perhaps reintroductions to Liberty Fen
Manitoba	9	2 sites (J 67, 8)	2 sites (J 67, 8)	TBA – sites 5, 11, 22 and 23 in MB?

Additional Programs

Short- and Long-Term Goals:

- Build up insurance program, until we have enough numbers for reintroduction (long-term).
- Conduct research on a surrogate species to inform all *ex situ* programs. Also conduct habitat research and management of sites (short-term).

Research Program: Research will be conducted concurrently, primarily on breeding and husbandry technique, using a closely-related species. Additional research (e.g., habitat) will occur at extant sites and potential reintroduction sites to determine suitability for reintroductions.

Reintroduction Program: If large numbers of larvae survive the head-start program, it will trigger a decision whether to reintroduce those larvae to extirpated sites (inter-site).

Insurance Program: If the surrogate husbandry research is successful, an insurance program may be created using captive-reared individuals (F1).

Challenges for All Programs: Limited funding and staffing. Limited number of individual Poweshiek skipperlings available for collection. Uncertainty in husbandry techniques. Uncertain causes of decline. Uncertain risk of disease transmission.

Long-Term/Short Term Plan Model (Figures 2 and 3)

Text description of the model

- Source from 4 sites in the wild population (2 sites in MI in 2016 and 2 MB sites – likely in 2017)
- If larva numbers are high, and surrogate species research is a success (husbandry research), then go to captive propagation
- If numbers are low, then reinforcement of the wild population where collection took place (intra-site until *Wolbachia* release complete) (post-diapause release)
- If numbers are high, then reintroduction into wild populations (not founder sites) – places with historical records, but may be extirpated.
- Throughout this process, we will simultaneously be conducting surrogate species research on husbandry, habitat, and release to inform the appropriateness of an insurance program and *ex situ* breeding potential.

- If numbers are high from head-start program, then captive propagation and the F1s would be used for reintroduction and/or to establish an insurance population (need to determine our trigger for starting an insurance population).

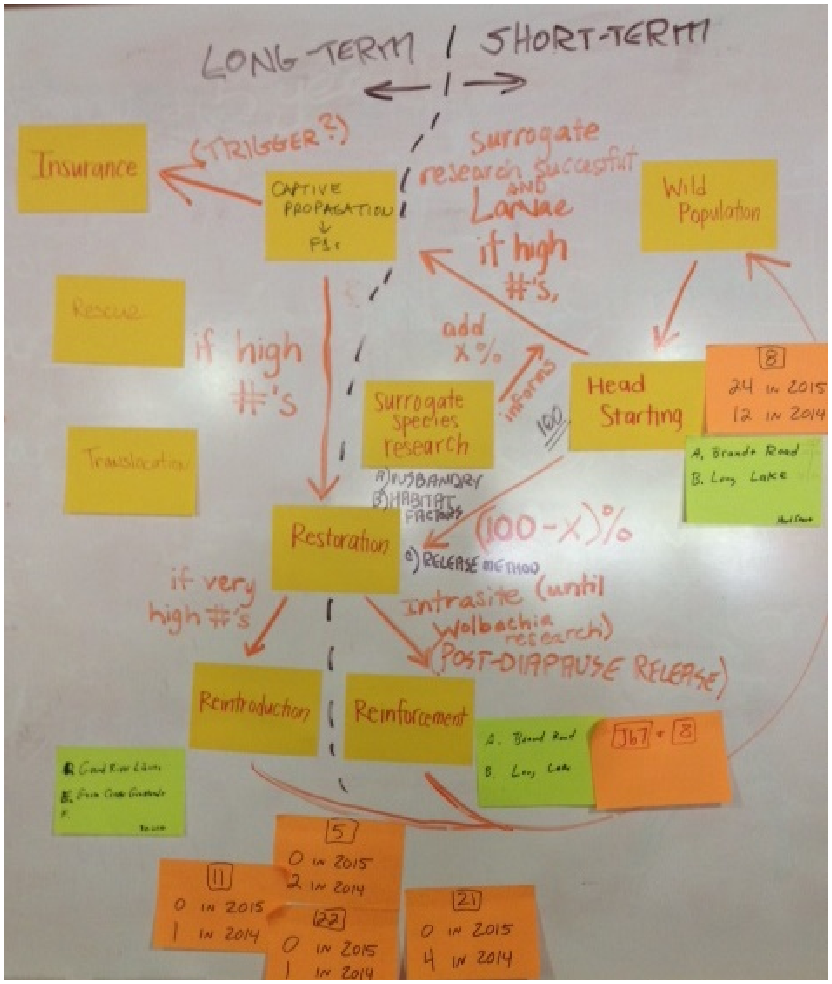


Figure 2: Photograph of the short- and long-term plan for population management of the Poweshiek skipperling.

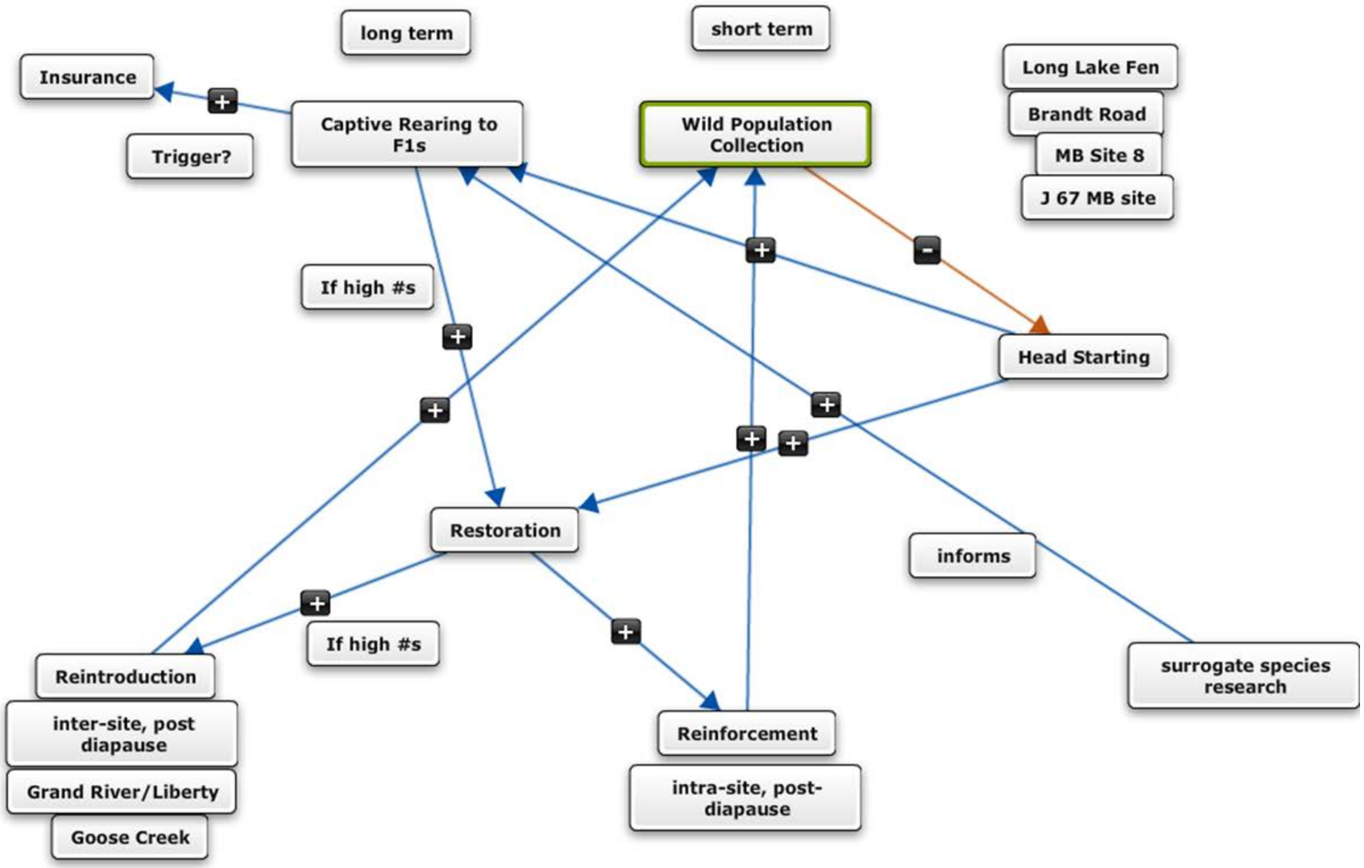


Figure 3: Flow chart showing relationships between the short- and long-term plans for population management of the Poweshiek skipperling.

Action Plan for Population Management of Poweshiek Skipperling

Table 10 below outlines the actions and tasks to be completed over the next 1-2 years for integrated population management of Poweshiek skipperling. US Fish and Wildlife Service may identify new tasks as necessary and will take an adaptive management approach to the head-start and captive rearing programs. The Service may collaborate with additional partners and will bring in new collaborators and facilities as needed.

Table 10. Poweshiek skipperling *ex situ* population management action plan.

Tasks	Responsible Parties (Poweshiek skipperling)	Timeline	Responsible Parties (surrogate)	Timeline
Identify collaborators & capacity	Manitoba Nature Conservancy of Canada – Melissa Grantham Assiniboine Park Zoo – Tara Harris/Melissa Grantham Others? – Dave Cuthrell	Dec. 2015	MN Zoo – Tara, Cale, Erik (*O.edwardsii*? and/or *O.garita*?)	Early 2016
Revise & secure permits for Poweshiek, surrogate species, and Mat muhly (States, Federal, MB)	MN Zoo - Erik Cooperating Zoo MI – Dave Cuthrell can help expedite the MI permit Manitoba – Nature Conservancy of Canada	US - Jan. 2016 – application MB – write proposal 2016, permit 2017	Cooperating zoo(s)	2016
Determine possible surrogates			Cale N. & Ron R., Su Borkin	Nov. 2015
Rearing training for MB Zoo/potential partners	Manitoba – Melissa Grantham will talk to Cary about potential partners MN Zoo – Erik and Cale	Nov. 2015		
Obtain landowner permissions	Michigan – Dave Cuthrell	Dec. 2015	Partner or MN Zoo	Early 2016
Site information matrix – (history of PS numbers, suspected reasons for decline, pesticides, host plants, ownership, size of site, size of	FWS – Tamara Smith (4 sites prioritized – asap , 14 total sites later) – coordinate with Su Boirkin, Dave Cuthrell, Melissa Grantham	Jan. 2016		

Tasks	Responsible Parties (Poweshiek skipperling)	Timeline	Responsible Parties (surrogate)	Timeline
occupied area, landowner contact info., etc.)				
Create budget – will feed into the future grant proposals	MN Zoo – Erik/Cale can budget for Zoo, need to collect info. from everyone (short term by year)	Asap by Jan. 2016	Partner Zoo (s)	
Identify research needs	FWS – Sarah Warner	Early 2016		
Prepare head-start facilities (includes many aspects of what is needed, plants, etc.) for PS and surrogate	MN Zoo – Tara Smith, Cale Nordmeyer, Erik Runquist	May 2016	MN Zoo, Partner Zoo (?)	May 2016
Finish *Wolbachia* strain identification research	MN Zoo / Emily Saarinen	May 2016		
Prepare for field work (e.g., training, supplies, and monitoring for PS and surrogate)	Michigan – Dave Cuthrell	May 2016	Partner (TBA) or MN Zoo	May 2016?
Field collection & training	Michigan – Dave Cuthrell MN Zoo	June/July 2016	Partner (TBA)	June/July 2016
Rearing	MN Zoo	2016-17	Partner Zoo(s)	2017
Release (late instar larvae or pupae)	MN Zoo MNFI FWS – ELFO, TCFO	June 2017		
Monitoring	MNFI, FWS, and partners	Flight 2017		
Regular meetings	FWS	Spring & fall2016		
Annual meeting	ALL - FWS will organize	Fall 2017		

Discussion Notes

- Halstead Lake site in Michigan was discussed as a potential source for restoration (reinforcement). Dave Cuthrell thought this site may be at its carrying capacity – may be a good source but we might want to think about releasing elsewhere (reintroduction) (e.g., Liberty Fen).
- May want to focus our initial efforts at Holly Fen (Brandt Road) and Long Lake? These sites have relatively higher numbers (than Puchyan Prairie in WI and Buckhorn Lake in MI). Collection may not be practical at Puchyan Prairie or Buckhorn. Might be able to incorporate this into our decision tree. Head-start – start at Brandt Road (Holly Fen) and Long Lake Fen.
- Are the small numbers observed a function of detectability? Su and Dave thought not, at Long Lake and Scuppernong, they observed the population coming together to one area (the population having shorter dispersal distances) during population lows.
- Head-start for intra-site reinforcement and use the insurance program for source of reintroductions - to avoid the disease spread issue.
- *Wolbachia* strain information – Even same strain may be deleterious. May be a limiting factor. So intra-site only until research indicates that inter-site is okay. Need a temporal decision tree.
- Puchyan Prairie was discussed as a potential collection site but Ann raised the question of practicality – not likely to catch all individuals, if any, since the numbers observed has been so low over the last 4 years. Puchyan may be used for inter-site reinforcement (medium-long term goal depending on # of restoration animals available, outcome of *Wolbachia* strain determination, possibly surrogate research, population trend at Puchyan based on continued monitoring results, and consensus from advisory group). This was discussed in the context of an option to consider instead of trying to collect animals as a rescue. This may be best treated as a research question.
- Adaptive management strategy – conducting research while conducting these programs and management actions. It may be difficult to monitor the outcomes.
- We have agreed that Long Lake Fen, Brandt Road, and two locations within the TGG may be reasonable source populations. There was some discussion to try starting out with a population with low numbers as a "test"? We may not be able to collect enough individuals to start the program, so that option didn't seem like a viable option.
- Disease transmission – stress factors that would make them more susceptible to fungus, etc. Pick anything up from host plants in the lab. *Wolbachia* is in all the remaining population, but would differences in strains, we are unsure of the effect that would be without. Assumption – disease is an unknown, work with the assumption that best practices mitigate the risk for disease for head-starting.
- Sensitivity analysis – towards our goal. Trying to determine at which point do we start an insurance population.
- Once we are successful breeding the surrogate (e.g., *O. garita*): if, while doing this, the population of Poweshiek crashes, would we have the option of rescue insurance population?
- In the short term, is it realistic to think of insurance? – The group thought this was more of a long-term plan.
- We need decision points for when the other sites are brought in to the plan.
- Numbers are so low, but with imperfect detectability, we are uncertain exactly how many are at the sites. There is some reasonable probability that the couple of animals that we collect are the last individuals out there. If Allee effect may be present, and if the population is so small, then do we want to collect and preserve/use these genetics?
- Research question: Can we work on developing novel ways of marking individuals, perhaps through the use of genetic modification, to monitor success? This may be desirable, but would certainly require extra handling of individuals and removal of tissue for analysis, which may reduce the value of this approach.
- Disease is lower risk for head-starting than a longer term insurance program.

Discussion: What is the numerical benefit we can expect to observe from a head-starting program?

Assumptions:

- Even sex ratio observed in the field
- 20% capture rate of individuals in the wild (Given 30 individuals, Su felt that she could capture about 6 females)
- Total female egg productive estimate = 100 eggs
- 30 eggs collected per female per 48-hour egg-laying period after capture
- Hatch rate of collected eggs = 80%
- Egg-to-adult survivorship in the wild = 3%
- Egg-to-pupa survivorship in captivity = 30%
- Pupa-to-adult survivorship in the wild = 95%

Scenario 1: No *ex situ* management

a. 10 females in the wild, each lays 100 eggs = total production of 1000 eggs.
b. If we assume 3% survival of those eggs to the adult stage, we then estimate **30 adults** are produced in wild conditions**.**

Scenario 2: *Ex situ* management – head-starting

a. We collect eggs from 20% of wild females. If we assume a total adult female population of 10 individuals as before, we will collect 60 eggs from two individuals during the egg-laying period after capture.
b. From 60 eggs we will expect 48 to successfully hatch.
c. From 48 newly-hatched individuals we will expect 14 pupae.
d. From 14 pupae we will expect **13 adults** to successfully emerge.
e. The two females captured for egg-laying are returned to the wild. We expect each of those females to lay an additional 70 (100-30) eggs in the wild, for a total of 140 eggs. We expect a total of **4 adults** to survive from this second batch of eggs.
f. The remaining 8 individuals in the wild will lay 100 eggs each, for a total of 800 eggs. We expect a total of **24 adults** to survive from this third batch of eggs.
g. The total numbers surviving would be 13+4+24 = **41 adults** produced under a combined program incorporating a head-starting component.

Scenario 2 results in a nearly 40% increase in the recruitment of adults to the wild population, compared to a scenario where *ex situ* management activities are not included. These calculations, of course, are based on a series of assumptions – but assumptions that are largely supported by field observations and *ex situ* management experience.

Discussion Notes on Roles and Responsibilities

1. MN Zoo – rearing, training of rearing staff, transport of eggs
2. NCC – providing facilities
3. FWS – permitting and overall regulatory and policy compliance with ESA; planning and coordination
4. MNFI – site identification and collection
5. Manitoba Zoo – facilities?
6. Milwaukee Public Museum – training, technical assistance

Budget Needs (short-term)

1. Additional staffing, MN Zoo
2. Training of other zoos and partners
3. Operation of Canada facility
4. Materials for other partners
5. Travel for other partners
6. Travel for meetings, etc.

Dakota Skipper: *Ex Situ* Assessment and Planning

Working Group participants:

Robert Dana, Minnesota Department of Natural Resources
Phil Delphey US Fish and Wildlife Service
Meg Royer, independent researcher
Emily Royer, independent researcher
Erik Runquist, Minnesota Zoo
Ann Swengel, independent researcher
Richard Westwood, University of Winnipeg

Threat Assessment

The working group referred to the threat assessment table produced in plenary on the first morning of the workshop and then prioritized which of the components/population characteristics (e.g., life stage) was most influential in determining long-term viability of the Dakota skipper (DS). Where desired, additional stressors were added to the threats originally defined in plenary. Each stressor under each component was then evaluated to see what contributes to each component. We asked: which parts of the life history are under the greatest threat to ensure long term viability? The results are presented below in order of priority, with the group score in parentheses (scoring was done by each working group member through a process of assigning points to those threat components they believed were of greatest concern).

1. <u>Pre-diapause larval survival (7)</u>
    a. Ant predation between hatching and shelter construction
    b. Abundance of (preferred) food plants
    c. Pesticides
    d. Extreme weather events – hailstorms, flooding
2. <u>Habitat fragmentation (6)</u>
    a. Populations vulnerable to extinction by stochastic events, poor management even at small scales
    b. Reduction in occupied range/susceptible to regional extirpations
    c. Pending local extinction
    d. Low reproduction
    e. Uncertainty in species/habitat ecology (e.g., carrying capacity)
3. <u>Post-diapause larval survival (4)</u>
    a. Extreme weather events – hailstorms, flooding
    b. Extreme fire
    c. Pesticides?
4. <u>Adult reproduction (3)</u>
    a. Low density (Allee effect)
    b. Fitness of adult females
    c. Low population growth
    d. Reproduction interrupted, precluded, or reduced by various sources or site threatened with destruction
    e. Can they survive in restored prairies?

5. Small population size (2)
    a. See Habitat fragmentation – we considered these two threats tightly linked
6. Egg survival (0)
    a. Summer burns; grazing
    b. Early haying
7. Diapausing larvae (0)
    a. High overwinter mortality
    b. High mortality due to temperature or humidity extremes

Notes from the discussion accompanying the threat evaluation:

- Larval stage most important and most mortality in captivity seen in early part of larval stage. Overwintering is long, but there is little perturbation (haying, etc.) during that time. Most fire management and flooding (e.g., in Manitoba) occurs post-diapause.
- Grazing – private is typically season-long; removes nectar; cattle not likely eating DS larvae, but may trample them; may cause adults to leave affected patch; and only depriving larvae of food when very overgrazed; may have secondary effects on habitat quality (e.g., reducing near-soil and soil humidity/moisture levels and altering plant composition); DS still extant on some grazed sites, but extirpated from others;
- Egg stage – probably a low priority, initially.
- *Ex situ* takes a lot of resources, so we may have to be very targeted to have an impact.
- What is feasible in terms of reintroduction based on *ex situ*? Release of pupae or moving adults; numbers would have to be in 100’s or 1000’s; if adults are moved, nectar resources would have to be sufficient and larval host plants would have to be present in sufficient abundance;
- Research as a purpose for *ex situ* management – recognized as important by group.
- Multi-colored Asian lady beetles – how can we handle this type of threat in this discussion?
- Late-stage larvae would rebuild shelter if reintroduced at that stage – potentially costly to survival.
- Where would we reintroduce?
    - Sites where fire has caused extirpation?
        - Tall Grass Prairie Preserve (Manitoba)
        - Lostwood NWR
        - Cayler Prairie Preserve
        - Where management will be conducive to conservation of species – planned fire management must be conducive to species’ conservation.
- How would we reintroduce?
    - Translocation of adults: May be less expensive (e.g., in MB could easily move 100s of adults)

Identification of Potential Population Management Roles to Address Threats

With the threat evaluation for Dakota skipper in hand, and the set of potential *ex situ* and *in situ* management options available to us, we identified which option would be effective in addressing each of the identified species threats. This information is summarized in Table 11 below.

Table 11. Applicability of population management alternatives to conservation of the Dakota skipper.

	Threat					
Population Management Option	Low Larval Survival (Pre-Diapause)	Habitat Fragmentation/ Small Population Size	Low Larval Survival (Post-Diapause)	Reduced Fecundity	Low Larval Survival (Diapause)	Reduced Egg Survival
Ex situ						
Insurance Population						
Source Population for Reintroduction / Reinforcement		Y	Y	Y		
Head-Start Program	Y		Y	Y	Y	Y
Maternity Ward		Y		Y		
Temporary Rescue						
Research Population	Y	Y	Y	Y	Y	
In situ						
Ex Situ Protected Conditions in the Field				Y	Y	Y
Wild-to-Wild Translocation		Y		Y		
Wild-to-Wild Rescue (Salvage)		Y		Y		

<u>Notes from the discussion accompanying the creation of the above table</u>

- A head-start program to address low pre-diapause larval survival would directly address ant predation between hatching and shelter construction.
- Low larval survival through extreme weather events, both pre- and post-diapause, could be addressed through a head-start program. However, this may not be feasible due to the unpredictable nature of these events.
- Habitat fragmentation and small population size were considered as tightly linked. Extinction risk from stochastic events or poor management (even at small scales) could be addressed by augmentation using an *ex situ* population as a source for restoration. Translocation among wild populations could address the negative impacts of a reduction in occupied range, and a wild-to-wild rescue could reduce the probability of a pending local extinction of a very small population. Inherently low reproduction in small populations could potentially be addressed through both a maternity ward approach and through protected conditions in the wild.
- Threats from extreme fire in important habitats could be addressed through release from an *ex situ* source populations, adult translocations from other wild populations, and a head-start program. These methods would have to be timed very carefully in case the habitat is not suitable for a few years.

- Low reproductive success in the wild may benefit from an *in situ* protected condition in the wild, in order to artificially concentrate adults to increase mating. Augmentation from an *ex situ* source population can supplement natural reproduction.
- Overwinter survival could be enhanced through protected conditions in the wild, e.g., manipulation of snow cover to provide optimal conditions. A research population could also be used to determine developmental thresholds, which may vary geographically.
- Egg survival could be enhanced through a head-start program, but the length of time that a female should be held in unknown, as is the proportion of eggs that should be collected.

A Deliberative Analysis of Each Population Management Alternative

A detailed study of all the options relevant for Dakota skipper population management appears below. This study includes an examination of the pros and cons of each program alternative. Where feasible, specific “fixes” were identified that could alleviate any one of the weaknesses (“cons”) of a given program management alternative.

Insurance Population

<u>*Goal and Purpose*</u>: Prevent the Dakota skipper from becoming extinct

Table 12: Pros and cons of an insurance population program for the Dakota skipper.

Pros	Cons
1. Remove individuals from a potential threat. 2. Ability to maintain a population over time. 3. Potential to ramp up numbers quickly with breeding.	1. Concerned with our ability to maintain a viable captive population in the long-term. 2. The current status of the species in the wild does not suggest that this option would be a high priority for long-term conservation.

Notes & Discussion Points:

- Based on this analysis, the group decided to discard the Insurance Population option for Dakota skipper.

Source for Population Restoration

Goal: Maintain a population of Dakota skippers at a propagation facility to serve as a source for reintroduction, with at least one generation of captive breeding.

Structure:

1. Initial process would resemble head-start program, but with continued infusion of new genes. Would also have to have agreements in place similar to what would be needed for headstarting to collect females, transport eggs, etc.

Table 13: Pros and cons of a source for population restoration program for the Dakota skipper.

Pros	Cons
1. Able to know the lineage of offspring to inform genetic concerns related to reintroductions. 2. Could facilitate reintroduction. 3. Cross populations to simulate gene flow. 4. Facilities outreach to public (e.g., to zoo visitors). 5. Could increase survival relative to wild individuals.	1. Potential loss of genetic diversity and/or selection for captive conditions. 2. Labor intensive. 3. Costly.

Notes & Discussion Points:

- There is a need to introduce genes from the wild periodically to maintain diversity of captive population.
- Replicate wild conditions as much as possible.
- There is a potential risk – potential for loss of wild adaptations and genetic diversity.

Head-Start Program / Maternity Ward

Goal: Manage Dakota skippers *ex situ* for a particularly vulnerable portion of the life cycle to provide individuals to reintroduce the species into suitable habitat from which it has been extirpated, with the ultimate goal of establishing new populations and expanding the existing range.

Structure:

1. Capture female and protect/provision her while she lays eggs; collect some of her eggs; return female to wild; and, release individuals that hatch from eggs at a later life stage.
2. Would pre-assess site to identify and mark ideal sites for release – e.g., best locations to place larvae.
3. Develop methodologies for identifying and ranking potential reintroduction sites and for identifying appropriate source populations. Determine number of founders (mated females) needed for reintroduction. Ensure that personnel, resources, and infrastructure, and plans are in place to ensure they would be sufficient to carry out activities – capture females from source sites, collect all or a portion of eggs from each, transport eggs to propagation facility, rear offspring to a later life stage, identify specific release sites in reintroduction area, and release at reintroduction site. Ensure that all necessary permits are in place (ESA; states; USDA; CITES, etc.).
4. Identify control sites that would not function as either source or reintroduction sites. Source sites would be different from release sites – i.e., we do not recommend augmenting populations, at least initially, except perhaps to release some individuals back into source sites to offset any negative impacts of egg removal on source populations.

Table 14: Pros and cons of a head-start/maternity ward program for the Dakota skipper.

Pros	Cons
1. Potential for increasing survival of offspring relative to what would occur in the wild. 2. May increase number of eggs laid if life of female is extended compared to natural survival. 3. Could facilitate reintroduction or augmentation. 4. Could reduce adverse or avoid impacts on source population if some offspring are returned to the source site. 5. Facilities outreach to public (e.g., to zoo visitors)	1. Reduce egg contribution to wild population – would be more adverse effect in small populations. 2. To be useful, there would have to be a viable site for their release. 3. Costly – costs increased with duration of time offspring kept in captivity. 4. Timing of release may conflict with other work – e.g., capture, holding and release of adults would have to take place during time with other work is underway. 5. Permanent removal of females from the wild could introduce the need to transport the female soon after its capture to an area where offspring can be housed. Permanent removal may not be pursued, however, with females likely to be returned to site of capture after collection of a portion of her eggs. 6. A chance of releasing offspring into habitats where they will not lead to establishment or will not effectively augment a population – need to address factors that would adversely affect population viability at release site. 7. Do not know male lineage of eggs – could figure this out retrospectively with dead larvae, but that is expensive. 8. Introduce/transmit disease, especially if placing into an area where a population is still present. 9. Impossible to measure success if augmenting established population with life stages that could not be tracked or resighted.

Notes & Discussion Points:

- There is a need to document carefully all procedures and structure program as a research project to learn from outcomes of releases.
- There needs to be an accepted system of ranking sites for reintroduction/augmentation – include a set of criteria that would indicate likelihood of success. This could include survey data; presence and status of important stressors (e.g., invasive species, management, etc.)
- There may be research needs to better understand how to rank sites for reintroduction.
- It is important to set up program to monitor and evaluate success of reintroduction efforts based on criteria established before the reintroduction
- There is a risk of keeping offspring to adult stage of having few in developmental synchrony – release of larvae may reduce this risk by allowing them to acclimate to local conditions.

- Feasibility – Current efforts at the Minnesota Zoo may already produce hundreds of late-stage larvae, pupae or adults for release into the wild.
- Existing expertise – Expertise is present with the program at the Minnesota Zoo, Robert Dana, Richard Westwood, Ron Royer, and others. Emily Saarinen may continue to be available to provide conservation genetics expertise. We need additional information to inform when it would be best to release propagated individuals and how to determine the likelihood that conditions at a site are sufficient to support a viable population.
- Staffing needs – The current staff at Minnesota Zoo provides necessary biological and husbandry expertise. Current staff is likely insufficient when fieldwork is needed – during that time additional staff is needed to ensure that field-based tasks, site evaluation, and monitoring will be carried out.
- Availability of resources – Infrastructure at zoo is established and sufficient to support this program, but is not permanent and depending on funding that only extends out for about five years. Potential for additional sites to garner resources to contribute to effort – e.g., Assiniboine Park Zoo in Winnipeg.
- Disease risk to wild populations – More research/expertise is needed on this topic. *Wolbachia* research is ongoing. Disease issues may only be a significant issue when releasing individuals where they could mix with existing wild populations. No disease issues evident thus far with Dakota skipper at Minnesota Zoo.
- Likelihood of success – Unknown. Success would be dependent on our ability to determine whether a site contains the features necessary to support a viable population; on the subsequent behavior of the released individuals; and, on the production of a sufficient number of individuals.
- Likely future for the wild population in the absence of *ex situ* or translocation activities – Recovery may be unlikely without our ability to reestablish populations in areas from which the species has been extirpated. A significant number of populations face significant threats and have an uncertain future. There are sites from which the Dakota skipper has been extirpated where habitat conditions are likely suitable to support the species if it can be reintroduced (e.g., Tall Grass Prairie Preserve in southern Manitoba).

Temporary Rescue (Salvage)

<u>Goal:</u> Prevent extirpation or high mortality of Dakota skippers – temporarily - due to predictable imminent threats.

The Temporary Rescue (Salvage) option for the Dakota skipper was briefly considered then discarded as a feasible conservation option. Events that would trigger the implementation of this option are quite unpredictable. Additionally, such a salvage operation could only occur during the short flight period. Finally, the release site would have to pre-identified, which would be difficult to implement in practical terms. Taken together, these issues prompted us to remove this option from consideration.

Research Population

Goal: to address key research and information needs to contribute to the species' conservation, including:

- Development of a protocol for rearing Dakota skippers in captivity – protocol should be feasible for use by other institutions – to produce animals for research and conservation activities
- To test methods to successfully release individuals into the wild to contribute to species' recovery. For example, we could experimentally release a certain number of head-start larvae and then monitor the reintroduction site to determine whether a population becomes successfully established

Structure:

1. Would depend in part on the research question; maintain individuals at propagation facility by using methods similar to the head-start and the source population programs. Wild females would be captured to collect eggs. Animals used in research would be those derived from captive rearing of individuals (eggs) removed from the wild as well as those obtained from captive breeding.

Table 15: Pros and cons of a source for research population program for the Dakota skipper.

Pros	Cons
1. Would facilitate increase in our understanding of species' life history, behavior, etc. by conducting research that may not be feasible with wild individuals. 2. Would provide more useful information than research using surrogate species. 3. Would increase knowledge base for improving captive rearing practices.	1. Would divert individuals from potential release into the wild for reintroduction. 2. Could decrease sizes of populations from which eggs are diverted – could release some of propagated larvae to offset this. 3. Funding may be difficult to obtain for research as opposed to rearing that is done with the intention of reintroducing populations – could resolve with public education/outreach.

Notes & Discussion Points:

- Existing expertise – We do have with the program at the Minnesota Zoo, Robert Dana, Richard Westwood, Ron Royer, and other. Emily Saarinen may continue to be available to provide conservation genetics expertise.
- Staffing needs – Current staff at Minnesota Zoo provides necessary biological and husbandry expertise. Current staff is likely insufficient when fieldwork is needed – during that time additional staff is needed to ensure that field-based tasks will be covered.
- Availability of resources – Infrastructure at zoo is established and sufficient to support this program, but is not permanent and depending on funding that only extends out for about five years. Potential for additional sites to garner resources to contribute to effort – e.g., Assiniboine Park Zoo in Winnipeg.
- Disease risk to wild populations – more research/expertise is needed on this topic. *Wolbachia* research is ongoing. No disease issues evident thus far with Dakota skipper at Minnesota Zoo.
- Likelihood of success – Success seems likely in terms of providing animals for research and for developing protocol that could be used by others to produce Dakota skippers for research – similar *ex situ* efforts have already been accomplished by Minnesota Zoo and it would take little additional work to draft a protocol. Ability to foster good and useful research projects is less certain.
- Likely future for the wild population in the absence of *ex situ* or translocation activities – research that would rely on an *ex situ* research program is essential to the wild population conservation.

Ex Situ Protected Conditions in the Field

Goal: To enhance survival in the wild through the mitigation of threats.

Structure:

1. A wide variety of possibilities – could include preventing combustion of portions of habitats during prescribed burns (e.g., mowing firebreaks around selected habitat patches); grazing exclosures; minimizing predation within exclosures; putting adults into tent in field to increase proportion of females that are mated (i.e., minimizing effects of Allee effect); capture adults and put them in cool and/or shaded spot to reduce heat stress.

Table 16: Pros and cons of an *ex situ* protected conditions in the field program for the Dakota skipper.

Pros	Cons
1. Reduce mortality due to land management practices. 2. May facilitate some research projects.	1. Generally difficult, labor intensive, and not feasibly implemented except in small areas – except for management of prescribed fire or grazing. 2. High cost-benefit ratio. 3. Generally more appropriate for research purposes.

Wild – to – Wild Translocation

Goal: Promote population viability through genetic and/or demographic augmentation of existing population and by increasing the number of populations through reintroduction.

Structure:

1. Capture of adults and moving them to sites from which the species has been extirpated. For example, in Canada – capture adults in SW Manitoba and move to Tall Grass Prairie Preserve where they appear to have been extirpated by fire management.

Table 17: Pros and cons of a wild-wild translocation program for the Dakota skipper.

Pros	Cons
1. Less costly than captive rearing. 2. Could facilitate reestablishment of populations in areas from which species has been extirpated.	1. Reduce sizes of source populations. This may be resolved by augmenting source site with captive-reared larvae/pupae. 2. Requires intensive work during the flight period. 3. Does not take advantage of captive rearing infrastructure that is already in place.

Notes & Discussion Points:

- There is a need for research to understand how likely adult translocation is to succeed relative to placing larvae or pupae into the reintroduction site.
- We need to have a site to put them or a legitimate use (e.g., research).
- There is also a need for a system to identify and rank potential reintroduction sites.
- The phenology of recipient sites may be out of synch with the source sites.

Wild – to – Wild Rescue (Salvage)

Goal: To remediate the emergency loss of a population and to prevent an inevitable loss of a population. This strategy would have to be limited to adults during their flight period and only to situations where the need for salvage would have to be prompted by something that anticipated before flight occurs.

Table 18: Pros and cons of a wild-wild rescue program for the Dakota skipper.

Pros	Cons
1. "If it works it would be awesome!" (E. Royer, pers. comm. 2015).	1. Must have sufficient personnel available to act during the flight period.

A Recommendation for Population Management of Dakota Skipper

This Dakota Skipper *Ex Situ* Management Program would have three overall goals:

1. Restoration of Dakota skipper at sites within the species' historical range where it has been extirpated;
2. Provision of Dakota skippers for research projects that are integral to the species' conservation; and,
3. Completion of a protocol that could be used by zoos or other facilities to manage the Dakota skipper *ex situ*.

The specific objectives of the program are:

- Production of at least 800 post-diapause larvae and/or pupae for reintroduction and research each year – at least 175 and 30 larvae would be targeted initially for use in a larval food plant and a pesticide study, respectively, at Minnesota Zoo.
- Restoration of least one population in the wild by 2021.
- An improved 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.
- Completion of a husbandry manual.

Larvae for reintroduction will be produced primarily by head-starting – that is, by collecting eggs from wild females and rearing the eggs at the zoo to produce larvae or pupae for release. Individuals used for controlled experiments will be derived from captive stock to the maximum extent practicable; up to 25% of larvae obtained from wild eggs, however, may be used for research (Fig. 4). 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 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.

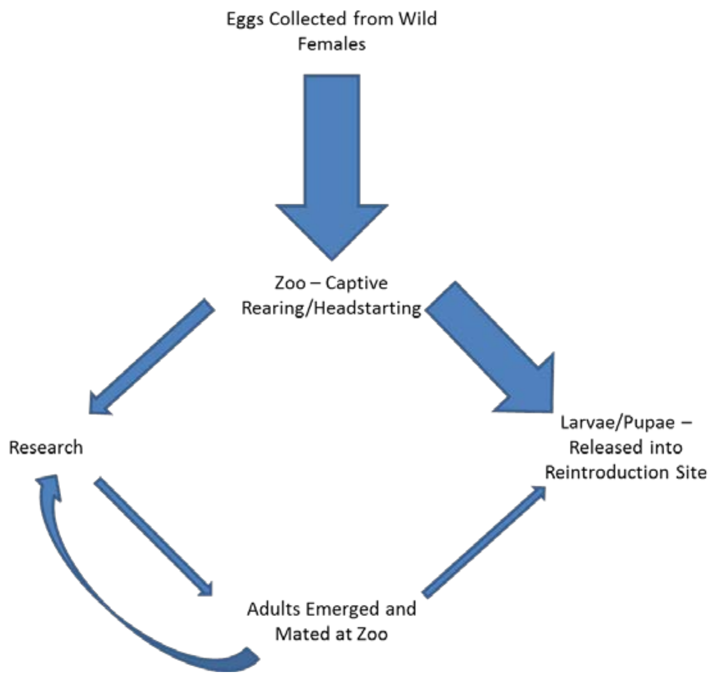


Figure 4. Schematic diagram of *ex situ* management proposed for the Dakota skipper.

US Fish and Wildlife Service will consult with species- and subject matter experts to help develop a process for selecting and ranking potential reintroduction sites within the historical range of the Dakota skipper. USFWS will coordinate the selection of team members and the ranking of sites in collaboration with Minnesota DNR and Minnesota Zoo; other entities will be consulted, as appropriate.

The Service will also convene a team of species experts to determine the most appropriate developmental stage when head-started or captive bred larvae or pupae will be released. This team will also develop the methods for release and will ensure that planned activities are appropriately permitted and that the public and any stakeholders are informed appropriately. Larvae may be ready for release from the Minnesota Zoo in the summer of 2016, although a systematic review of potential reintroduction sites may not be complete before then. Therefore, this release site may best be described as a trial release.

The detailed methods to be followed for site selection and release techniques will form the basis of a reintroduction plan to be developed in accordance with the USFWS *Policy Regarding Controlled Propagation of Species Listed under the Endangered Species Act* (http://www.fws.gov/endangered/laws-policies/policy-controlled-propagation.html). This reintroduction plan will also follow relevant IUCN guidelines, including the 2013 *Guidelines for Reintroductions and Other Conservation Translocations*. In addition to the information contained in this action plan, the reintroduction plan will include the following components:

- A justification for controlled propagation of the Dakota skipper;
- Descriptions of the methods to be used to select reintroduction sites;
- A description of monitoring to be carried out;
- Descriptions of sites to be used as egg sources;
- A description of the facilities to be used for *ex situ* management;
- Genetic considerations;
- A description of the risks associated with the planned activities; and,
- A description of alternatives to *ex situ* management.

Responsibility

Agencies and individuals that will be responsible for general tasks are described below. Persons named in parentheses were present during the workshop held at Minnesota Zoo on October 20-22, 2015 and were members of the Dakota Skipper planning team.

- USFWS (Phil Delphey) will organize reintroduction activities in collaboration and communication with partners, including Minnesota DNR, Minnesota Zoo, and others.
- Minnesota DNR (Robert Dana) will carry out or oversee monitoring of the Minnesota source population, Felton Prairie, and any reintroduced populations in Minnesota.
- Minnesota Zoo (Erik Runquist) will be the primary entity to carry out *ex situ* management (headstarting, captive breeding, etc.) and will also carry out research.

Additional responsibilities are shown in the timeline below (Table 19). The Reintroduction Working Group will be an ad hoc group convened by members of the planning team to assist with the development of the proposed program.

Action Plan for Population Management of Dakota Skipper

Table 19 presents the action steps required to implement the proposed population management plan for the Dakota skipper. Minnesota Zoo currently maintains a captive population of the Dakota skipper at its facilities and has initiated development of a husbandry protocol.

Table 19: Proposed action items for implementation of the *ex situ* population management program for the Dakota skipper.

Tasks	Responsible Parties	Timeline
Draft methods for ranking potential reintroduction sites and request review from species- and subject matter experts	USFWS – Phil Delphey	15 December 2015
Finalize methods for ranking potential reintroduction sites[1]	USFWS – Phil Delphey	1 March 2016
Determine developmental stage at which head-started individuals would be moved to reintroduction sites	MN Zoo – Erik Runquist MN DNR – Robert Dana	1 March 2016
Determine whether larvae will be available in release 2016.	MN Zoo – Erik Runquist	1 March 2016
Select site for trial release	USFWS – Phil Delphey MN DNR – Robert Dana MN Zoo – Erik Runquist	1 March 2016
Ensure that appropriate plans, permits, permissions, and agreements are in place for any release of individuals in 2016.	USFWS – Phil Delphey	15 April 2016
Estimate number of larvae available for research and reintroduction in 2016.	MN Zoo – Erik Runquist	15 May 2016
Evaluate and rank potential reintroduction sites for 2017 release.	USFWS – Phil Delphey MN DNR – Robert Dana MN Zoo – Erik Runquist	Summer 2016
Survey and monitor egg-source and potential reintroduction sites.	MN DNR – Robert Dana	Summer 2016

[1] Criteria may include degree of certainty that the Dakota Skipper is absent from a site; degree of certainty that site will be appropriately managed for the Dakota skipper; likelihood of species persistence in light of potential long-term factors, such as climate change; and, etc.

Tasks	Responsible Parties	Timeline
Trial release (tentative).	USFWS – Phil Delphey MN DNR – Robert Dana MN Zoo – Erik Runquist	Summer 2016
Larval food plant study carried out using captive-reared larvae.	MN Zoo – Erik Runquist	Summer 2016 – Summer 2017
Egg collections at source sites for captive rearing at zoo.	MN Zoo – Erik Runquist	Summer 2016 – Summer 2017
Rearing of larvae and/or pupae at zoo for reintroduction and research	MN Zoo – Erik Runquist	Fall 2016 – Spring 2017
Study of effects of pesticides used for control of soybean aphids is initiated using surrogate species and small number (approx. 30) Dakota skipper larvae.	MN Zoo – Erik Runquist	Summer 2017
Biannual coordination of meetings/conference calls to review results of studies, captive rearing, and reintroduction efforts.	USFWS – Phil Delphey	2017 – 2021

Budget

The budget shown in Table 20 is a preliminary estimate of the needed funds to complete the actions described above and summarized in Table 19.

Table 20. Estimated annual budget for project activities.

Description	Cost ($)/year
Egg collection, *ex situ* management (MN Zoo)	~200,000
Monitoring/Surveys (MN DNR)	

Partners

In addition to the members of the planning team that were present at the workshop, the following groups and individuals are essential to accomplish the action. Additional partners are likely to be needed and added as the project progresses.

- Minnesota Zoo
- Minnesota DNR
- USFWS
- Sisseton-Wahpeton Oyate
- The Nature Conservancy
- Dennis Skadsen
- South Dakota Department of Game, Fish, and Parks

Obstacles

The following are some of the hurdles that must be overcome to reach the project's goals.

- The number of Dakota skipper populations that are large enough to safely remove eggs while avoiding effects to their viability may be limiting. This may be the primary factor limiting the number of larvae that can be produced.
- Sites where reintroduction may have a high probability of success may be limiting. It may be difficult to identify one or more sites where habitat conditions and other factors are suitable to ensure that viable populations of the Dakota skipper would be supported. Management activities or research may be necessary to ensure that we find sites suitable for reintroduction.
- Personnel available for *ex situ* management, including husbandry at zoo and fieldwork, is currently limiting. The zoo may need at least one more person on the project to ensure that project goals may be met.
- Our attempts to determine the number of Dakota skippers that are needed to reestablish the species in formerly occupied habitats and to evaluate potential reintroduction sites may rely on finding and funding researchers to address important research questions. Funds for research are often limiting and could limit our ability to maximize reach our goals.

Measurable Outcomes

- Production of at least 800 post-diapause larvae and/or pupae for reintroduction and research each year.
- Completion of husbandry manual (likely to be approximately March/April 2016)
- A description of the number of larvae/pupae that must be released to reestablish a viable population – consistent evidence of recruitment would be the basic criterion for population viability.
- At least one viable population reestablished in the wild by 2021.
- Contributed at least 175 larvae to the larval food study and 30 for ‘soybean aphid’ pesticide study.

Appendices

Appendix 1. Workshop Participants

Appendix 2. Workshop Agenda

Appendix 3. Workshop Presentations

Appendix 4. IUCN/SSC Guidelines

Appendix 1.

Poweshiek Skipperling and Dakota Skipper: An *Ex Situ* Assessment and Planning Workshop
20 – 22 October, 2015

WORKSHOP PARTICIPANTS

Name	Organization	E-mail
Rich Baker†	Minnesota Dept. Natural Resources	Richard.baker@state.mn.us
Susan Borkin	Milwaukee Public Museum	borkin@mpm.edu
David Cuthrell	Michigan Natural Features Inventory – MSU Extension	cuthrell@msu.edu
Robert Dana	Minnesota Dept. Natural Resources	Robert.dana@state.mn.us
Melissa Grantham	Nature Conservancy of Canada	Melissa.grantham@natureconservancy.ca
Tara Harris	Minnesota Zoo	tara.harris@state.mn.us
Patricia Heglund	US Fish and Wildlife Service – National Wildlife Refuge System	Patricia_heglund@fws.gov
Karen Lewis†	Oregon Zoo	karen.lewis@oregonzoo.org
Lisa Mandell	US Fish and Wildlife Service – Ecological Services (MN/WI)	Lisa_mandell@fws.gov
Phil Miller	Conservation Breeding Specialist Group (SSC-IUCN)	pmiller@cbsg.org
Kelly Nail	US Fish and Wildlife Service – Twin Cities Field Office	Kelly_nail@fws.gov
Cale Nordmeyer	Minnesota Zoo	Cale.nordmeyer@state.mn.us
Laura Ragan	US Fish and Wildlife Service – Ecological Services Regional Office	Laura_ragan@fws.gov
Emily Royer	Independent	emilyroyer@gmail.com
Meg Royer	Independent	Mroyer2000@yahoo.com
Ron Royer	Minot State University (Retired)	Ron.royer@minotstate.edu
Erik Runquist	Minnesota Zoo	Erik.runquist@state.mn.us
Emily Saarinen†	New College of Florida	esaarinen@ncf.edu
David Shepherdson†	Oregon Zoo	david.shepherdson@oregonzoo.org
Alisa Shull	US Fish and Wildlife Service – Ecological Services Regional Office	Alisa_shull@fws.gov
Tamara Smith	US Fish and Wildlife Service – Twin Cities Field Office	Tamara.ann.smith@fws.gov
Ann Swengel	Independent	swengel@naba.org
Scott Swengel	Independent	Aswengel@jvlnet.com
Kathy Traylor-Holzer	Conservation Breeding Specialist Group (SSC-IUCN)	kathy@cbsg.org
Sarah Warner	US Fish and Wildlife Service – Ecological Services (WI)	Sarah_warner@fws.gov
Richard Westwood	University of Winnipeg	r.westwood@uwinnipeg.ca

†Online participant

Appendix 2.

Poweshiek Skipperling and Dakota Skipper: An *Ex Situ* Assessment and Planning Workshop

20-22 October, 2015
Minnesota Zoo, Apple Valley, MN

WORKSHOP AGENDA

Meeting Purpose: To evaluate the recommended role of *ex situ* activities, if any, in the conservation of the Poweshiek skipperling and Dakota skipper, and to identify the structure and development of any recommended programs.

DAY ONE: 20 October

9:00 Workshop opening (*Lisa Mandell, USFWS; Kevin Willis, Minnesota Zoo*)

9:15 Participant introductions and preliminary issue generation (Participants will be asked to share their view on the biggest challenge to the conservation of these two butterfly species)

9:45 Background presentations

1. Status review – Poweshiek skipperling (*Tamara Smith, USFWS*)
2. Status review – Dakota skipper (*Phil Delphey, USFWS*)
3. State of the science for *ex situ* management of hesperid butterflies (*Erik Runquist, Minnesota Zoo*)

10:45 Coffee / tea break

11:00 Overview of the *IUCN SSC Guidelines on the Use of* Ex Situ *Management for Species Conservation* as part of the One Plan approach to conservation (*Kathy Traylor-Holzer, CBSG*)

11:30 Issue generation and diagramming of threats to butterfly viability

12:00 Plenary discussion of potential *ex situ* conservation roles for prairie butterflies

12:30 Lunch (provided)

1:30 Introduction to working group dynamics; working group formation by species (*Phil Miller, CBSG)*

2:00 <u>Working Group Session I</u>: Evaluating threats and vulnerabilities specific to each species; defining the potential role(s) for *ex situ* and translocation activities and how they can improve viability of Poweshiek skipperling and Dakota skipper

3:00 Coffee / tea available during working group session

4:30 <u>Plenary Session I</u>: Working Group presentations of potential conservation roles of *ex situ* and translocation activities, and how they might impact wild population viability

5:00 Adjourn

DAY TWO: 21 October

8:30 Working Group Session II: Defining the characteristics of the *ex situ* or translocation program needed to fulfill each potential role, including factors such as:

- Number and source of any wild-caught individuals
- Population size to be maintained, life stage, and type of management
- Type of facilities needed
- Capture and release techniques
- Anticipated length of program

Identify the purpose and goal of each potential conservation program.

10:00 Coffee / tea break available during working group session

11:15 Plenary Session II: Presentation of goal and characteristics of each potential *ex situ* and/or translocation program

12:00 Lunch (provided)

1:00 Working Group Session III: Assessing the needs, risks and feasibility of each potential *ex situ* program and/or translocation program, including factors such as:

- Existing expertise (capture, release, *ex situ* management)
- Staffing needs (number, expertise)
- Availability of resources
- Disease risks/risk to wild populations
- Likelihood of success
- Likely future for wild population in absence of *ex situ* or translocation activities

Develop Working Group's recommendation regarding management decision for *ex situ* and/or translocation program(s) for species based on evaluation of benefits, risks, and feasibility

3:00 Coffee / tea break available during Working Group Session

4:00 Plenary Session III: Presentation of needs, risks, and feasibility of each potential program, group's decision regarding *ex situ* and translocation activities, and the identified goal and recommended program structure for any recommended program

5:00 Adjourn

DAY THREE: 22 October

8:30 Working Group Session IV: Action planning for *ex situ* and translocation activities, including monitoring and exit strategy considerations, collaborating partners, timelines, and costs

10:30 Coffee / tea break available during Working Group Session

11:30 Plenary Session IV: Presentation of action plans

12:30 Lunch (provided)

1:30 Plenary Session V: Next steps and timeline for action

3:00 Coffee / tea break

4:00 Workshop closing

Appendix 3.

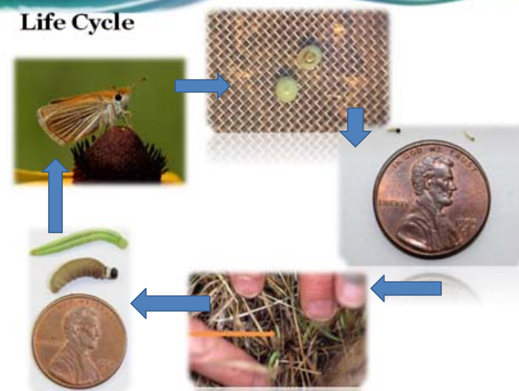
Status Review -- Poweshiek Skipperling
Tamara Smith, United States Fish and Wildlife Service

Poweshiek Skipperling
(*Oarisma poweshiek*)

Tamara Smith, USFWS
October 20, 2015

Photo : USFWS, Wisconsinbutterflies.org

Life Cycle



Photos: E. Runquist, Minnesota Zoo; Wisconsinbutterflies.org; Susan Borkin, Milwaukee Public Museum

Outline

- Biology & Habitat Needs
- Historical & Current Distribution
- Trends at Remaining Sites
- Stressors
- Conservation Measures

Photos: T. Smith, USFWS; Wisconsinbutterflies.org

Habitat

Native remnant wet-mesic mixed grass to dry tall grass prairies, moist meadows, & prairie fens

- Diverse & abundant sources of nectar for adults during flight period
  - Black-eyed Susan, shrubby cinquefoil, etc.
- Abundant fine-stemmed native grasses for larval feeding
  - Prairie dropseed, mat muhly, little bluestem, etc.

Photos: Tamara Smith, USFWS

Biology

- Skipper (Hesperiidae) family
- Univoltine = **single flight per year**
- Flight period is 2-4 weeks in **June – July**
- Adult lifespan ~3-10 days
- **One generation per year**
- Maximum dispersal distance ~1 km
- **Overwinter as larvae**
  - Above ground on grasses

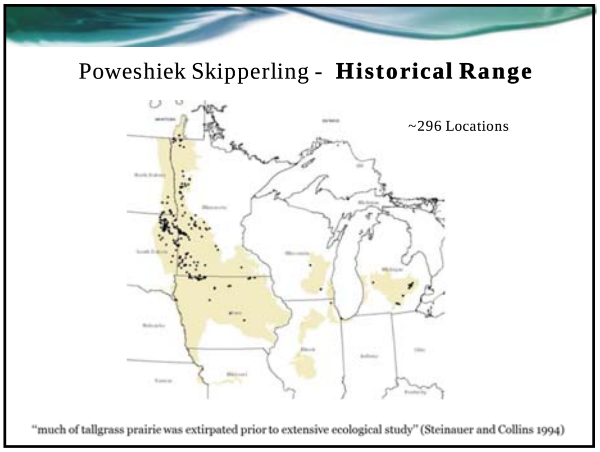
Poweshiek skipperling

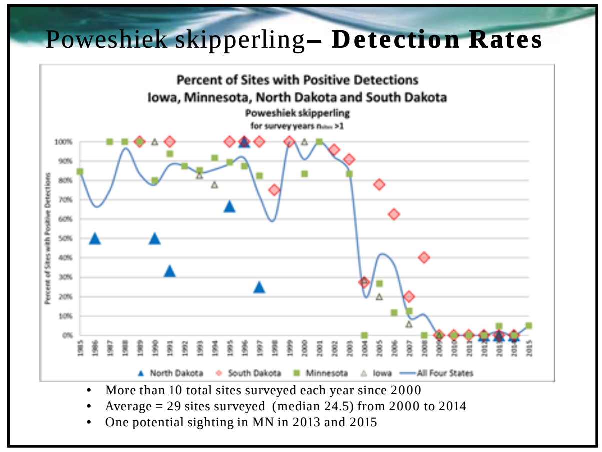
Photo: Wisconsinbutterflies.org

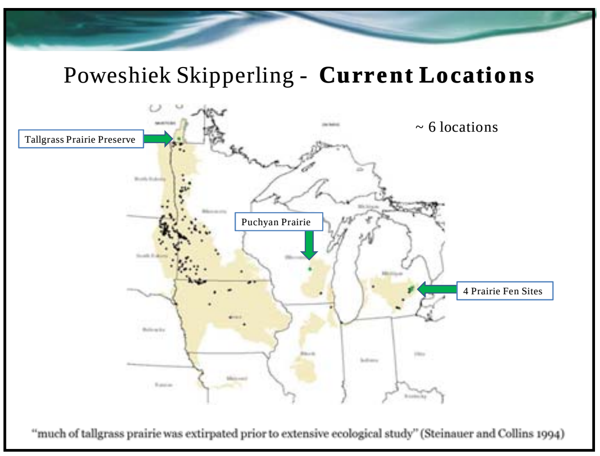
Declines in Tallgrass Native Prairie

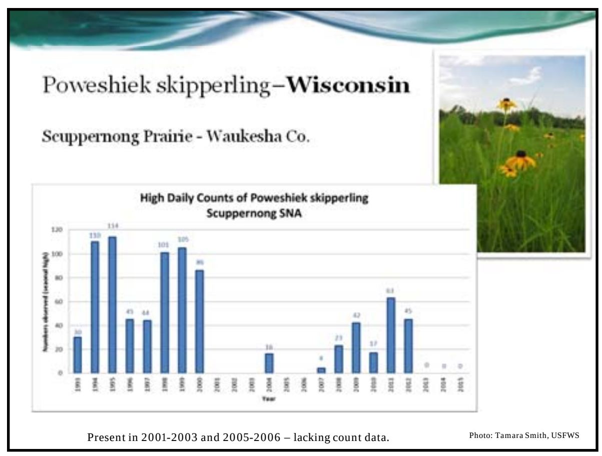
- According to Sampson and Knoff (1994) the percent decline in area of native tallgrass prairie in each state (historic - 1994) is:
  - 99.9% - Illinois, Iowa, Indiana, North Dakota, Wisconsin & Manitoba
  - 99.6% - Minnesota
  - 85.0% - South Dakota
- Destruction of tallgrass prairie began ~ 1830
- Documentation of butterfly fauna began ~1960
- ➢ *Therefore most of the initial decline of Poweshiek skipperling probably went unrecorded*
- ➢ *Similar declines of mixed grass prairies (72 to 99% loss)*

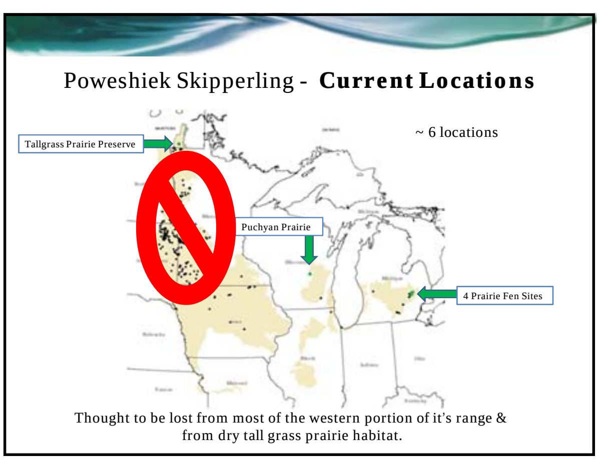
Photo: Tamara Smith, USFWS

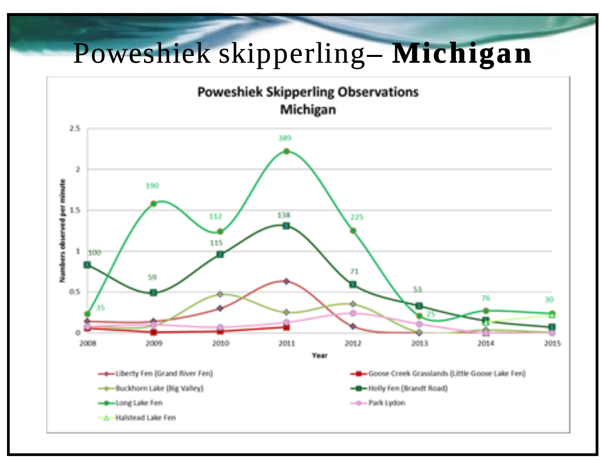

Poweshiek Skipperling - Historical Range
~296 Locations
"much of tallgrass prairie was extirpated prior to extensive ecological study" (Steinauer and Collins 1994)


Poweshiek skipperling– Detection Rates
Percent of Sites with Positive Detections
Iowa, Minnesota, North Dakota and South Dakota
Poweshiek skipperling
North Dakota
South Dakota
Minnesota
Iowa
All Four States
More than 10 total sites surveyed each year since 2000
Average = 29 sites surveyed (median 24.5) from 2000 to 2014
One potential sighting in MN in 2013 and 2015


Poweshiek Skipperling - Current Locations
~ 6 locations
Tallgrass Prairie Preserve
Puchyan Prairie
4 Prairie Fen Sites
"much of tallgrass prairie was extirpated prior to extensive ecological study" (Steinauer and Collins 1994)


Poweshiek skipperling–Wisconsin
Scuppernong Prairie - Waukesha Co.
High Daily Counts of Poweshiek skipperling
Scuppernong SNA
Year
Present in 2001-2003 and 2005-2006 – lacking count data.
Photo: Tamara Smith, USFWS


Poweshiek Skipperling - Current Locations
~ 6 locations
Tallgrass Prairie Preserve
Puchyan Prairie
4 Prairie Fen Sites
Thought to be lost from most of the western portion of it's range &
from dry tall grass prairie habitat.

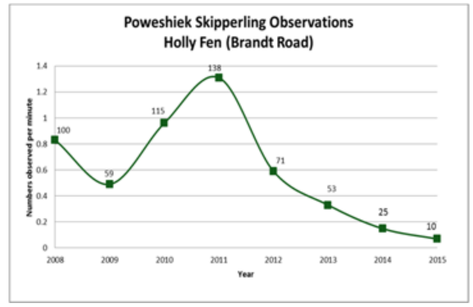

Poweshiek skipperling– Michigan
Poweshiek Skipperling Observations
Michigan
Numbers observed per minute
Year

Poweshiek skipperling- **Remaining Populations**

- **Michigan** - Four remaining locations
  - Long Lake Fen- Oakland Co.
  - Holly Fen- Oakland Co.
  - Halsted Lake Fen- Oakland Co.
  - Buckhorn Lake Fen- Oakland Co.
- **Wisconsin** – One location
  - Puchyan Prairie – Green Lake Co.
- **Manitoba**
  - Tall Grass Prairie Preserve

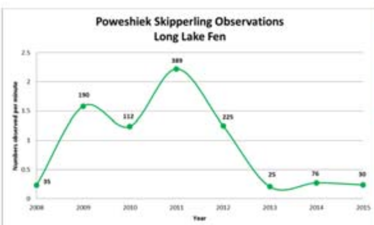
Photo: Tamara Smith, USFWS

Poweshiek skipperling – **Holly Fen**



Numbers over data points indicate the highest daily count

Poweshiek skipperling – **Long Lake Fen**



Numbers over data points indicate the highest daily count

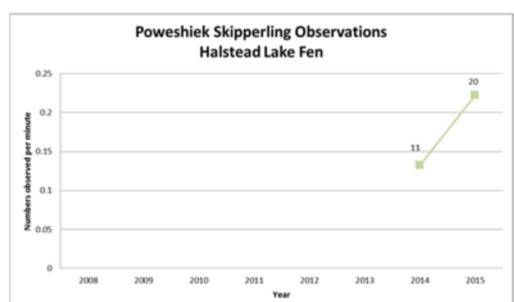
Poweshiek skipperling – **Holly Fen (Brandt Road)**

- **Oakland Co. Michigan**
- ~25 ac (10 ha)
- Primary owners/managers
  - MI DNR Parks & Recreation
  - Holly State Recreation Area
- Prairie Fen
  - Mat muhly
  - Little bluestem
  - Diverse flowering forbs
- Known stressors
  - Small size/isolation
  - Woody vegetation
  - Invasive species

Poweshiek skipperling – **Long Lake Fen**

- **Oakland Co. Michigan**
- ~394 ac (159 ha)
- Primary owners/managers
  - Private
  - Springfield Township (Shiawassee Basin NP)
- Prairie Fen
  - Mat muhly
  - Diverse flowering forbs
  - Shrubby cinquefoil
- Known stressors
  - Development
  - Woody vegetation
  - Invasive species

Poweshiek skipperling – **Halstead Lake Fen**



Numbers over data points indicate the highest daily count

Poweshiek skipperling – **Halstead Lake Fen**

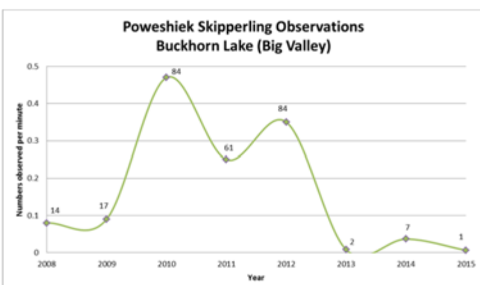
- **Oakland Co. Michigan**
- ~66 ac (27 ha)
- Primary owners/managers
  - MI DNR Parks & Recreation
  - Private
- Prairie Fen
  - Mat muhly
  - Black-eyed Susan
  - Shurbby cinquefoil
- Known stressors
  - Small size/isolation
  - Woody vegetation
  - Invasive species

Population Viability Analysis (C. Pogue, unpublished)

- 8 Michigan sites
- Used count data
- Indicates that the species faces a probability of extinction in MI of:
  - 16.7% in 5 years
  - 55.8% in 10 years
  - 75.5% in 20 years

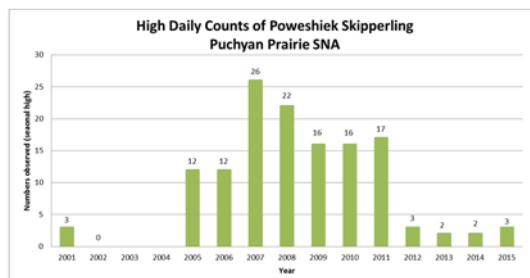
Photo Credit: Wisconsinbutterflies.org

Poweshiek skipperling – **Buckhorn Lake Fen**



Numbers over data points indicate the highest daily count

Poweshiek skipperling – **Puchyan Prairie**



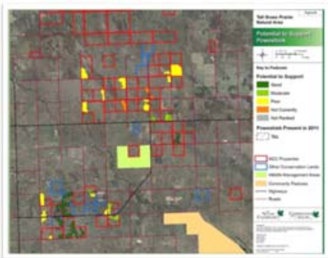
Poweshiek skipperling – **Buckhorn Lake Fen**

- **Oakland Co. Michigan**
- ~256 ac (104 ha)
- Primary owners/managers
  - Private
  - MI Nature Association
- Prairie Fen
  - Mat muhly
  - Black-eyed Susan
  - Shurbby cinquefoil
- Known stressors
  - Small size/isolation
  - Woody vegetation
  - Invasive species
  - Lack of management

Poweshiek skipperling – **Puchyan Prairie SNA**

- **Green Lake Co, WI**
- ~116 ac (47 ha)
- Primary owners/managers
  - WI DNR
- Wet-mesic prairie
  - Prairie dropseed
  - Black-eyed Susan
  - Surrounded by low prairie & sedge meadow
- Known stressors
  - Small size/isolation
  - Woody vegetation
  - Invasive species

Poweshiek skipperling – **Tall Grass Prairie Preserve**



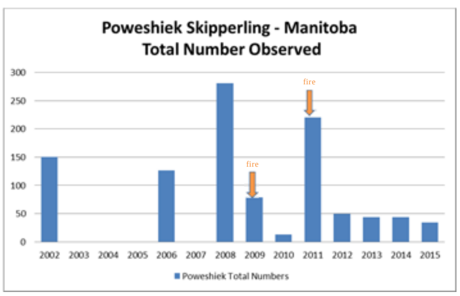
- **Manitoba**
- Complex of several small nearby locations
- Primary owners/managers
  - The Nature Conservancy of Canada
- Prairie meadows
  - Prairie dropseed
  - Black-eyed Susan
- Known stressors
  - Wild –fires

Conservation Measures

- ESA protections
- Eco-risk assessment
- Conservation recommendations for invasive plant removal
- Genetics Studies – Saarinen & MN Zoo
- Captive Rearing – Borkin & MN Zoo

Photo: T. Smith, USFWS

Poweshiek skipperling – **Manitoba**



Poweshiek skipperling – Federal Protections

- October 24, 2014 – Listed as Endangered under the ESA
- October 1, 2015 – Critical Habitat Designation
- May 2015 - Recovery Outline
- Recovery Plan – target date is April 2017

Photos: T. Smith, USFWS; Wisconsinbutterflies.org

Major Stressors of Poweshiek Skipperling

- Fragmentation & degradation of native prairie habitat
  - Conversion to agriculture, gravel mines, development
  - Woody & non-native plant invasion
  - Droughts & floods
  - Overgrazing
  - Lack of management
  - Groundwater alteration
- Isolation
- Herbicides
- Fires /Wildfires
- Unknown stressors
  - Pesticides?
  - Disease/pathogen?

Critical Habitat Designated – Poweshiek skipperling

State	Proposed Critical Habitat (acres)	Number of Units
Iowa	2,365	11
Michigan	1,539	9
Minnesota	16,760	20
North Dakota	166	2
South Dakota	3,406	12
Wisconsin	1,651	2
Total	**25,888**	**56**

- 8 occupied units
- 48 unoccupied units
- Ranging in size from 23 to 2,751 acres

Conservation Measures – **Ecological Risk Assessment**

- FWS & Michigan Natural Features Inventory
- Evaluate pesticide use as a possible stressor at occupied sites
- Follows an ecological risk assessment process to determine:
  - Which pesticides (if any) may be exposed to different life stages & supporting habitat of Poweshiek at remaining occupied sites;
  - What effects (if any) those pesticides may be causing to Poweshiek & its supporting habitat;
  - The ecological significance of documented and probable effects, leading to:
  - Recommendations to:
    - Eliminate or reduce the risk of pesticides to Poweshiek skipperling at remaining occupied sites,
    - Inform possible augmentation and/or re-introduction efforts .

Conservation Measures – **Disease**

- Determine if Poweshiek skipperling is infected by Wolbachia
- Recommendation that no new eggs be removed from extant populations until the Wolbachia strains are characterized (Saarinen 2014).
- Sampled 2 populations in Michigan
  - Brandt Road (N=30)
  - Eaton Road (N=15)
  - 45 samples
- Results
  - 100% infection rate
  - Strain being analyzed by MN Zoo
- Additional Studies – MI and MB populations

Photo: T. Smith, USFWS

Conservation Measures – **Management Recommendations**

- East Lansing Field Office FWS Management Recommendations
  - Reduce trampling – up to 10 individual workers
  - Targeted herbicide spray
  - Plant identification to avoid spraying prairie dropseed, mat muhly, etc.
- Dakota skipper conservation guidelines:
  - http://www.fws.gov/midwest/endangered/insects/dask/DASKconservationguidelines.html
  - Prescribed fire
  - Haying
  - Grazing
  - Habitat preservation & restoration
  - Invasive species control
  - Coordinated management

Conservation Measures – **Propagation**

Photos: E. Runquist, MN Zoo; T. Smith, USFWS

Conservation Measures – **Genetics Studies** (Saarinen, Runquist)

- 133 samples collected from MB, MI, and WI in 2013 & 2014
- Preliminary study of 12 polymorphic microsatellite markers shows the genetic diversity of the Brandt Rd population is reduced, but not dissimilar to that of non-endangered Lepidoptera (Saarinen 2015).

Site	Location	No. Samples	Current Population Status	Comments
Tall Grass Prairie Preserve South Block	Manitoba, Canada	7	Extant	
Grand River Fen	Michigan - Jackson County	13	Unknown	Surveys negative in 2013 and 2014
Big Valley Preserve	Michigan - Oakland County	15	Extant	
Brandt Road Fen	Michigan - Oakland County	30	Extant	
Long Lake Fen	Michigan - Oakland County	30	Extant	
Park Lyndon	Michigan - Washtenaw County	6	Unknown	2014 surveys negative; one PS observed in 2013
Scuppernong Prairie	Wisconsin - Waukesha County	30	Unknown	Surveys negative in 2013 and 2014
Wilton Road	Wisconsin - Waukesha County	2	Unknown	Surveys negative in 2013 and 2014

Thanks!

- Minnesota Zoo – Erik Runquist, Cale Nordmeyer & Tara Harris
- Michigan Natural Features Inventory – Dave Cuthrell
- Milwaukee Public Museum – Su Borkin
- Minnesota DNR – Robert Dana
- Wisconsin DNR – Owen Boyle & Jay Watson
- Ann and Scott Swengel
- University of Winnepeg - Richard Westwood
- Nature Conservancy Canada - Melissa Pearn
- Emily Saarinen
- USFWS - TCFO, ELFO, RIFO, SDFO, NDFO.

Status Review -- Dakota Skipper
Phil Delphey, United States Fish and Wildlife Service

Status Review – Dakota Skipper

Acknowledgements

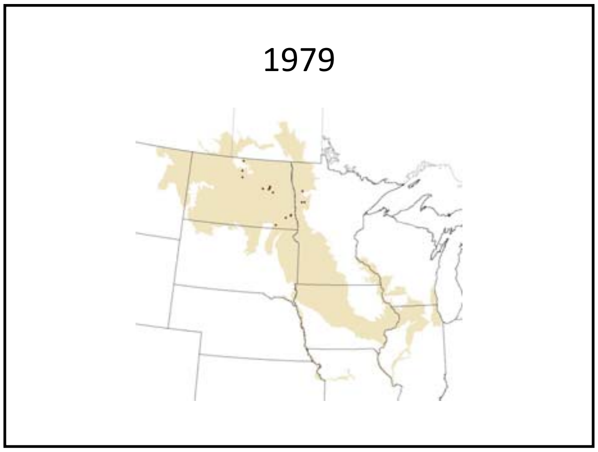
- Robert Dana, Minnesota DNR
- Richard Westwood, University of Winnipeg
- Minnesota Zoo
- South Dakota Department of Game, Fish, and Parks
- Sisseton Wahpeton Oyate
- Ron Royer
- Andrew Horton, USFWS

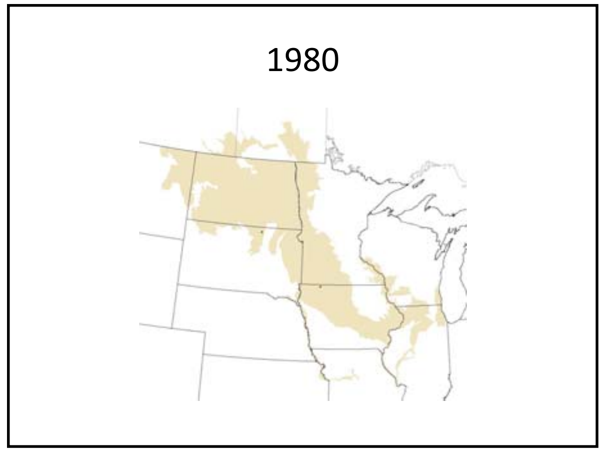
1905-1911

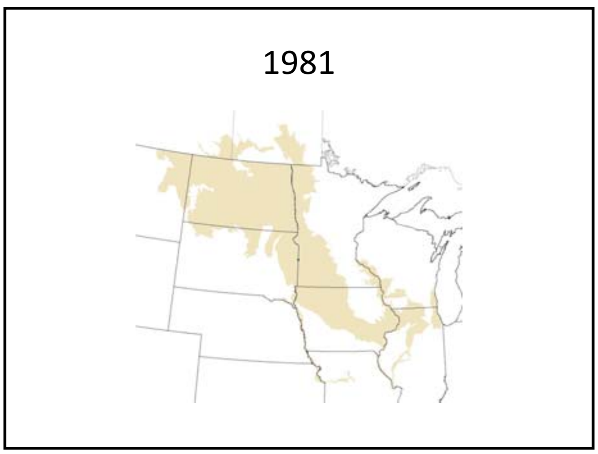
1933-1936

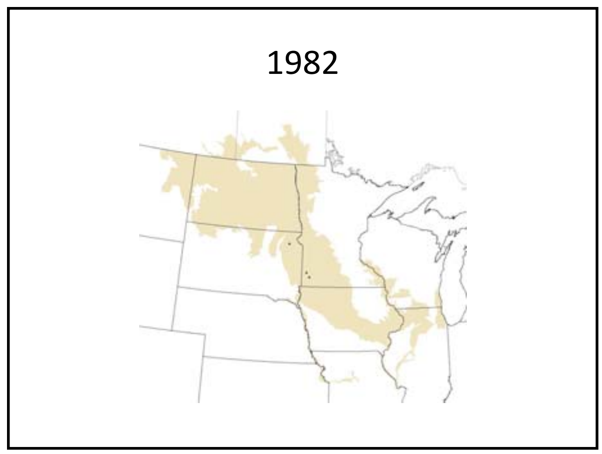
1944-1947

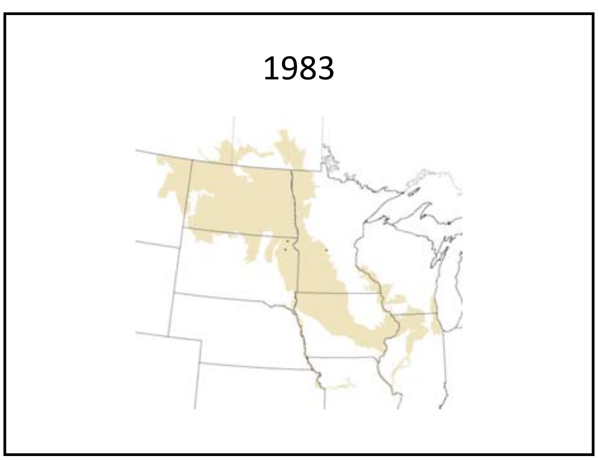
1965-1978

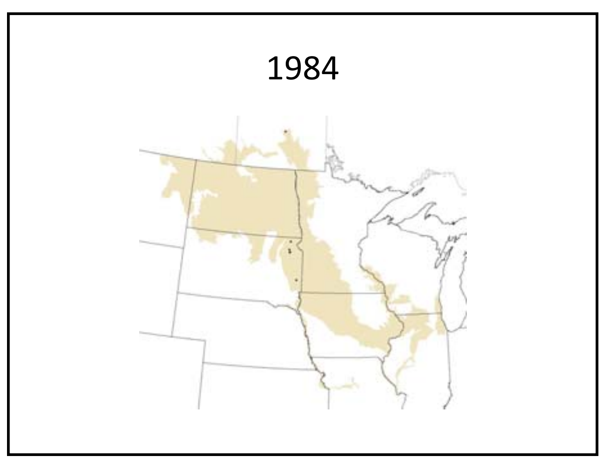

1979


1980


1981


1982


1983


1984

1985

1986

1987

1988

1989

1990

1991

1992

1993

1994

1995

1996

1997

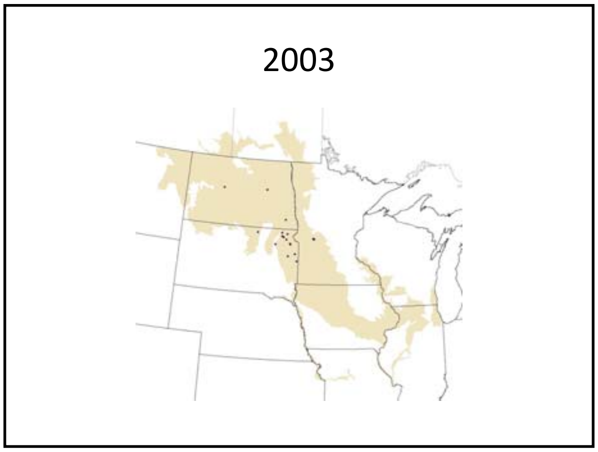
1998

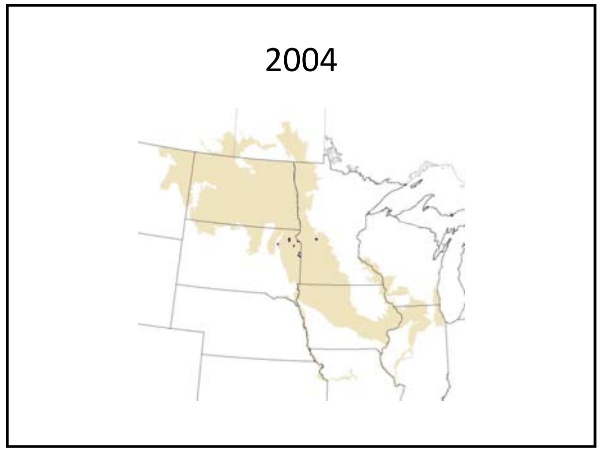
1999

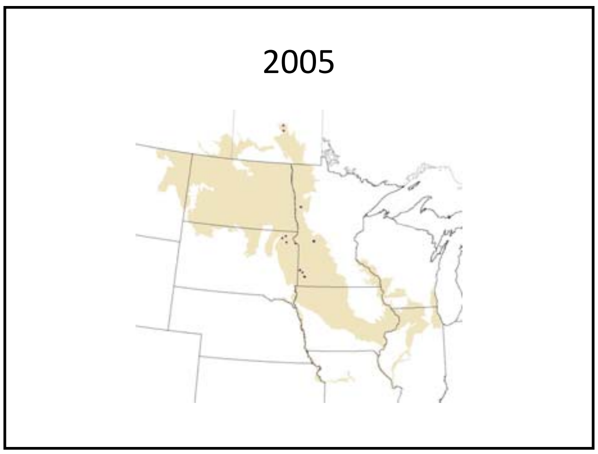
2000

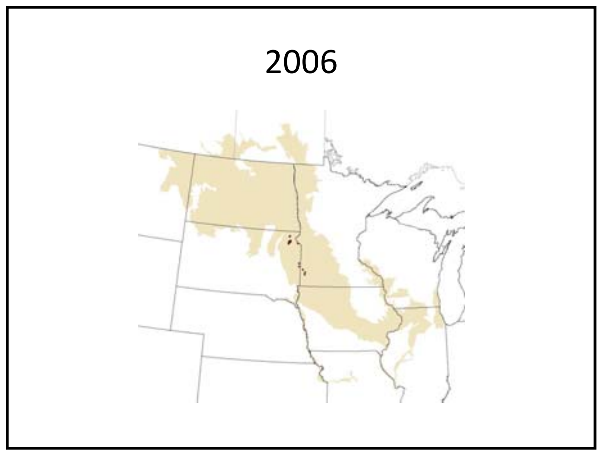
2001

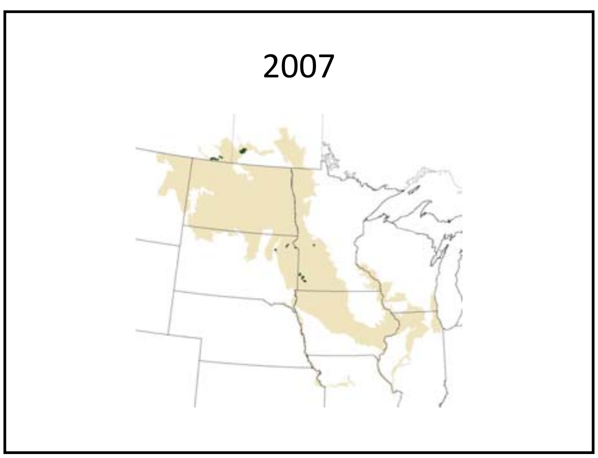
2002

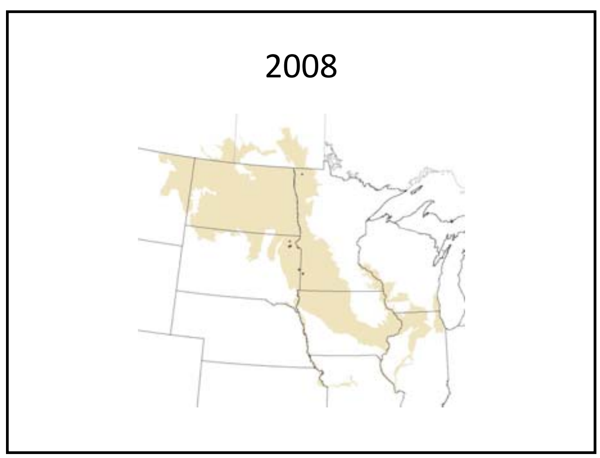

2003


2004


2005


2006


2007


2008

2010

2011

2012

2013

2014

All Records

Extant Sites

Newly Reported Sites – 2015

Manitoba 'Interlake'

R. Westwood Photo

Manitoba 'Interlake'

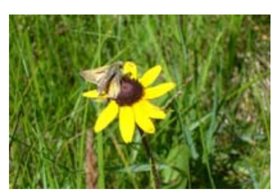
R. Westwood Photo

- 16 sites
- Low relief
- Succeeds to aspen w/o haying, fire, etc.
- Flooding/ponding occurs in some years
- Evidence suggestive of decline between 2007 and 2010-2012 (Rigney 2013)

SW Manitoba

R. Webster Photo

SW Manitoba



R. Westwood Photo

- 12 sites
- 'Type A' (mesic) habitat – similar to Interlake region
- "nearly all" used for hay with late season mowing (Webster 2007)
- "probably threatened by conversion to a grazing regime or grain crops" (Webster 2007)

Saskatchewan

R. Webster Photo

Saskatchewan

R. Webster Photo

- 14 sites
- Steep hillsides with a southerly exposure (Webster 2007)
- …"in patches within low relief gullies (possibly seepage areas?)"…
- Undisturbed prairie (not fenced) or under a light grazing regime

McHenry County, ND

R. Webster Photo

McHenry County, ND

Royer 2014

- 11 sites
- Low relief 'Type A' habitats
- Late summer haying
- Ownership
  - Private
  - State School Trust Lands

Western North Dakota

Royer 2014

Western North Dakota

- Dunn, McKenzie, and Mountrail Counties, ND
- 14 sites – ten newly discovered in 2015
- Dry-mesic
- Lightly grazed
- Patchy
- Ownership
  - Two U.S. Forest Service
  - Private

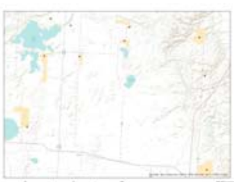
NE South Dakota

NE South Dakota

Skadsen Photo

- 10 sites
  - Five Tribal
  - Four Private
  - One USFWS
- Dry-mesic habitat (‘Type B’)
- Primary Management
  - Tribal – fall/late summer haying
  - Private – grazed
    - “Habitat continues to degrade with grazing…continued loss of floral diversity and abundance especially forbs like purple coneflower…” (Skadsen & Backlund 2014)
  - USFWS – mixed fire & grazing

NE South Dakota



Clay County, MN

Clay County, MN

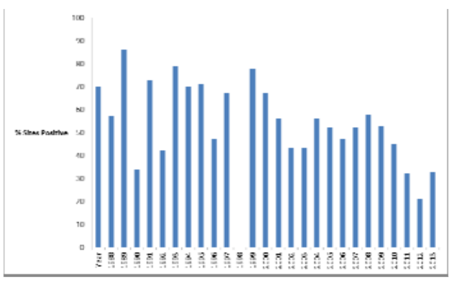
- Two distinct areas
  - Felton Prairie
  - Bluestem Prairie
- Felton Prairie
  - TNC
  - DNR
  - County
  - Private
- Bluestem Prairie
  - TNC
  - DNR

Clay County, MN

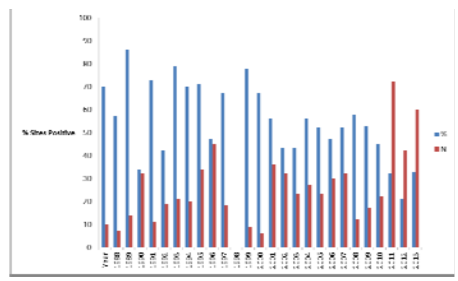
MN – Recent Extirpations?

Extant Sites

Dakota Skipper Surveys

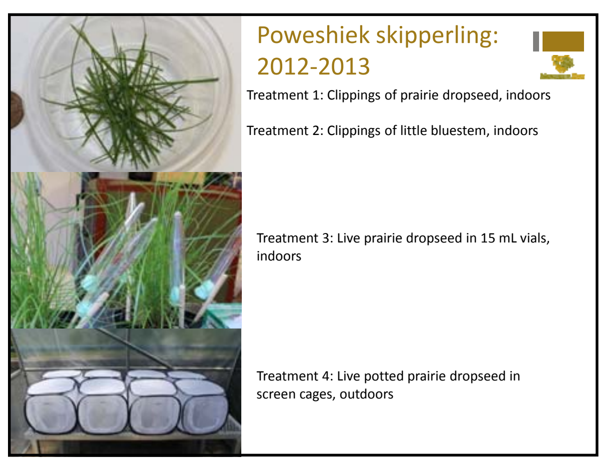


Dakota Skipper Surveys



State of the Science for *Ex situ* Management of Hesperid Butterflies
Erik Runquist, Minnesota Zoo

State	Eggs (Females)	Hatched (Females)	% Hatched
Michigan	255 (17)	221 (16)	86.7%
Wisconsin	51 (5)	45 (5)	88.2%



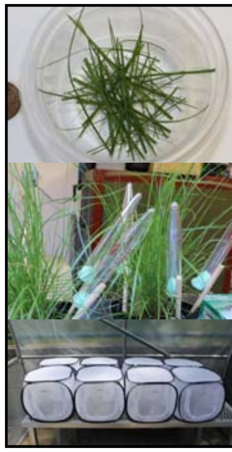
Poweshiek skipperling: 2012-2013

Treatment	Initial # Larvae	# Found, Day 8	% Found, Day 8
Clippings - prairie dropseed	84	37	44.0%
Clippings - little bluestem	66	13	19.7%
Live prairie dropseed in 15 mL vials indoors	60	31	51.7%
On potted live prairie dropseed outdoors	56	14*	25.0%*
	266	95	35.7%

*More larvae were found later once they grew larger

Day 8: Clippings treatments halted. All 81 survivors transferred to Tubes

47 survived (17.7%) across all treatments to winter diapause



Poweshiek skipperling: 2012-2013

Treatment 1: Clippings of prairie dropseed, indoors

Treatment 2: Clippings of little bluestem, indoors

1) **Clippings dried out quickly**
2) **Time intensive**

Treatment 3: Live prairie dropseed in 15 mL vials, indoors

1) **Less time intensive**
2) **Less handling**
3) **Could be on live plants**
4) **Could not be outside**

Treatment 4: Live potted prairie dropseed in screen cages, outdoors

1) **Least time intensive**
2) **Least handling**
3) **Exposed to elements**

Poweshiek skipperling: 2012-2013

Two Winter Treatments:

1) In cups in an office fridge/freezer at -4^{o}C

12 of 24 survived to spring

2) In cups outside under pots and snow

4 of 23 survived to spring
- mold found in cups during March heat wave

Poweshiek skipperling: 2012-2013

Post-diapause:

-Remaining 16 larvae were reared in tubes with live prairie dropseed (Treatment 3).

- 7 pupated
- 5 individuals survived to adulthood
  - no known disease issues
  - random accidents (failed sheds, etc.)

- 2 males and 3 females

- Females emerged over staggered 2 week period after males had emerged
- No known matings; no viable eggs

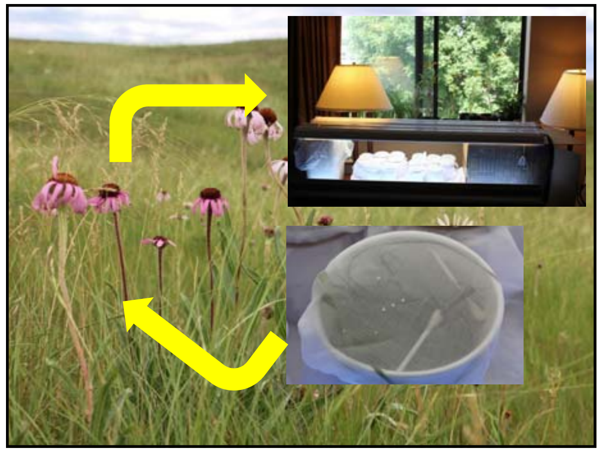
- Adults survived 5-13 days in our care in cages outside

Poweshiek skipperling: Late 2013

Low wild populations in 2013

- Limited egg collection attempt to Manitoba
- Only got 1 Female
- Laid 11 eggs, 8 hatched
- Reared in new 50 mL Vial method
- 5 died early from “failure to thrive”, as before
- Reared indoors
- 3 reached pre-pupa by mid-Sept
- Allowed to develop to adulthood; all females

Dakota skipper: 2013-2015



Dakota skipper: late 2013-early 2014

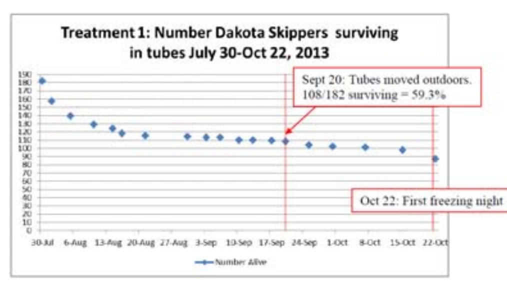
- Collected 447 eggs from 16 females from three sites in South Dakota
- 428 hatchlings (95.7%) from 15 females
- For 4-7 days, all larvae reared in 50 mL tubes with live prairie dropseed

Dakota skipper: late 2013-early 2014

Three Treatments:

1) 50 mL vials with live prairie dropseed, indoors
   -required changing every 3-4 days
2) Potted prairie dropseed, indoors
3) Potted prairie dropseed, outdoors

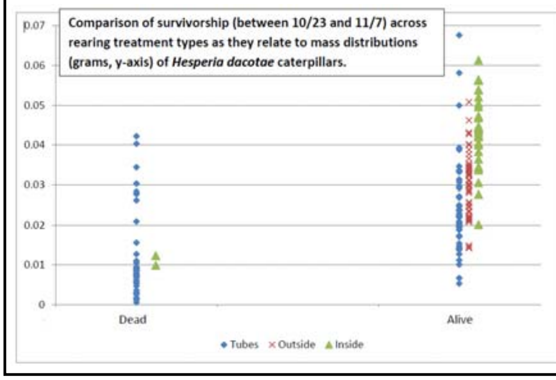
Dakota skipper: 2013-early 2014



Dakota skipper: late 2013-early 2014

Treatment	Initial # July 30	# Alive, Oct 23	% Alive, Oct 23
50 mL tubes, indoors	182	87	44.0%
Potted plants, indoors	71	35	49.3%
Potted Plants, outdoors	141	49	34.8%
	394	171	43.4%

Dakota skipper: late 2013-early 2014



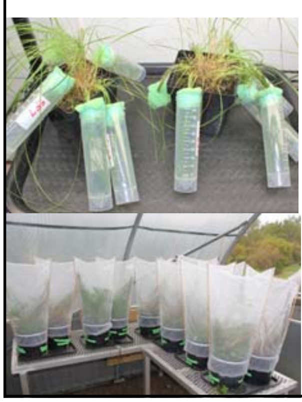
Dakota skipper: late 2013-early 2014

Dakota skipper: late 2013-early 2014

Treatment	Initial # July 30, 2013	# Alive Oct 23, 2013	% Alive Oct 23, 2013	# Alive Spring 2014	% Alive Spring 2014
50 mL tubes, indoors	182	87	44.0%	0	0%
Potted plants, indoors	71	35	49.3%	19	26.7%
Potted Plants, outdoors	141	49	34.8%	39	27.6%
	394	171	43.4%	59	27.3%

42 reached adulthood summer 2014

Dakota skipper: late 2013-early 2014



Lessons from Three Treatments:

1) 50 mL vials with live grass, indoors
   - required changing every 3-4 days
   - smaller on average pre-diapause

2) Potted prairie dropseed, indoors
   - less work; status not known
   - buffered from extreme weather

3) Potted prairie dropseed, outdoors
   - less work; status not known
   - acclimated to seasons

Dakota skipper: late 2013-early 2014

42 reached adulthood

4 confirmed matings

3 produced 119 viable eggs

Dakota skipper: 2014- early 2015


119 eggs from Zoo matings
575 wild eggs from 27 SD females
39 wild eggs from 4 wild MN females

Treatments:
1) Plugs in 10” T12 Tubes indoors

2) “Free-range” on mature potted plants outdoors

Dakota skipper: 2014- early 2015

Treatment	Initial # July 2014	# Found, Fall 2014	% Found, Fall 2014	# Alive, Spring 2014	% Alive, Spring 2014	# Adults	% Adults
10” T12 Tubes, indoors	425	301	70.8%	105	24.7%	68	16.0%
Free Range, outdoors	111	62	55.9%	59	53.2%	44	39.6%
	536	363	67.7%	164	30.6%	112	20.9%

+23% vs 2013

Dakota skipper: 2014- early 2015


Treatments:
1) Plugs in 10” T12 Tubes indoors

- **Very poor overwintering**
- **High variance in larval size**

2) “Free-range” on mature plants outdoors

- **Low ability to know status**
- **Much better overwintering**
- **More consistent sizes/emergence**

Dakota skipper: late 2015

Dakota skipper: late 2015

Dakota skipper: late 2015

112 Zoo-reared adults:
60 males, 52 females

Observed matings	Observed matings that did NOT produce viable eggs	Unobserved matings that produced viable eggs	Total Matings that produced viable eggs	Cages with unknown matings that produced viable eggs*
15	3	2	14	3*

*Could be from observed matings

Produced **1199 Zoo eggs**

Also collected:

- **386 eggs** from 20 females from 2 sites in South Dakota

- **46 eggs** from 5 females from 1 site in Minnesota

Dakota skipper: late 2015

Hatchlings placed in Tubes for a few weeks,
then placed outdoors Free Range on 3 pot sizes as:

- Singletons
- 5/pot
- 10/pot
- X/pot

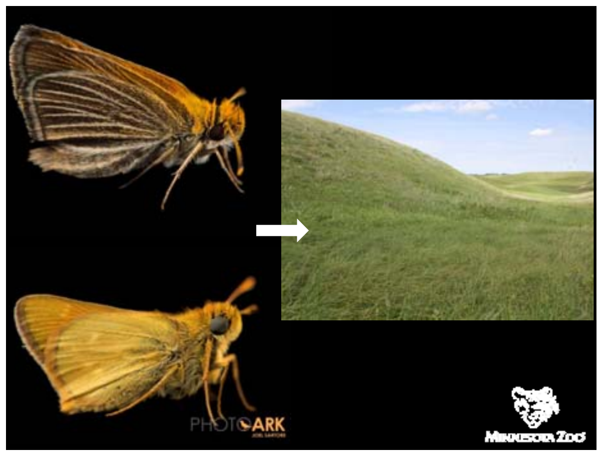
Dakota skipper: late 2015

Site	Eggs collected	Hatchlings	% Hatching Success	Upward limit, pre-diapause
Wild South Dakota	386	317	82.1%	303
Wild Minnesota	46	43	93.5%	39
From Zoo reared*	1199	280	23.4%	262
Total	1631	640	39.2%	604

+18.9% vs 2014
+43.2% vs 2013

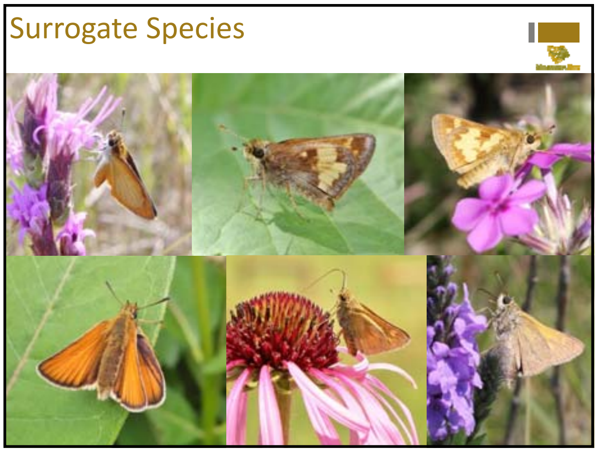
To Date:
Censused: 149
Found: 129
Estimated Pre-diapause Survivorship: **86.6%**
Estimate of Current # of Larvae: **554**

2015 and beyond

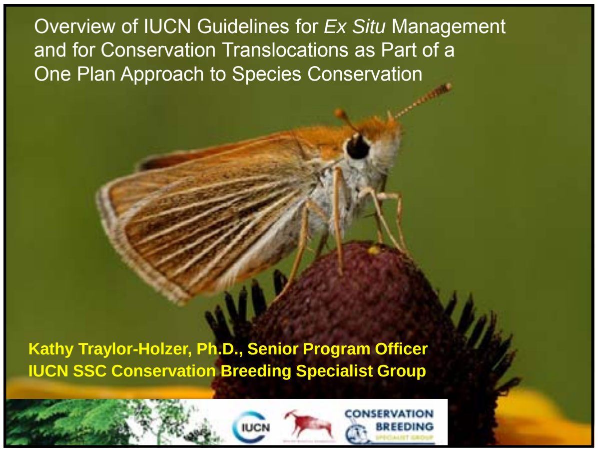


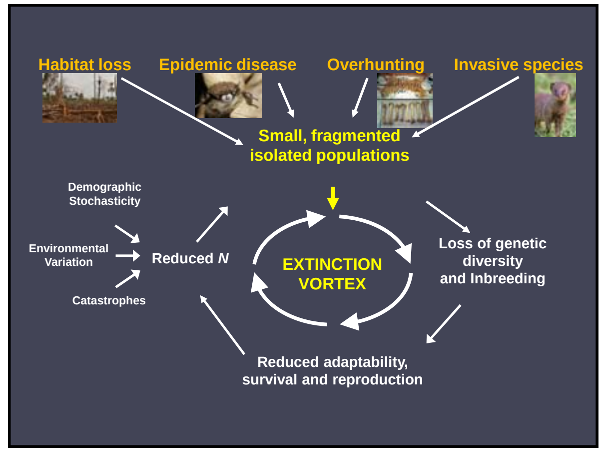
Pesticides Threats Research

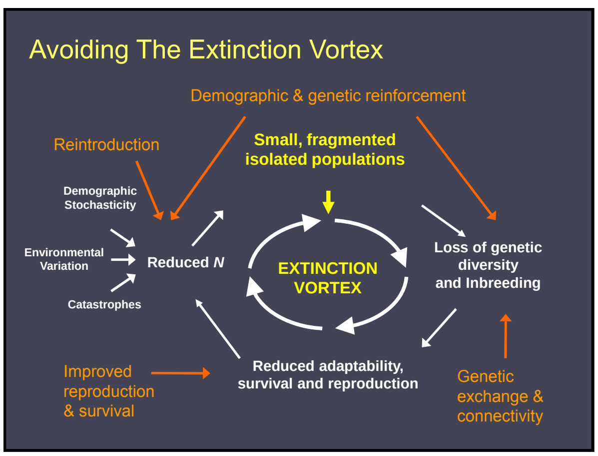
Pesticides Threats Research

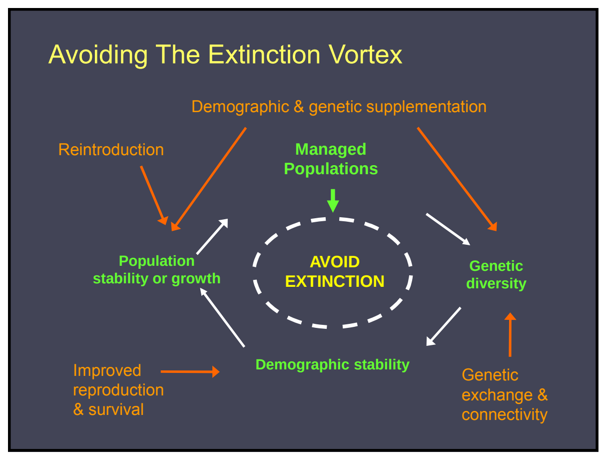

Surrogate Species

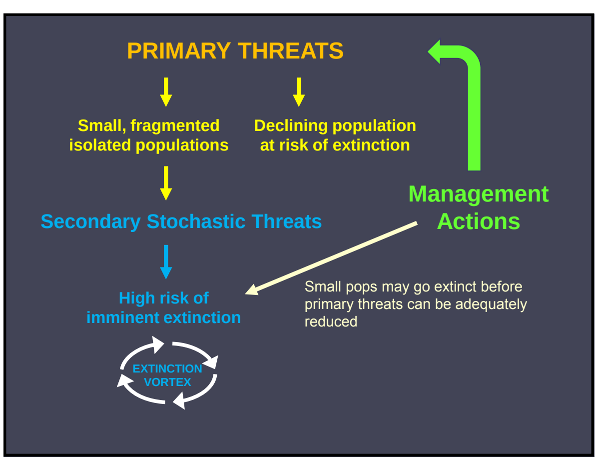
Overview of the *IUCN SSC Guidelines on the Use of* Ex situ *Management for Species Conservation* as part of the One Plan approach to conservation
Kathy Traylor-Holzer, Conservation Breeding Specialist Group

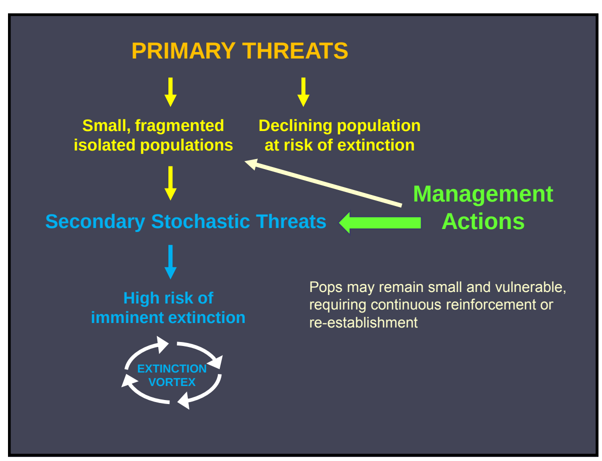


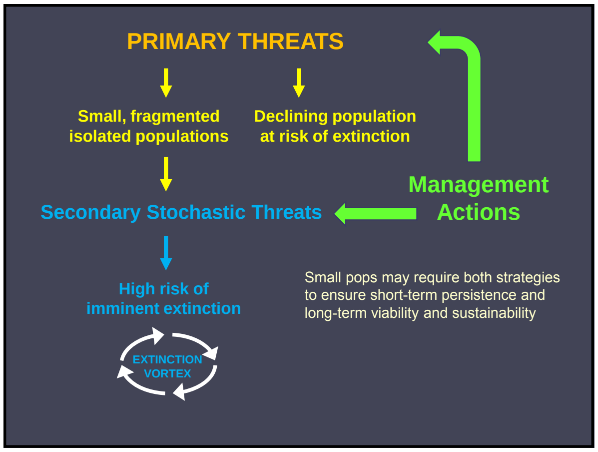






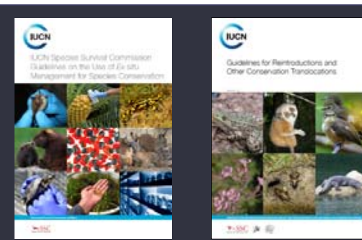






IUCN Guidelines for Population Management Strategies

- Reinforcement of existing populations
- Reintroduction into unoccupied habitat to establish new populations
- Headstart (via capture and release of 'wild origin' individuals)
- *Ex situ* breeding population (source population, research, etc.)



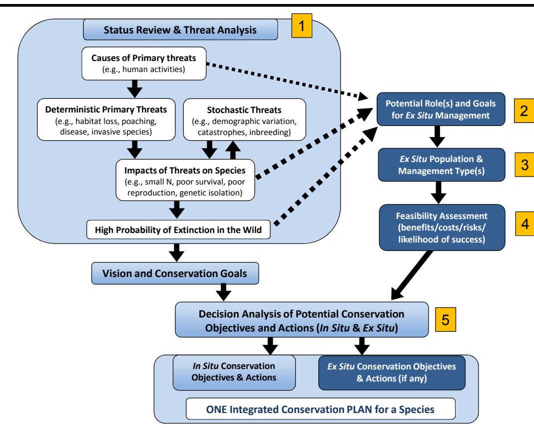
Need to assess CONSERVATION VALUE, RISKS, COSTS and FEASIBILITY

IUCN SSC Guidelines on the Use of *Ex Situ* Management for Species Conservation

If ex situ activities or program should be established, and, if so, the structure of any recommended ex situ programs

Five-step Decision-Making Process:

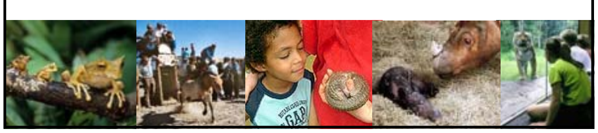
1. Review threats and current status of wild (and any captive) populations.
2. Define potential *ex situ* conservation role(s) to address constraints on the species' viability.
3. Determine characteristics of *ex situ* programs that would meet these potential conservation roles.
4. Determine the feasibility, risks and likelihood of success.
5. Make a decision regarding whether an *ex situ* activity should be established and for what purpose.



Diverse Roles of *Ex Situ* / Intensively Managed Populations

- Source population for reintroduction or release
- Rescue population in the face of severe immediate threat
- Insurance population against possible extinction in the wild (demographic and genetic backup)
- Head start program to increase survival
- Research population to benefit wild population
- Exhibition and education opportunities
- Fundraising to support *in situ* field conservation
- And more …

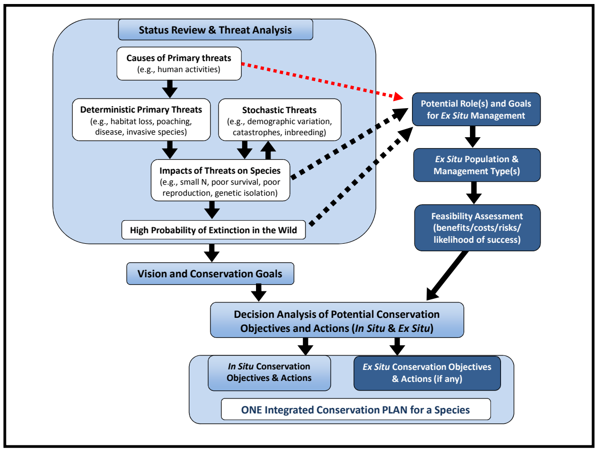
Ex Situ ≠ long-term captive breeding population by default

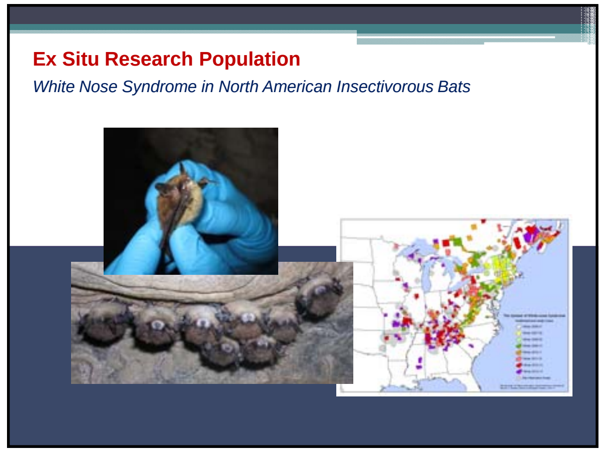


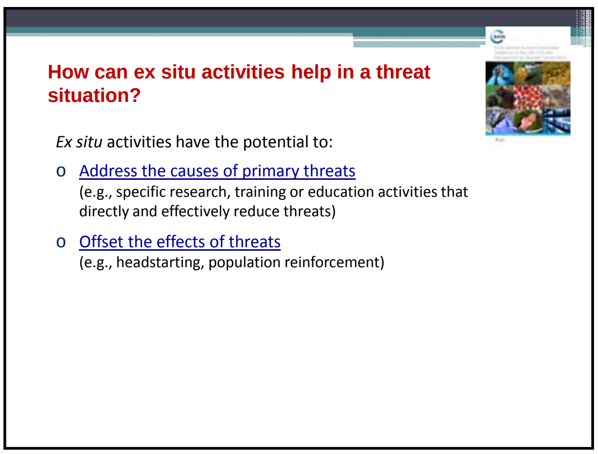
How can ex situ activities help in a threat situation?

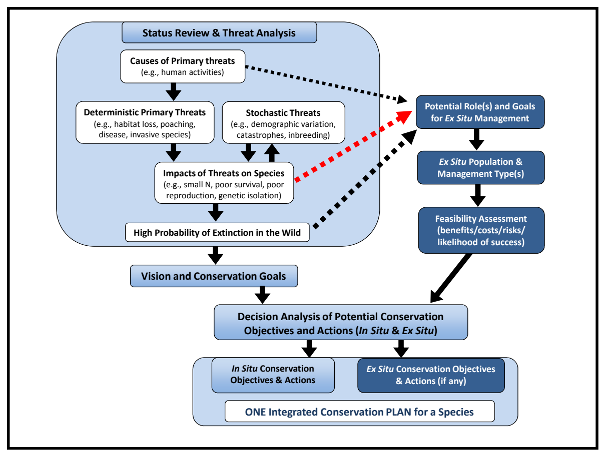
Ex situ activities have the potential to:

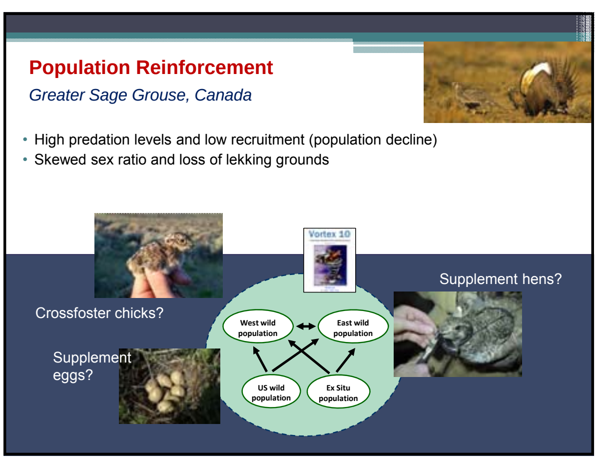
- Address the causes of primary threats
  (e.g., specific research, training or education activities that directly and effectively reduce threats) – *can also address data gaps*

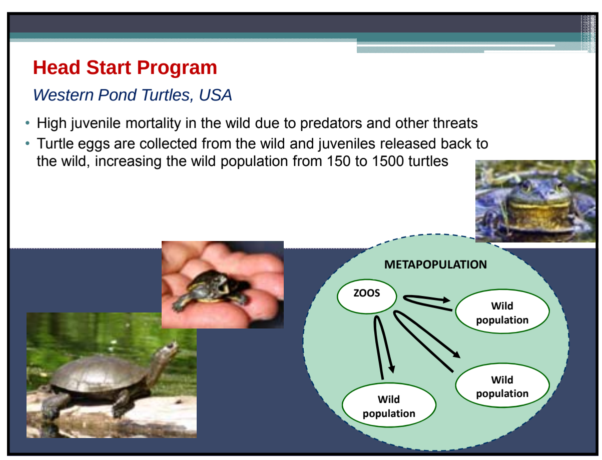

Status Review & Threat Analysis
Causes of Primary threats
(e.g., human activities)
Deterministic Primary Threats
(e.g., habitat loss, poaching, disease, invasive species)
Stochastic Threats
(e.g., demographic variation, catastrophes, inbreeding)
Impacts of Threats on Species
(e.g., small N, poor survival, poor reproduction, genetic isolation)
High Probability of Extinction in the Wild
Vision and Conservation Goals
Potential Role(s) and Goals for Ex Situ Management
Ex Situ Population & Management Type(s)
Feasibility Assessment (benefits/costs/risks/ likelihood of success)
Decision Analysis of Potential Conservation Objectives and Actions (In Situ & Ex Situ)
In Situ Conservation Objectives & Actions
Ex Situ Conservation Objectives & Actions (if any)
ONE Integrated Conservation PLAN for a Species


Ex Situ Research Population
White Nose Syndrome in North American Insectivorous Bats

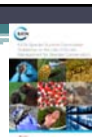

How can ex situ activities help in a threat situation?
Ex situ activities have the potential to:
o Address the causes of primary threats
(e.g., specific research, training or education activities that directly and effectively reduce threats)
o Offset the effects of threats
(e.g., headstarting, population reinforcement)


Status Review & Threat Analysis
Causes of Primary threats
(e.g., human activities)
Deterministic Primary Threats
(e.g., habitat loss, poaching, disease, invasive species)
Stochastic Threats
(e.g., demographic variation, catastrophes, inbreeding)
Impacts of Threats on Species
(e.g., small N, poor survival, poor reproduction, genetic isolation)
High Probability of Extinction in the Wild
Vision and Conservation Goals
Potential Role(s) and Goals for Ex Situ Management
Ex Situ Population & Management Type(s)
Feasibility Assessment (benefits/costs/risks/ likelihood of success)
Decision Analysis of Potential Conservation Objectives and Actions (In Situ & Ex Situ)
In Situ Conservation Objectives & Actions
Ex Situ Conservation Objectives & Actions (if any)
ONE Integrated Conservation PLAN for a Species


Population Reinforcement
Greater Sage Grouse, Canada
• High predation levels and low recruitment (population decline)
• Skewed sex ratio and loss of lekking grounds
Crossfoster chicks?
Supplement eggs?
Supplement hens?
Vortex 10
West wild population
East wild population
US wild population
Ex Situ population

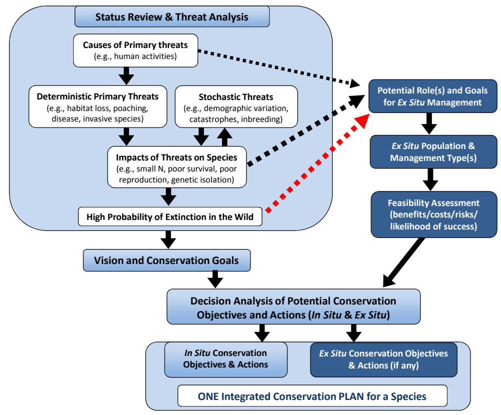

Head Start Program
Western Pond Turtles, USA
• High juvenile mortality in the wild due to predators and other threats
• Turtle eggs are collected from the wild and juveniles released back to the wild, increasing the wild population from 150 to 1500 turtles
METAPOPULATION
ZOOS
Wild population
Wild population
Wild population

How can ex situ activities help in a threat situation?



Ex situ activities have the potential to:

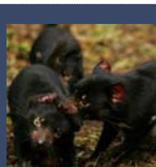
- Address the causes of primary threats
  (e.g., specific research, training or education activities that directly and effectively reduce threats)
- Offset the effects of threats
  (e.g., headstarting, population reinforcement)
- Buy time (e.g., rescue or assurance populations)

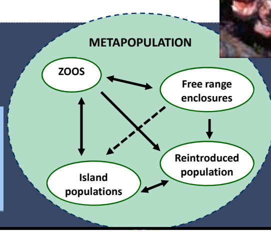


Assurance / Rescue Population

Tasmanian Devils in Tasmania

- High mortality in wild due to Devil Facial Tumour Disease (DFTD)
- DFTD moving across entire range
- Establishment of an assurance / rescue population across a range of intensive population management strategies in response to the high risk of extinction due to DFTD, possibly as a source population for re-establishment of the wild population if it perishes

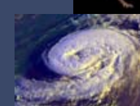




Rescue Programs

Long term:
Amphibians at risk from chytrid fungus

Short term:
Perdido key beach mice at risk due to hurricanes



Assurance Population

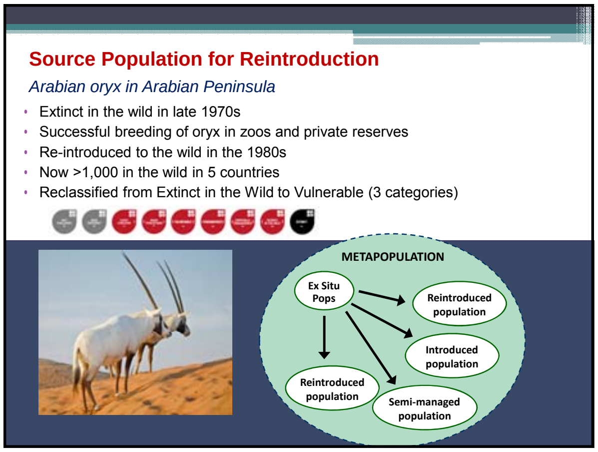
Millennium Seed Bank Partnership for Plants

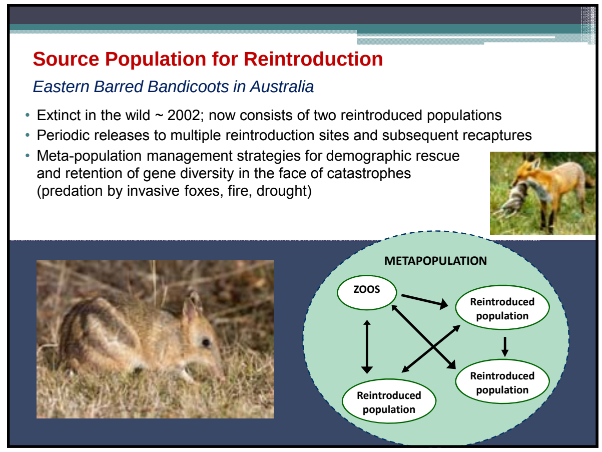
- Largest *ex situ* plant conservation program in the world
- Banked over 13% of the world's wild plant species (36,000+ species)
- Goal of 25% by 2020 (75,000 species)
- Target plants and regions most at risk from human activities
- Seeds available for research, restoration and reintroduction

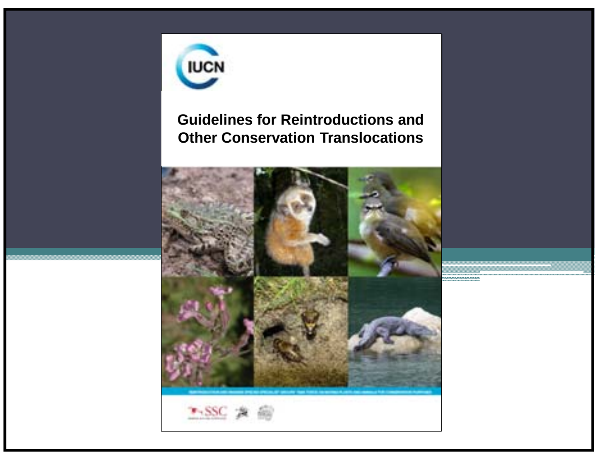
How can ex situ activities help in a threat situation?

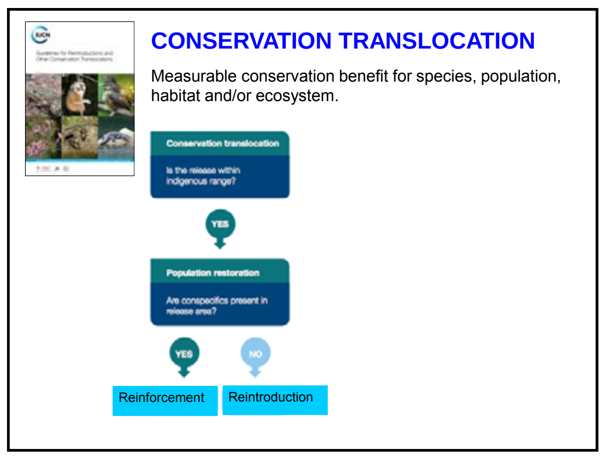
Ex situ activities have the potential to:

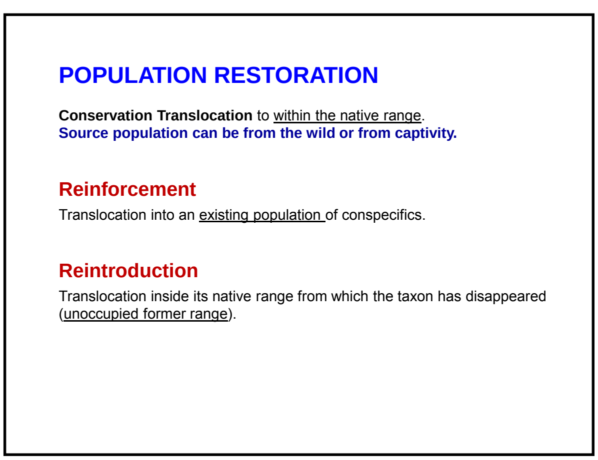
- Address the causes of primary threats
  (e.g., specific research, training or education activities that directly and effectively reduce threats)
- Offset the effects of threats
  (e.g., headstarting, population reinforcement)
- Buy time (e.g., rescue or assurance populations)
- Restore wild populations
  (e.g., population restoration or conservation introduction)

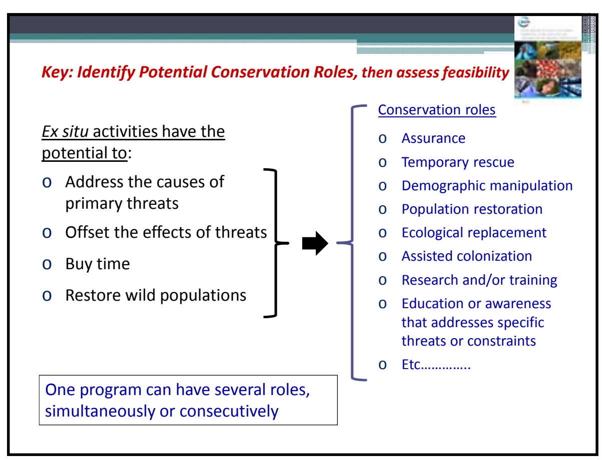

Source Population for Reintroduction
Arabian oryx in Arabian Peninsula
Extinct in the wild in late 1970s
Successful breeding of oryx in zoos and private reserves
Re-introduced to the wild in the 1980s
Now >1,000 in the wild in 5 countries
Reclassified from Extinct in the Wild to Vulnerable (3 categories)
METAPOPULATION
Ex Situ Pops
Reintroduced population
Introduced population
Reintroduced population
Semi-managed population


Source Population for Reintroduction
Eastern Barred Bandicoots in Australia
Extinct in the wild ~ 2002; now consists of two reintroduced populations
Periodic releases to multiple reintroduction sites and subsequent recaptures
Meta-population management strategies for demographic rescue and retention of gene diversity in the face of catastrophes (predation by invasive foxes, fire, drought)
METAPOPULATION
ZOOS
Reintroduced population
Reintroduced population
Reintroduced population


IUCN
Guidelines for Reintroductions and Other Conservation Translocations


CONSERVATION TRANSLOCATION
Measurable conservation benefit for species, population, habitat and/or ecosystem.
Conservation translocation
Is the release within indigenous range?
YES
Population restoration
Are conspecifics present in release area?
YES
NO
Reinforcement
Reintroduction


POPULATION RESTORATION
Conservation Translocation to within the native range.
Source population can be from the wild or from captivity.
Reinforcement
Translocation into an existing population of conspecifics.
Reintroduction
Translocation inside its native range from which the taxon has disappeared (unoccupied former range).


Key: Identify Potential Conservation Roles, then assess feasibility
Ex situ activities have the potential to:
Address the causes of primary threats
Offset the effects of threats
Buy time
Restore wild populations
Conservation roles
Assurance
Temporary rescue
Demographic manipulation
Population restoration
Ecological replacement
Assisted colonization
Research and/or training
Education or awareness that addresses specific threats or constraints
Etc.............
One program can have several roles, simultaneously or consecutively

Purpose determines population structure and management

Example: White-nose syndrome (WNS) in North American insectivorous bats

Up to 90% mortality in bat colonies with WNS → Interrupts hibernation; wake up in cold weather when there are no insects and starve

Purpose determines population structure and type of management:

Short-term holding during winter hibernation →	**Ability to hold large number of animals, hibernate successfully through winter (off exhibit), and release successfully**
Long-term breeding population as a genetic and demographic backup →	**Capture sufficient founders and breed successfully for many generations while minimizing adaptation to captivity**
Research populations for understanding and treating White Nose Syndrome →	**May be able to use a related common species to apply results and techniques to endangered bat species**
Exhibits to raise public awareness about spreading WNS while caving →	**Can use common species that is easy to maintain in captivity, and exhibit to the public in many zoos near the habitat**

Revision of the IUCN Guidelines on the Use of *Ex Situ* Management for Species Conservation

Program characteristics to meet conservation role

- Number and source of wild-caught founders
- Population size to be maintained and life stage
- Type of management (reproduction required?)
- Type of facilities required
- Capture and release techniques
- Anticipated length of program
- Etc…

Revision of the IUCN Guidelines on the Use of *Ex Situ* Management for Species Conservation

Resources, feasibility and risks

Biological Feasibility
- Founder source and availability
- Existing expertise (*ex situ* management, capture, release)

Social Feasibility
- Existing plans and governing agencies
- Other stakeholder issues
- Organization aspects
- Regulatory compliance

Resource Availability
- Staffing needs
- Finance needs

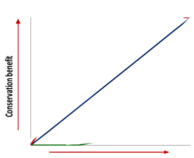
Risk Assessment
- Risk to source population viability
- Risk to recipient population
- Disease and parasite risks
- Potential political, social or public conflicts of interest
- Likely future for wild population in absence of *ex situ* or translocation activities

Likelihood of Success

Revision of the IUCN Guidelines on the Use of *Ex Situ* Management for Species Conservation

Decision

- Decision should be informed and transparent.
- Relative importance of conservation benefit, feasibility and risks will vary among stakeholders and taxa.



When is CONSERVATION TRANSLOCATION acceptable?

A **thorough understanding** of the taxon:
Taxonomy
Status
Ecology
Habitat

Evaluation of alternate conservation strategies

Original **threats** identified, assessed and removed

An understanding of the **risks** (including ecological, social and economic)

A clear understanding of **higher level of risk** in Conservation Introduction

Level of risk **weighed against** all expected benefits

Objectivity/Wisdom
In case of high uncertainty or high risks, alternate solutions/strategies to Conservation Translocation should be pursued

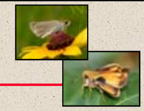
Introduction to Working Group Dynamics
Philip Miller, Conservation Breeding Specialist Group

Poweshiek Skipperling and Dakota Skipper
An *Ex Situ* Assessment and Planning Workshop

Minnesota Zoo
20 – 22 October, 2015

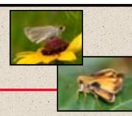



Workshop Goals



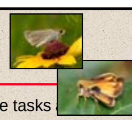
- To identify and prioritize threats to the long-term persistence of the Poweshiek skipperling and Dakota skipper
- To evaluate the potential role of *ex situ* activities, if any, in the conservation of these species
- To characterize the structure and function of each recommended program
- To identify specific action steps required to initiate and maintain the recommended programs


CBSG Workshop Processes: Defining Principles



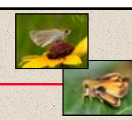
- Knowledge-based facilitation
- Inclusive and participatory
- Non-threatening; collaborative
- Culturally sensitive
- Designed to assemble information – formal and informal, published and unpublished
- Structured steps for analysis and discussion
- Scientifically rigorous – credibility among peers
- Designed to move toward a shared understanding of issues and alternative solutions

The CBSG Workshop: Working Agreement



- Leave all personal agendas at the door to focus on the tasks
- All ideas are valid
- Primary work will be conducted in sub-groups
- Everything is recorded on flip charts
- Everyone participates; no one dominates
- Listen to each other
- Treat each other with respect
- Seek common ground and agreement on recommendations
- Differences and problems are acknowledged - not "worked"
- Observe time frames
- Plan to complete working group reports by end of meeting

The CBSG Workshop Working Group Roles



- Facilitator / Flip chart recorder
  - A person to lead the discussion and to take notes on a flip chart. These notes will serve as the group memory for your discussions. [Recording can be assigned to another person if desired.]
- Computer recorder
  - A person to enter notes into a computer. These notes will form the basis of the report that will come out of the meeting.
- Presenter
  - A person to report back to plenary on the progress of the working group.
- Timekeeper
  - A person to keep track of time during working group sessions; reports to facilitator so that all tasks can be completed within the allotted timeframe.

The CBSG Workshop
Role of the Facilitator

- Not a content resource in the group
- Not the boss
- Neutral servant of the group
- Do not evaluate ideas presented
- Helps group:
  - Formulate problem by rewording;
  - Find methods to work on problem; and
  - Keep energy focused on the problem
- Suggest alternatives when no progress
- Protect individuals and ideas
- Encourage equal participation
- Help group build consensus
- Keep deadlines and produce product

The CBSG Workshop
Role of the Recorder

- Group memory - flip charts
- Listen for key words and record
- Capture basic ideas
- Mark key ideas or agreements
- Hang flip charts so all information can be seen
- All contributions have equal weight

Group Memory
A Tool for Encouraging Group Participation

- An instant record of a meeting's content and process
- Assures you that you have been heard
- Enables you to check that ideas are recorded accurately
- Helps prevent endless repetition
- Encourages participation and transfers "ownership" to the group

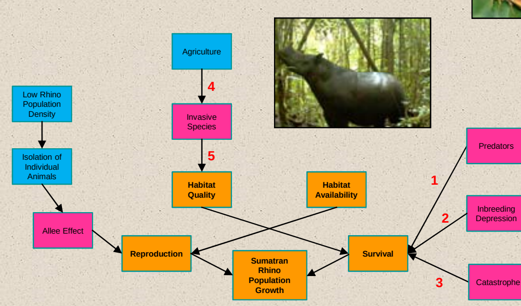
The CBSG Workshop
Role of the Reporter

- Assign role at the start of the meeting
- Present progress and results of group work
- Be concise, descriptive, non-judgmental
- Observe timeframes

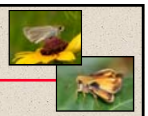
Working Group Task #1:
Threat Analysis and Potential *Ex Situ* Roles

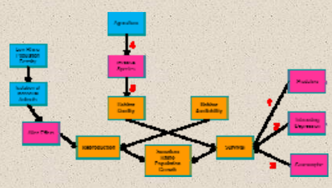
- Identify the roles within your group
- Discuss the threats specific to your group. Add or modify processes or relationships as necessary, considering both the causes of the threat and the consequence for PS or DS. Don't be afraid to ask "why"!
- Prioritize your list of threats
- For each threat:
  - Develop a full statement describing the threat and its impact
  - What is the level of certainty about this threat impacting PS/DS?
  - What is the nature and intensity of impact on PS/DS?
  - [*Consider creating a table of your threat information*]
  - What are the potential *ex situ* conservation roles that can address this threat (a description of each role/program and how it addresses the threat)

Working Group Task #1:
Threat Analysis and Potential *Ex Situ* Roles



Working Group Task #1:
Threat Analysis and Potential *Ex Situ* Roles



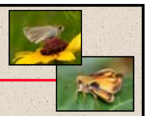


RELATIONSHIP	SIGN	CERTAINTY	IMPACT
1	-	High	Low
2	-	Medium	High
3	-	Medium	Medium
4	+	High	High
5	-	Low	Medium

Working Group Task #2:
Potential *Ex Situ* Program Characterization

- Identify the roles within your group
- Task 2A: Identify the goal and purpose of each potential *ex situ* conservation program
- Task 2B: Identify the structure of each potential *ex situ* conservation program
- Important points to remember…
  - The aim of this session is to describe what an *ex situ* program would look like in order to meet each potential conservation role identified yesterday
    - (e.g., number of founders, long-term population size, capture/release techniques required, type of facilities, management regimes, anticipated duration of program)
  - This is NOT yet the time to decide on which *ex situ* program to implement!
  - Keep in mind that a single ex situ program could address more than one threat to population viability

Working Group Task #3A:
Potential *Ex Situ* Program Analysis



- Identify the roles within your group
- Assess the needs, risks and feasibility of each potential *ex situ* program, considering such factors as:
  - Biological feasibility – founder source/availability, existing capture expertise
  - Social feasibility – organizational aspects, existing plans in place, stakeholders
  - Regulatory compliance
  - Resource availability – staffing needs, resource availability
  - Likelihood of success
  - Risk assessment – viability of source population, recipient/site population, diseases/parasites, socio-economics, politics, finances, "counterfactual analysis"
- Important element: weighing the conservation benefits and likelihood of success against the risks and costs of each potential *ex situ* program

Working Group Task #3B:
Potential *Ex Situ* Program Analysis

- Based on the group's evaluation of the benefits, risks, and feasibility of each potential program, develop the Working Group's recommendation for adopting that proposed ex situ conservation program
  - Make a decision on whether or not to go forward with each of the potential ex sit conservation programs proposed

Working Group Task #4:
Ex Situ Program Action Planning

- Describe the overall goal of your ex situ conservation program, with goals for each component (head start, research, etc.).
- For the *ex situ* conservation programs you are now proposing, develop the action steps necessary to make the proposed programs an effective component of the broader species conservation strategy.

  Each specified action should include the following characteristics:
  - Description: A short statement describing the action.
  - Responsibility: Who **in the room** is responsible for organizing or conducting the action?
  - Time line: Beginning and completion of the action. Dates.
  - Budget: Estimates of cost
  - Collaborators or Partners: Who is essential to accomplish the action?
  - Obstacles: Hurdles to overcome?
  - Measurable: A description of the outcome of completing the action. How will the outcome be measured?

IUCN

IUCN Species Survival Commission Guidelines on the Use of *Ex situ* Management for Species Conservation

International Union for Conservation of Nature

SSC
Species Survival Commission

IUCN Species Survival Commission Guidelines on the Use of *Ex situ* Management for Species Conservation

Version 2.0

Approved by the Steering Committee of the IUCN Species Survival Commission, Tallinn, Estonia, 29 August 2014

The designation of geographical entities in this document, and the presentation of the material, do not imply the expression of any opinion whatsoever on the part of IUCN or the organisations of the authors and editors of the document concerning the legal status of any country, territory, or areas, or of its authorities, or concerning the delimitation of is frontiers or boundaries.

Citation: IUCN/SSC (2014). Guidelines on the Use of *Ex Situ* Management for Species Conservation. Version 2.0. Gland, Switzerland: IUCN Species Survival Commission.

Available online at:
www.iucn.org/about/work/programmes/species/publications/iucn_guidelines_and__policy__statements/

Cover images (left to right, top to bottom):
- Northern long-eared bat (*Myotis septentrionalis*) © Steve Taylor
- Sclavo's cycad (*Encephalartos sclavoi*) © Montgomery Botanical Center
- Southern corroboree frog (*Pseudophryne corroboree*) © Michael McFadden
- Vancouver Island marmot (*Marmota vancouverensis*) © oligardner.com
- Cooba (*Acacia salicina)* © Wolfgang Stuppy, Royal Botanic Gardens Kew
- Iberian lynx (*Lynx pardinus*) © Iberian lynx *ex situ* Programme
- Blanding's turtle (*Emydoidea blandingi*) © Toronto Zoo
- Pacific chorus frog (*Pseudacris regilla*) © Katie Holzer
- Seed vault at Kew's Millennium Seed Bank © Wolfgang Stuppy, Royal Botanic Gardens Kew

Contents

Drafting process and acknowledgements

A working group was established to revise the *IUCN Technical Guidelines on the Management of Ex Situ Populations for Conservation* to clarify the process and bring the guidelines into line with developments that had taken place since their publication in 2002. This process started with an analysis of decision-making steps for evaluating *ex situ* activities for conservation benefit during the Annual Meeting of the IUCN Species Survival Commission (SSC) Conservation Breeding Specialist Group (CBSG) in Cologne, Germany in October 2010. This analysis was undertaken by individuals involved in a range of taxonomic and disciplinary SSC Specialist Groups, *in situ* conservation organisations, and the zoo and aquarium community. Subsequently, a drafting team was formed under the auspices of CBSG, comprising Kristin Leus (CBSG Europe, Copenhagen Zoo), Kathy Traylor-Holzer (CBSG), and Philip McGowan (Galliformes Specialist Group). They were supported by representatives from all SSC Subcommittees, namely Mike Maunder (Plant Conservation Subcommittee), Yvonne Sadovy (Marine Conservation Subcommittee), Paul Pearce-Kelly (Invertebrate Conservation Subcommittee), Topiltzin Contreras MacBeath (Freshwater Conservation Subcommittee), and Mark Stanley Price (Species Conservation Planning Subcommittee). In addition, Mike Jordan represented the Reintroduction Specialist Group. Mike Hoffmann served as the SSC Steering Committee liaison for this project.

A first draft was presented to the 2011 CBSG Annual Meeting in Prague, Czech Republic, and a series of drafts were submitted for increasingly wide review between 2011 and 2013 to the SSC Steering Committee, its Subcommittees, all Specialist Groups and Task Force Chairs, and Red List Authority Focal Points. A consultation was held during the SSC Chairs' meeting in February 2012. The consultative and open review process was reported in the SSC e-bulletin and presented at the 2012 World Conservation Congress in Korea. The consultation included a range of non-IUCN entities, including wildlife health professionals; botanical collections and botanical gardens; national, regional and global zoo and aquarium associations; and national and international organisations, including, but not restricted to, International Fund for Animal Welfare, Royal Society for the Prevention of Cruelty to Animals, Royal Society for the Protection of Birds, Pan African Sanctuary Alliance, UN Food and Agriculture Organisation, BirdLife International, Wildlife Conservation Society, and the Leibniz Institute for Zoo and Wildlife Research. The final draft was submitted to and approved by the SSC Steering Committee on 29 August 2014.

The drafting team (Kristin Leus, Kathy Traylor-Holzer and Philip McGowan) would like to express heartfelt thanks to each and every person that contributed to the development of the guidelines. We also acknowledge the support of home institutions and organisations of all contributors for allowing them the time to carry out this work. We hope that these guidelines contribute to the evaluation and, where appropriate, application of *ex situ* management for effective species conservation.

Guidelines

Section 1: Introduction

As habitats and ecosystems become increasingly altered and populations evermore impacted by human activities, a growing number of species will require some form of management of both individuals and populations to ensure their survival. Effective species conservation planning should consider all options when assessing what actions are necessary to address the conservation pressures facing a particular species. *Ex situ* management (see Section 2 for definition) is one possible option that can contribute to the conservation of threatened species. The range of *ex situ* scenarios and tools is diverse and can target different conservation needs and roles and, therefore, serve various purposes.

Ex situ management has been used to deliver conservation benefit for threatened species. Species extinctions have been prevented and for an increasing number of species there have been conservation restorations or introductions following periods of *ex situ* management. However, the need for, and suitability of, an *ex situ* programme must be carefully evaluated as part of an integrated conservation strategy. In order to be successful, *ex situ* programmes need to be carefully planned and implemented in a way that provides conservation benefit. In addition, as conservation challenges become more complex and urgent, the need to further develop scientifically based and innovative approaches to *ex situ* conservation will increase.

Not all species will require an *ex situ* component as part of their conservation strategy, and not all *ex situ* populations will have a direct conservation purpose. These guidelines are intended to be used in situations in which *ex situ* management is being considered as part of an overall integrated species conservation strategy.

The aim of these guidelines is to provide practical guidance on evaluating the suitability and requirements of an *ex situ* component for achieving species conservation objectives. They should not be misconstrued as promoting *ex situ* management over any other form of conservation action, and specific elements should not be selected in isolation to justify *ex situ* management for conservation. Indeed they are intended to ensure that proposals for any such activities are rigorously designed and scrutinised, whatever the taxon or scale of operation. Accordingly, the need for risk assessment and sound decision making processes in all *ex situ* management for conservation is emphasised, but with the level of effort in proportion to the scale, risk and uncertainties around any such activity.

These guidelines replace the 2002 IUCN Technical Guidelines on the Management of *Ex Situ* Populations for Conservation. In addition, aspects of these guidelines merge with many other disciplines in contemporary conservation, which also have their own guidelines or policies. Within IUCN, these guidelines should be seen as complementary to, and consistent with, the following key works:

- *IUCN Guidelines for Reintroductions and Other Conservation Translocations* (2013)[1]. In those cases where individuals are used for population restoration or conservation introduction following a period of *ex situ* management, these guidelines should be consulted together.
- *IUCN Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive Species* (2000)[1].
- IUCN (2008). *Strategic Planning for Species Conservation: A Handbook*[1].

[1] http://www.iucn.org/about/work/programmes/species/publications/iucn_guidelines_and__policy__statements/

- IUCN (2000). *The IUCN Policy Statement on Sustainable Use of Wild Living Resources*[1]
- OIE and IUCN (2014). *Guidelines for Wildlife Disease Risk Analysis*[1]
- IUCN World Commission on Protected Areas (2012). *Ecological Restoration for Protected Areas: Principles, guidelines and best practices*[2]
- IUCN Red List[3]

It should also be noted that many other organisations have developed their own guidelines for activities in the spectrum from species reintroduction to ecosystem restoration.

These guidelines are in line with the Convention on Biological Diversity and its Strategic Plan for Biodiversity (the Aichi Biodiversity Targets).

Section 2: Scope and definitions

The term "*ex situ*" can be problematic to define in some circumstances, just as it is sometimes difficult to distinguish precisely the conditions that define "wild" or "managed" in today's increasingly altered landscapes. Consequently, in many contexts there is now a gradient of management interventions between no management at one end and intensive management of individuals at the other, and between the traditional *in situ* and *ex situ* categories. Many populations both within and outside protected areas are subject to varying intensities of management such as anti-poaching interventions, predator or pathogen control, the provision of supplementary nutrition, habitat modification (e.g. controlled burning or flooding), the application of assisted reproduction, restriction of natural migration and dispersal, meta-population management, population regulation, etc., that show some characteristics in common with those used in the intensive management of *ex situ* populations. While we encourage the evaluation of the full "*in situ* to *ex situ*" spectrum of population management options in the process of identifying the most suitable conservation strategies for a species, these guidelines are designed to provide guidance for situations towards the *ex situ* end of the spectrum.

For the purpose of these guidelines, "*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. In essence, the individuals are maintained in artificial conditions under different selection pressures than those in natural conditions in a natural habitat. These are generally circumstances in which humans exercise control over many of the natural dynamics of a population, including control of climate and living environments, access to nutrition and water, shelter, reproductive opportunities, and protection from predation or certain other natural causes of mortality. *Ex situ* management may take place either within or outside the species' geographic range, but is in a controlled or modified environment. This may include highly artificial environments where individuals are stored as dormant in subzero conditions (e.g. seedbanks, genome resource banks), or semi-natural conditions where individuals are subject to near natural environments.

[2] http://www.iucn.org/about/work/programmes/gpap_home/gpap_capacity2/gpap_bpg/?10734/Ecological-Restoration-for-Protected-Areas

[3] http://www.iucnredlist.org/

These guidelines are specifically intended for situations in which *individuals (or live bio-samples) of any species (or other taxonomic unit) are present* ex situ *for any period of time for a clearly defined conservation purpose.*

For simplicity, the guidelines use the terms of "individual" to represent both individuals and live bio-samples and "species" to represent any taxonomic unit of conservation interest. These guidelines apply to:

Ecological contexts

- All taxonomic groups (animals, plants, fungi, bacteria, protozoa, etc.);
- All taxonomic levels (e.g. species, subspecies or different groupings of these);
- All population levels (e.g. all individuals of a species, single population, multiple populations);
- All live entities (not only whole living organisms, but also gametes, seeds, living cell lines, etc.); and
- All geographic levels (e.g. local, national, global).

Management contexts

- Both situations in which individuals need to be taken from the wild and brought under *ex situ* management, and situations in which the management of existing *ex situ* populations may be utilized or adapted for conservation benefit;
- The complete spectrum of very short term to very long term *ex situ* phases that may or may not include all life stages or reproduction; and
- Only *ex situ* populations with clearly defined conservation goals and objectives that contribute to the viability of the species as a component of its overall conservation strategy. While many different types of *ex situ* populations exist, with many different and sometimes overlapping roles and contexts, *ex situ* management for conservation only applies to those *ex situ* populations that have conservation as their primary aim. The *ex situ* activities must benefit a population, the species, or the ecosystem it occupies and the primary benefit should be at a higher level of organisation than the individual. The conservation goals and objectives can be diverse and may include not only providing individuals for reintroduction or other conservation translocations, for genetic rescue or as insurance against extinction, but also for allowing tailored conservation education, conservation research and training that targets the reduction of threats or the accruement of conservation benefits for the species. This does not preclude these *ex situ* populations for conservation from having additional roles that are not necessarily, or only indirectly and generally, related to conservation.

Section 3: *Ex situ* management as a conservation tool

Not all species conservation strategies will require an *ex situ* component, in the same way that other management interventions may or may not be required to conserve a species. In some cases *ex situ* management will be a primary part of a conservation strategy and in others it will be of secondary importance, supporting other interventions. It is necessary, therefore, to consider how *ex situ* management may contribute to the overall conservation objectives set for the species and to document this clearly.

Often primary threats such as habitat loss, invasive species, or overexploitation lead to small isolated populations, which then in turn become highly susceptible to additional stochastic threats that can lead to a feedback loop of population decline and eventual extinction (often referred to as the 'extinction vortex'). It is in such instances that intensive management, including but not restricted to *ex situ* management, can be of particular conservation value if deemed appropriate for the species and situation.

Ex situ conservation has the potential to:

Address the causes of primary threats

Ex situ activities can help reduce primary threats such as habitat loss, exploitation, invasive species or disease when specifically designed conservation research, conservation training or conservation education activities directly and effectively impact the causes of these threats (e.g. training in the recognition of specific life stages or gender characteristics for preferential exploitation, education to limit the spread of an invasive species, or research into disease epidemiology or treatment).

Offset the effects of threats

Ex situ activities can improve the demographic and/or genetic viability of a wild population by ameliorating the impacts of primary or stochastic threats on the population. Small populations that are vulnerable to primary threats and stochastic processes may require some form of intensive management of individuals and populations to improve demographic and genetic viability and avoid extinction. Challenges faced by small populations (e.g. reduced survival, reduced reproduction, decreased population size, and genetic isolation) can be counteracted by a range of population management options, such as head start programmes to address high juvenile mortality, or population reinforcement to balance age and sex distribution.

Buy time

Establishment of a diverse and sustainable *ex situ* rescue or insurance population may be critical in preventing species extinction when wild population decline is steep and the chance of sufficiently rapid reduction of primary threats is slim or uncertain or has been inadequately successful to date. Examples include *ex situ* populations in response to severe disease threat, catastrophic events or continued habitat degradation.

Restore wild populations

Once the primary threats have been sufficiently addressed, *ex situ* populations can be used for population restoration (reinforcement or reintroduction) or conservation introduction (assisted colonisation or ecological replacement). As such, these guidelines should be seen as complementary to, and consistent with, the IUCN Guidelines for Reintroductions and Other Conservation Translocations[1], and any *ex situ* programme for conservation that includes a return of individuals from *ex situ* conditions to natural conditions must equally refer to these.

For a growing number of taxa *ex situ* management may play a critical role in preventing extinction as habitats continue to decline or alter and become increasingly unsuitable. Furthermore, it should be acknowledged that even under the most optimistic of climate change impact and adaptation scenarios, an increasing percentage of species (for example, polar and mountain species; reef corals and their dependent species) may have little likelihood of long-term persistence in the wild, despite the option of assisted colonisation in certain carefully selected cases. At present, many threat assessment processes are inadequate in predicting the complex impacts of climate change and ocean acidification on the potential persistence of a species *in situ* (either within its current or a new range).

Section 4: Integrating *in situ* and *ex situ* conservation planning

There is an increasing need to ensure the integration of *in situ* and *ex situ* conservation planning to ensure that, whenever appropriate, *ex situ* conservation is used to support *in situ* conservation to the best effect possible. These guidelines would therefore ideally be used as an integral part of, and complementary to, existing species conservation planning processes (Figure 1). Any *ex situ* conservation support should follow a logical process from initial concept to design, feasibility, risk assessment, decision-making, implementation, monitoring, adjustment and evaluation. Furthermore, the Species Survival Commission's approach to conservation planning for species[1] requires the specification of goals, objectives and actions:

- 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 realised; and
- Actions are statements of what should be done to meet the objectives.

When used strategically *ex situ* conservation can be a potent tool for species conservation that does not undermine, but complements, the imperatives of field conservation. Potential *ex situ* goals, objectives and actions should therefore be evaluated alongside potential *in situ* activities in the process of conservation planning to ensure that they are used appropriately and to best effect. More specifically, before an *ex situ* conservation programme is developed or continued, it is important to consider the roles it can play, the characteristics and dimensions it should take, and what factors will impede or likely contribute to conservation success. As is the case for conservation planning in general, these evaluations are ideally made by a multi-stakeholder group, including both *in situ* and *ex situ* expertise and experience.

These guidelines outline five steps (Figure 1) to evaluate the appropriateness of *ex situ* management as part of a comprehensive species conservation strategy. They explore the conservation role and design, feasibility, and risk assessment, and guide a final decision on whether or not to proceed with an *ex situ* programme for conservation. The five-step process also provides input for the formulation of clear goals, objectives and actions for any *ex situ* conservation programme undertaken after the decision making process.

FIVE-STEP DECISION MAKING PROCESS

to decide when *ex situ* management is an appropriate conservation tool

Ex situ management should be applied to the conservation of a species where, on balance, stakeholders can be confident that the expected positive impact on the conservation of that species will outweigh the potential risks or any negative impact (which could be to the local population, species, habitat or ecosystem), and that its use will be a wise application of the available resources. This requires an assessment of the potential net positive impact, weighted by how likely it is that this potential will be realised, given the expertise, level of difficulty or uncertainty, and available resources.

The following five-step outline provides a logical decision-making process that can be applied to evaluate the appropriateness of *ex situ* management as a tool to support the conservation of a species and to identify the form that such management would need to take. All steps of the process should be documented for transparency and clarity.

STEP 1. Compile a status review of the species, including a threat analysis.
A detailed review should be undertaken of all relevant information on the species, both in the wild and ex situ*, with the aim of assessing the viability of the population(s) and to identify and understand threats that affect the species. This is a normal step in any conservation planning process and may therefore for some species already be available in existing conservation strategies or action plans. If not, this process would ideally be conducted in the wider framework of the creation of one integrated conservation strategy for a species.*

a. The status review should contain information on all factors that are appropriate to the life history and taxonomy, current population status, and other factors that are relevant to the demographic and genetic viability and ecosystem function of the species being considered. The structure of the status review (and threat analysis – see b. below) should, wherever possible, be consistent with IUCN processes that also compile information on status, such as the IUCN Red List Assessments[3] and the IUCN/SSC Species Conservation Planning approach[1]. The character and scale of the status review will vary depending on the precise circumstances, including data availability and relevance. Important information gaps concerning the status should be noted.

b. A threat analysis should be undertaken to identify the specific historical, current and likely future primary direct and indirect threats as well as stochastic threats facing the species in the wild and the constraints limiting its viability and conservation. This analysis should, wherever possible, utilise the rapidly growing data knowledge on anticipated climate change scenarios to predict likely changes in status. This provides the framework for evaluating specifically how *ex situ* management of the species may contribute to its conservation.

c. Genetic and demographic modelling should where possible be used to assess the viability of the wild population. This can be very valuable to guide population management by identifying the effects and relative importance of threats (including stochastic processes) and the strategies that may address them effectively.

d. The status of any free-living populations living outside of the species' indigenous range, as well as the status of existing *ex situ* population(s) (if any), should be reviewed, including current population size, demographic and genetic characteristics, provenance and history, taxonomy, and any programme goals and management methods if applicable.

e. In the absence of sufficient data for a thorough assessment, other information may be considered as evidence suggestive of current or impending population decline or reduced viability, such as population trends, likelihood of future habitat loss, vulnerability to climate change, projected impact of invasive species, and restricted range to one or few locations.

STEP 2. Define the role(s) that *ex situ* management will play in the overall conservation of the species.

The potential ex situ *management strategies proposed should address one or more specific threats or constraints to the species' viability and conservation as identified in the status review and threat analysis, and target improvement of its conservation status.*

a. There should be a clear statement on how the proposed *ex situ* programme will contribute quantifiable benefits to the conservation of the species and address certain specific threat(s) and/or constraints to its viability as identified in the status review and threat analysis. This should include quantifiable goal(s) and objectives, and how success towards those objectives will be measured and assessed. When sufficient data and expertise are available, population modelling can be effective in assessing the potential impact of the *ex situ* programme on the viability of the wild population.

b. Potential roles (purpose/function) that an *ex situ* programme might serve for the conservation of a species generally fall into the four categories of *Addressing the causes of primary threats, Offsetting the effects of threats, Buying time, and Restoring wild populations* (see Section 3) and more specifically include but are not restricted to:

- Insurance population (maintaining a viable *ex situ* population of the species to prevent predicted local, regional or global species extinction and preserve options for future conservation strategies);
- Temporary rescue (temporary removal from the wild to protect from catastrophes or predicted imminent threats, e.g. extreme weather, disease, oil spill, wildlife trade). This could be appropriate at either local or global scale;
- Maintenance of a long term *ex situ* population after extinction of all known wild populations and as a preparation for reintroduction or assisted colonisation if and when feasible;
- Demographic manipulation (e.g. head-start programmes that remove individuals from the wild to reduce mortality during a specific life stage and then subsequently return them to the wild);
- Source for population restoration, either to re-establish the species into part of its former range from which it has disappeared, or to reinforce an existing population (e.g. for demographic, behavioural or genetic purposes);
- Source for ecological replacement to re-establish a lost ecological function and/or modify habitats. This may involve species that are not themselves threatened but that contribute to the conservation of other taxa through their ecological role;
- Source for assisted colonisation to introduce the species outside of its indigenous range to avoid extinction;
- Research and/or training that will directly benefit conservation of the species, or a similar species, in the wild (e.g. monitoring methods, life history information, nutritional requirements, disease transmission/treatment); and
- Basis for an education and awareness programme that addresses specific threats or constraints to the conservation of the species or its habitat.

c. One *ex situ* programme may serve several conservation roles – either simultaneously or consecutively.

It is recognised that an *ex situ* population can also serve to avoid extinction of a species that has no chance in the foreseeable future for persistence in the wild (for example in the face of climate change). In such circumstances a careful appraisal of the allocation of available resources should be made, and a prioritization based on conservation benefits and other values may assist in the decision making.

STEP 3. Determine the characteristics and dimensions of the *ex situ* population needed to fulfil the identified conservation role(s).
The identified conservation purpose and function of the ex situ *programme will determine its required nature, scale and duration.*

a. Biological factors that are important in assessing requirements for achieving the programme's aim and objectives include:

- The number of founders (unrelated individuals of wild origin) required to attain the genetic and demographic goals of the *ex situ* population. This may involve making use of founders (and their descendants) of existing *ex situ* populations and/or sampling (additional) individuals (and where appropriate propagules or biomaterials from individuals) from the wild, across different habitat types, populations, etc.;
- The number of individuals or bio-samples to be maintained or produced *ex situ*;
- Whether reproduction or propagation is required during the duration of the programme;
- The likely required length of programme (in generations and in years) where possible;
- The relative risk for artificial selection/adaptation (genetic, phenotypic, etc.) during consecutive generations in *ex situ* conditions;
- Whether the *ex situ* phase is envisaged to be followed by a release (which has consequences for the required characteristics of the *ex situ* environment); and
- The type of environment required to maintain the individuals in a suitable condition during the length of the programme.

b. These lead to the following practical considerations that should be evaluated:

- The most suitable geographic location and scale for the *ex situ* activities (for example, inside *vs.* outside of the current/indigenous range; a centralized *vs.* a multi-facility programme; etc.). Where possible *ex situ* management should be undertaken within the range states and under similar climatic regimes to the wild population. However, because the current distribution of *ex situ* facilities and professional capacity generally does not match with the geographic areas of greatest species loss, the need for capacity building and the availability of material resources and suitably trained and committed personnel requires consideration;
- Whether whole living organisms and/or live bio-samples (e.g. tissue or gametes/seeds/spores) will need to be maintained *ex situ*;
- Whether whole living organisms and/or live bio-samples will need to be marked and tracked and if so, how;
- Whether individuals from existing *ex situ* populations (potentially with other, or additional, roles than conservation) can be included in the *ex situ* conservation programme, thus reducing the risks to the wild population associated with the removal of individuals;
- The intensity of genetic and demographic management required to achieve the roles and goals of the *ex situ* programme;
- The potential bio-security risks associated with the project, both at the *ex situ* location(s) and in any subsequent population restoration or conservation introduction if this is planned;
- The welfare issues associated with the programme;
- The potential options for, and benefits of, maintaining individuals on public display *vs.* in non-public facilities that restrict access, visibility or disturbance;

- The degree of human proximity and interaction that can be allowed in terms of the potential for habituation of *ex situ* individuals to people, due to the management approach chosen and/or exposure to the public;
- The legal and regulatory requirements for removing individuals or biomaterials from the wild and/or transporting them regionally, nationally or internationally;
- The ownership of, and access to, individuals and bio-samples and the degree of assurance of ongoing commitment to the programme by both holding and owning parties; and
- The fate of any individuals or bio-samples remaining in the *ex situ* programme when its purpose has been achieved.

Population models may be used to determine the necessary population size, composition and level of management needed to meet the conservation role(s) of the population.

STEP 4. Define the resources and expertise needed for the *ex situ* management programme to meet its role(s) and appraise the feasibility and risks.

It is not sufficient to know the potential value of an ex situ *programme designed to meet a specific conservation role – it is also critical to evaluate the resources needed, the feasibility of successfully managing such a programme, the likelihood of success at all steps of the programme, including where relevant any subsequent return to the wild, and the risks, including risks to the species in the wild and to other conservation activities. These should be balanced against the risks of failing to take appropriate conservation action.*

a. It is essential to assess the resources required to establish and maintain an *ex situ* population with the characteristics defined in Step 3 in order to achieve the aims and objectives stated in Step 2. These should be considered in detail at this stage. Some of the practical factors that will determine the overall scale of resources required include:

- The facilities, infrastructure and space required;
- The staffing required (in terms of numbers, skills and continuity);
- The risk for the spread of disease (need for biosecurity, quarantine, diagnostics, research on pathogens and disease, etc.).
- The risk of catastrophes impacting the *ex situ* programme (natural or human-caused catastrophes, such as fire, civil unrest, etc.); and
- The finances required for all essential activities over an adequate period of time (in proportion to the expected total length of the programme).

b. Other factors that need to be determined to investigate the feasibility and risks of the proposed project include:

- The probability of obtaining the required resources, including technical experts and project managers with the required skill sets. Effective *ex situ* management for conservation will require effective multidisciplinary teams within the biological, technical and social skill sets;
- Competition for resources with other programmes for the same or other taxa as well as opportunities for cost sharing;
- Available expertise in husbandry/disease control/cultivation/propagation/banking for relevant life stages for this and/or for related/comparable taxa. In some areas of the world, particularly in regions facing the highest rates of biodiversity loss, the capacity for skills in *ex situ* conservation may need to be strengthened. Similarly, the increasingly diverse range of candidate species and challenges to be addressed may require additional tools and techniques;
- The degree of stability in, or level of agreement about, the taxonomy of the taxon in question and the degree of knowledge on evolutionary significant units, genetic population structure and risks for inbreeding and outbreeding depression;
- The critical governmental and non-governmental partner institutions and the probability of successful collaboration among these (including partners responsible for field conservation);
- The degree of compatibility of the ecological, demographic, behavioural or other characteristics of the species with the type of *ex situ* management proposed;
- Requirements to ensure the welfare of any living individuals *ex situ*. *Ex situ* conservation programmes should adhere to internationally accepted standards for welfare, and efforts should be made to reduce stress or suffering;
- All legal and regulatory requirements for the project (so that the intended *ex situ* management is approved and supported by all relevant agencies) and how likely

they can be fulfilled. An *ex situ* conservation programme may need to meet regulatory requirements at any or all of the international, national, regional or sub-regional levels. This may among others involve regulations for the capture or collection of individuals from the source populations, for the movement of individuals across international borders (e.g. CITES) and across jurisdictional or formally recognised tribal boundaries, for dealing with benefits arising from the use of genetic resources and/or traditional knowledge (e.g. Nagoya Protocol), for veterinary and phyto-sanitary aspects, and for the holding of wild individuals in *ex situ* conditions;

- Any formal endorsements required for the project from relevant *in situ* and/or *ex situ* entities, and how likely they can be obtained;
- Where relevant, assessment of the impact of the removal of individuals from the wild on the remaining wild source population (e.g. through modelling);
- The likely impact on the remaining wild population and its habitat of establishing, or not establishing, an *ex situ* population. Special consideration may be given to situations in which all remaining wild individuals may need to be removed due to a very high probability of extinction in the wild that cannot be mitigated in time;
- The ecological risks (e.g. containment of potentially invasive species, hybridisation risks) and what is required to minimise them;
- Any health and safety risks (for people and/or other species) and what is required to minimise them; and
- Any potential political, social or public conflicts of interest and how they can be dealt with. A review of the cultural status of the species should be conducted to ensure that any *ex situ* conservation management is compatible with local traditions and values and supported by local communities at the source location(s) and/or the *ex situ* location(s). Mechanisms for communication, engagement and problem-solving between the public (especially key individuals most likely affected by or concerned about the removal of individuals from nature or the maintenance of individuals *ex situ*) and *ex situ* managers should be established.

A review of the factors mentioned above will allow the assessment of an overall probability of the *ex situ* programme achieving the intended results in terms of conservation benefit.

The scope of the risk assessment should be proportional to the level of identified risk. Where data are poor, the risk assessment may only be qualitative but it is necessary, as lack of data does not indicate absence of risk.

STEP 5. Make a decision that is informed (i.e. uses the information gathered above) and transparent (i.e. demonstrates how and why the decision was taken).

The decision to include ex situ *management in the conservation strategy for a species should be determined by weighing the potential conservation benefit to the species against the likelihood of success and overall costs and risks of not only the proposed* ex situ *programme, but also alternative conservation actions or inaction.*

The relative importance (weight) of potential conservation benefit *vs.* likelihood of success, costs and risks will vary for each species and situation, according to factors such as, but not limited to:

- The severity of threats and/or risk of extinction of the wild population;
- The significance of the species (ecological, cultural, sociological, economic or evolutionary distinctness, value of the species in leveraging large scale habitat conservation, etc.); and
- Legal and political mandates.

In general, any conservation management strategy including *ex situ* management is warranted when potential conservation benefit is both high and likely to be achieved. Similarly, *ex situ* management is not warranted if there is little conservation benefit, feasibility is low, and costs and risks (especially to the wild population) are high.

If the decision to implement *ex situ* management of a species is left until extinction is imminent, it is frequently too late to implement effectively, thus increasing the chance of failure and risking permanent extinction of the species. This reinforces the need for comprehensive strategic planning for species to be undertaken as early as possible.

Documentary evidence of information gathered and decisions made for Steps 1 through 5 is highly important, *regardless of whether the decision to proceed with the* ex situ *management is positive or negative*. Archiving of documents in publicly accessible libraries and on public web sites is recommended.

SECTION 5: Programme implementation, monitoring, adjustment and evaluation

Implementation

If a decision is made to establish or continue an *ex situ* management programme, further considerations that are important in the development of this programme include:

- Actions needed to achieve the identified goals and objectives of the programme should be formulated and implemented (including actions to mitigate the most important risks identified in Step 4). Actions should be specific, measurable, have time schedules attached, and indicate the resources needed and parties responsible for their implementation;
- Data collection and management protocols for all important aspects of the programme should be developed in order to enable adequate monitoring;
- Any *ex situ* management programme should be developed within national, regional and international conservation infrastructure, recognizing the mandate of existing agencies, legal and policy frameworks, organisational conservation strategies, national biodiversity action plans or existing species recovery plans. Of noteworthy mention in the context of these guidelines are the Convention on Biological Diversity (CBD), the International Agenda for Botanic Gardens in Conservation, the Global Strategy for Plant Conservation, the International Treaty on Plant Genetic Resources for Food and Agriculture, the World Zoo and Aquarium Conservation Strategy, the Global Plan of Action for Animal Genetic Resources and the Interlaken Declaration;
- Any *ex situ* conservation programme should adhere to national and international obligations with regard to access and benefit sharing (as outlined in the CBD);
- The *ex situ* programme should consult during its planning, implementation, monitoring and evaluation stages with all relevant stakeholder groups, professional associations and organisations, both with regard to the indigenous range of the species and the location of the *ex situ* programme;
- The *ex situ* programme personnel should stay up to date with relevant scientific work and scientific publications;
- Where multiple bodies such as government agencies, non-government organisations, academia, private organisations, informal interest groups, etc. all have statutory or legitimate interests in an *ex situ* programme, it is essential that mechanisms exist for all parties to play constructive roles. This may require establishment of special teams working outside formal, bureaucratic hierarchies that can guide, oversee and respond swiftly and effectively as management issues arise. Different parties involved in an *ex situ* project may have their own mandates, priorities and agendas that need to be aligned through effective facilitation and leadership in order not to undermine the success of the project. A memorandum of understanding with appropriate parties defining the collaboration structure, ownership issues and responsibilities may be beneficial. Inter-project, inter-regional or international communication and collaboration is encouraged as relevant. The programme should consult with external experts as needed;
- The *ex situ* project should have a clear and appropriate time frame established.

Monitoring, adjustment and evaluation

There should be regular evaluations of the *ex situ* programme, not only of its own success, but also of its role within the overall conservation strategy for the species, which is likely to change over time.

The management of an *ex situ* programme is a cyclical process of implementation, monitoring, feedback and adjustment of both biological and non-biological aspects until either the goals are met or the *ex situ* programme is deemed unsuccessful. Despite thorough planning and design, inherent uncertainty and risk will lead to both expected and unexpected situations. The monitoring is the means to measure the performance of the *ex situ* programme against objectives, to assess conservation impacts, and provide the basis for adjusting objectives or adapting management regimes or activating an exit strategy. In addition to refining an ongoing *ex situ* programme, the conclusions from monitoring may guide other *ex situ* programmes.

Adequate resources for monitoring should be part of financial feasibility and commitment. The purpose and duration of monitoring of the *ex situ* populations and the species' situation in the wild (especially those aspects that that the *ex situ* population is trying to address) should be appropriate to each situation.

Learning from *ex situ* conservation programme outcomes can be improved through application of more formal adaptive management approaches, whereby alternative models are defined in advance and are tested through monitoring. This process means that the models used to decide management are based on the best possible evidence and learning.

SECTION 6: Dissemination of information

Regular reporting and dissemination of information should start from the intention to initiate *ex situ* activities for conservation and throughout subsequent progress. It serves many purposes both for each *ex situ* project and collectively:

1. To create awareness and support for the *ex situ* programme amongst all parties;
2. To meet any statutory requirements; and
3. To contribute to the body of information on, and understanding of, *ex situ* management for conservation. Collaborative efforts to develop *ex situ* management science are helped when reports are published in peer-reviewed journals (as an objective indicator of high quality), and include well-documented but unsuccessful *ex situ* projects or methods as well as successful ones.

The means of dissemination are many (e.g. publications, press, interpretation in public institutions). The media, formats and languages used all should be appropriate for the target audience.

Figure 1: Incorporation of the five-step decision process outlined in these guidelines (yellow numbers) into the species conservation planning process to develop an integrated conservation strategy for a species.