

National Fish and Wildlife Foundation

Monarch Butterfly Business Plan

August 9, 2016

Purpose of a Business Plan

The purpose of a NFWF business plan is to provide a concise blueprint of the anticipated strategies and resources required to achieve the desired conservation outcomes. The strategies discussed in this plan do not represent solely the Foundation's view of the actions necessary to achieve the identified conservation goals, but instead reflect the majority view of federal, academic, and organizational experts consulted during plan development. This plan is not meant to duplicate ongoing efforts but rather to invest in areas where gaps might exist so as to support the efforts of the larger conservation community.

Acknowledgements

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About NFWF

The National Fish and Wildlife Foundation protects and restores our nation's wildlife and habitats. Chartered by Congress in 1984, NFWF directs public conservation dollars to the most pressing environmental needs and matches those investments with private contributions. NFWF works with government, nonprofit and corporate partners to find solutions for the most complex conservation challenges. Over the last three decades, NFWF has funded more than 4,000 organizations and committed more than \$2.9 billion to conservation projects. Learn more at www.nfwf.org.

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Conservation Need

People throughout North America cherish monarch butterflies.¹ We value monarchs for their beauty and are fascinated by their life cycle—whether in a classroom changing from caterpillar to adult or contemplating their multigenerational migration across the continent. Unfortunately, monarch butterfly populations have declined over the past two decades and the spectacle of monarch migration is at risk.

Monarch butterflies in North America primarily consist of two migratory populations, one east of the Rocky Mountains and one to the west. Although the two populations are unlikely to be distinct genetically, we treat them as separate for conservation purposes because trends in their numbers appear to be independent of one another and driven by different factors. Both migratory populations winter in relatively small areas, with eastern monarchs inhabiting high elevation fir forests in Central Mexico and western monarchs in clusters along California's coastal zone.² The breeding range for migratory monarch butterflies, however, expands over multiple generations to cover most of the conterminous United States and southern Canada. This business plan focuses on the eastern migratory population. We anticipate the need to update the plan in three years' time to include strategies for monarch butterflies on the wintering sites in Mexico and for the western monarch population.

The eastern population contains >95% of the continent's monarch butterflies. Over the past decade the eastern population has declined by approximately 80%.³ Population modelers have shown that in the absence of conservation efforts eastern monarch numbers could decrease within the next 20 years to the point where they would be unable to rebound.

Conserving migratory species requires information about the threats faced throughout the range and over the course of the journey, so called “full life-cycle” conservation.⁴ Monarch butterflies are no exception. Habitat is necessary: on the wintering grounds, across the breeding range, and to fuel migration in spring and fall.⁵ Wintering sites for monarch butterflies continue to be eliminated by deforestation.⁶ In addition, catastrophic weather events such as winter storms periodically kill huge numbers of monarch individuals and severe drought and extreme temperatures are also seen as important threats.⁷



On the breeding grounds, habitat loss has resulted from the disappearance of milkweed and other nectar sources. Monarch butterfly larvae require milkweed to develop and its loss has been implicated in the reduction of monarch numbers. Milkweed can also serve as a source of nectar for adult butterflies, but monarchs feed on a number of other flowering species. In addition to milkweed, the ideal habitats for monarch butterflies contain a diversity of flowering plants in bloom at any time monarchs are likely to be present, thus facilitating both breeding and migration. Milkweed (along with

other nectar sources) has declined in the past two decades due to urban/suburban expansion, agricultural expansion into areas that once held milkweed, and the adoption of herbicide tolerant crops that have made it easier for farmers to eliminate weeds from their fields.⁸ On their breeding grounds, there are many other potential threats to monarch butterflies (e.g., insecticides, diseases, predators), but the relative importance of these is difficult to assess.

Current Conservation Context

Efforts to conserve monarch butterflies occur throughout North America in each phase of the annual cycle: winter, breeding, and during spring and fall migration. Some of this work has been conducted for decades, with government agencies, non-profits, and committed individuals taking part. However, much of it has occurred recently, due in part to the decline in monarch population numbers and a petition to list the species under the U.S. Endangered Species Act.⁹ It is also due to the heightened attention that pollinators have received and the recognition that the conservation of monarch butterflies will aid other species, as made apparent in the President's "National Strategy to Promote the Health of Honey Bees and Other Pollinators" (2015).

In 2008, the Commission for Environmental Cooperation (CEC)¹⁰ published a landmark document, the "North American Monarch Conservation Plan" (NAMCP). The plan summarized information pertaining to the conservation of monarch butterflies and established priorities for the species. The plan was innovative in its treatment of the actions needed within each of the three countries and it sparked a lot of interest in monarch butterflies as a unifying conservation concern for North America. The Trilateral Committee¹¹ regularly references the plan and the Monarch Joint Venture (MJV), which was formed in 2008 and serves as the umbrella organization for much of the work in the United States, adopted the plan as its guiding framework. The MJV has 56 member organizations, including federal agencies and non-profits.¹² The MJV also funds on-the-ground conservation and research that is aligned with the NAMCP (from 2009–2015 totaling \$1.9 million in conservation projects).¹³

In Mexico, most efforts have gone to establishing (in several stages) the Monarch Butterfly Biosphere Reserve (MBBR) and its management. Land ownership in much of Mexico is communally based, making the designation of a protected area of little consequence without effective community engagement and concomitant local buy-in. This engagement is led by multiple federal agencies and NGOs. In 2000, a fund was created to compensate landowners for lost logging revenue in exchange for habitat protection. This fund stood at \$7.3 million in 2012, and has received support from the David and Lucile Packard Foundation and the Mexican telecommunications company, Telcel.¹⁴ In addition, it is partially matched by Mexican federal funds. The U.S. Fish and Wildlife Service and U.S. Forest Service have both contributed to conservation in and around the MBBR over the past decade.¹⁵ As a result of all of these efforts, logging rates have decreased markedly, though not all communities have participated in conservation and logging still occurs.¹⁶

Finally, no description of the conservation landscape for monarch butterflies would be complete without mentioning the untold enthusiasm and dedication of thousands of citizens across the three countries and the massive efforts at restoration within urban/suburban areas. Citizen science monitoring has become a sophisticated endeavor with data being collected via multiple digital platforms. Individuals, communities, schools, nature centers, and corporations have all been planting native flower gardens to attract butterflies and support the monarch migration.¹⁷ NFWF seeks to complement this work by

expanding both outreach and habitat improvements in areas that have not received enough attention from funders, particularly on rural lands.

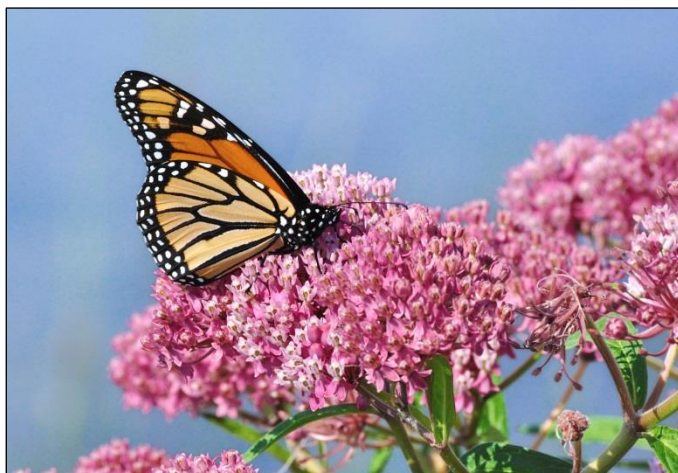
This business plan sets forth an ambitious 10-year budget that will result in major contributions to the conservation of monarch butterflies. NFWF's Monarch Butterfly Conservation Fund will implement this business plan. In its second year, the Fund is already recognized as one of the key sources of support for monarch work and it is a partnership that includes: Monsanto Company; the U.S. Department of the Interior's Bureau of Land Management, U.S. Fish and Wildlife Service, and U.S. Geological Survey; and the U.S. Department of Agriculture's Natural Resources Conservation Service and U.S. Forest Service. The strategic focus of the business plan will make a meaningful contribution by focusing habitat efforts where they are most needed. Finally, the business plan will send an important signal to practitioners; that sustained funding for monarch butterfly conservation is likely to remain for the coming decade.

Conservation Outcomes

Ultimately, this program seeks to increase the population of migratory monarch butterflies in North America. NFWF aims to achieve this by funding habitat conservation throughout the full life-cycle of the species. We anticipate most of our funding to be directed at benefitting breeding and flyway habitat for the eastern monarch butterfly population. By supporting restoration that follows best management practices, we will be changing habitats that are now devoid of milkweed and other prairie plant species into functioning landscapes for monarch butterflies. As a result of our investments, we anticipate achieving the following intermediate conservation results:

- 330,000 acres of breeding and flyway habitat restored
- 170,000 acres of breeding and flyway habitat under improved management

At this time, it is difficult to determine the impact these acres will have on the monarch butterfly population overall. There is little agreement about the number of acres of habitat needed to conserve monarch butterflies over the long term. Therefore, while we make investments to improve habitat, we will simultaneously work to gather data and build consensus within the community so that we can set an appropriate population level goal for the 10-year period covered by this business plan. We expect to fund targeted research into the optimal size of habitat patches and their location (both regionally and in relation to each other) for producing monarch butterflies. We will also support efforts to track habitat restoration of the community at large so that we have a better understanding of the ongoing work by multiple entities. With this information, we should be able to help establish a common goal for conservation within the first few years of the plan that we can all work towards. Moreover, we will address habitat needs on the wintering grounds by developing goals and strategies for this portion of the monarch's life cycle by year three.



Geographic Focus

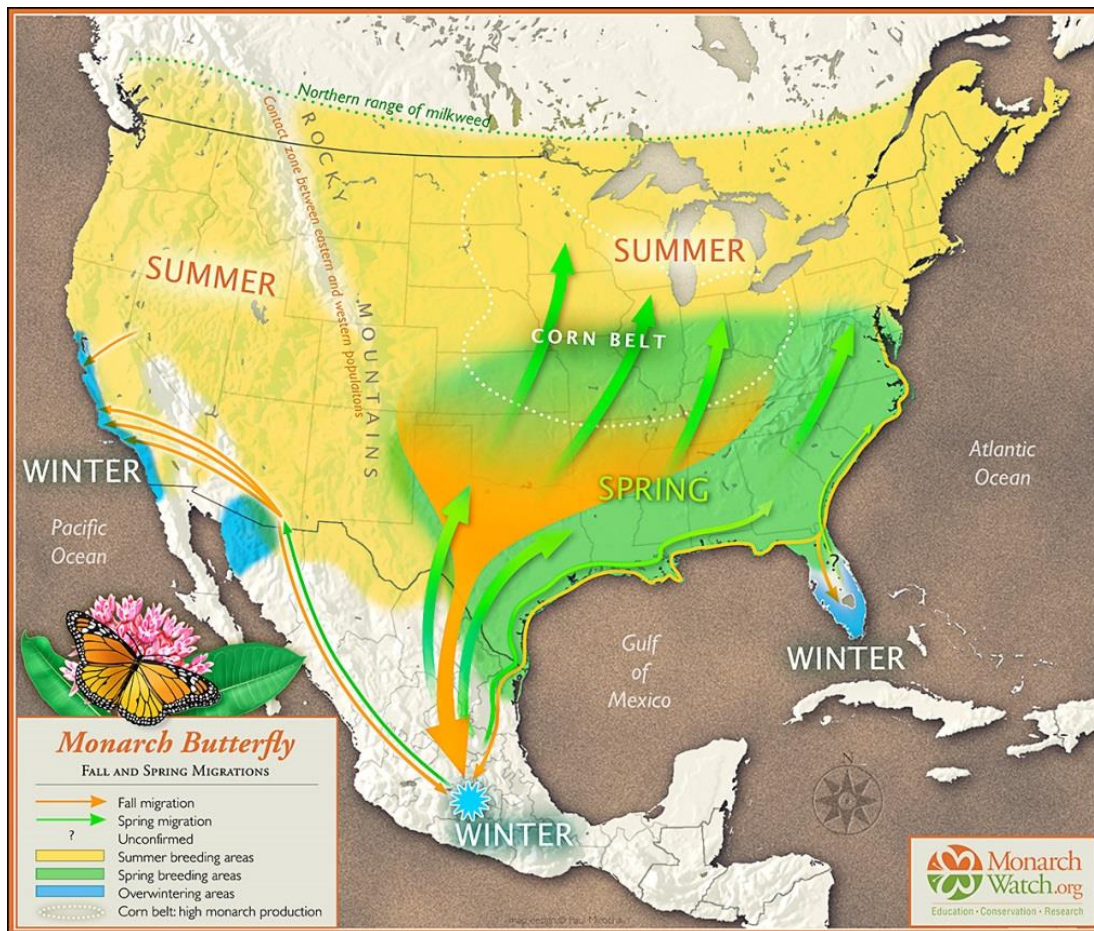


Figure 1. Monarch butterfly range in North America. Courtesy of Monarch Watch.

Over the next ten years NFWF will invest in the conservation of migratory monarch butterflies throughout North America (Figure 1). The focus of this business plan, however, is on the breeding and migratory phases of the eastern population which holds the vast majority of the continent's butterflies.

NFWF will target certain landscapes to maximize the impact of our habitat strategy. We anticipate much of our funding will be directed at states along the I-35 monarch butterfly corridor, which runs from Texas to Minnesota. This geography is important because it includes the early spring breeding grounds (e.g., Texas and Oklahoma) that are believed to contribute disproportionately to the overall population. It also contains the Midwest (depicted as the Corn Belt in the graphic above), which produces a large proportion of the butterflies that migrate to the wintering grounds in Mexico. We can advance conservation of the species by identifying focal areas within these geographies. This refinement of priorities will result from investments to address gaps in knowledge regarding patch size and configuration. NFWF will also amend the results chain that appears in the Implementation Plan to include butterflies on their wintering grounds in Mexico within the first three years. We anticipate the need to update this business plan to incorporate these future planning endeavors.

Implementation Plan

There is broad agreement among monarch experts, conservation organizations, and government agencies about the types of interventions monarch butterflies require. These interventions have not changed substantially since they were put forward in 2008 by the Commission for Environmental Cooperation (CEC). Each year the Monarch Joint Venture builds on the CEC effort by reviewing and updating priorities for monarch butterfly conservation in the United States. The results chain (Figure 2, pg. 2) does not add new priorities; rather it depicts the relationships and sequence of strategies-to-outcomes by which we intend to reach our goals. For the monarch butterfly population to rebound there needs to be a net gain in the quality, quantity, and connectivity of breeding and flyway habitat. To help achieve this we will restore and improve the management of existing habitat to support more butterflies. We will invest in organizational coordination and capacity so that there are vehicles to carry out the necessary habitat improvements. We also recognize that monarch conservation strategies will become more effective through targeted research and monitoring, which is embedded in the plan.

Strategy 1: Increase the quality, quantity, and connectivity of habitat¹⁸

Habitat restoration and management in the early spring states and the Midwest will be needed to create the necessary network of patches for monarch butterflies. Monarch butterflies are highly mobile creatures that fly from one habitat patch to another. The acreage of habitat on a landscape and quality of plants growing within it are important to butterflies, but so too is the distance between patches. Even a large site with optimal habitat might be of little use to monarch butterflies if there is no other suitable habitat within a reasonable distance. Thus, the spatial configuration of habitat patches is a critical part of functioning landscapes for monarch butterflies.

The strategies in this plan will be focused on the following lands:

- **Habitat within agricultural lands:** Agricultural lands are of particular interest, because they occupy most of the central U.S. The marginal portions of the agricultural landscape alone, such as hedgerows, buffer strips, and drainage ditch edges, have huge potential because of their regularity of occurrence in both rangelands and croplands.¹⁹
- **Rights-of-way habitat:** Other non-residential lands that could benefit monarchs include habitats managed and retained for the movement of people and goods and services (e.g., transmission/pipeline corridors, roadsides, levees, and railroad rights-of-way). These lands can contribute disproportionately to the conservation of monarch butterflies because of their potential for north–south linkages.²⁰
- **Federal, state, and tribal lands:** A variety of federal, state, and tribal lands will serve as key components within a network of habitat patches.²¹

Within these targeted lands, the plan’s strategies will be implemented to establish the network of patches necessary for improving monarch habitat.

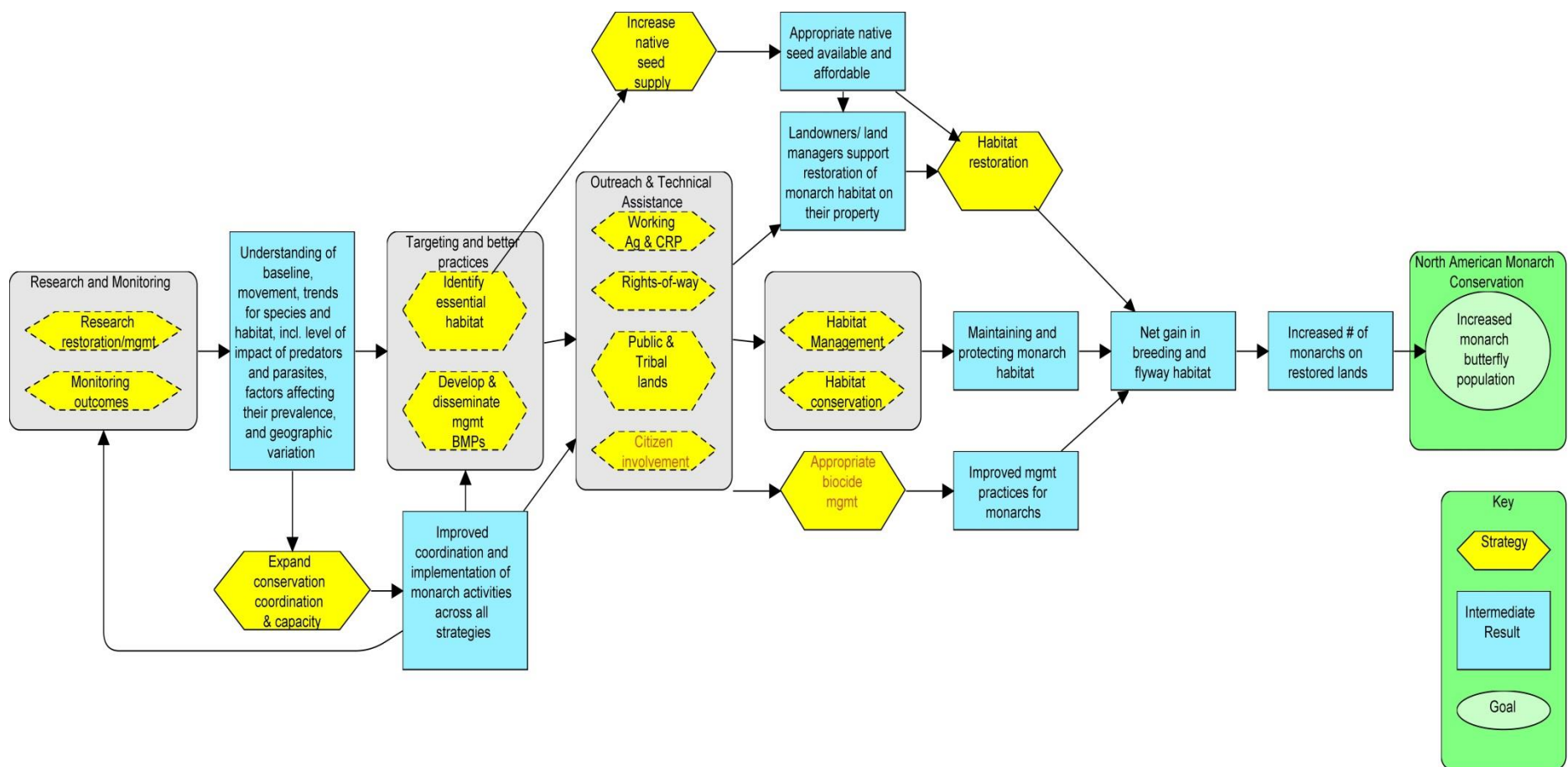


Figure 2. Results chain depicting the relationship of various strategies (yellow hexagons) within the business plan to each other, to the intermediate results (blue boxes), and ultimately to an increase in the monarch butterfly population (green oval). Although they have a role in monarch conservation, strategies in **brown text have not been identified as priorities for NFWF investment as part of this plan.**

1.1 Habitat Management and Enhancement²²

For the purposes of this plan, habitat management refers to management activities—particularly existing sites that require ongoing maintenance and enhancement activities such as controlled burns or mowing to mimic historical disturbance regimes—aimed at decreasing threats to monarch butterflies or improving the quality of their key habitats. In many cases, habitat management for monarch butterflies is more cost-effective than restoration in achieving quality habitat in crucial areas.

1.2 Habitat Restoration²³

Habitat restoration is necessary throughout much of the monarch butterfly range in order to improve habitat quality, quantity, and connectivity. Habitat restoration refers to activities that are aimed at restoring habitats that are important for monarch butterflies, such as planting regionally appropriate milkweed, adding more forb species to existing habitat to provide nectar resources, and eradicating invasive species. Habitat restoration will also require long-term maintenance and conservation (e.g., easements) of the restored sites. Because the greatest restoration challenge in many parts of the country is the availability and affordability of regionally appropriate seed and seedlings, we will also fund activities to improve native seed supply in priority geographies.

- *Increase native seed supply²⁴*

Monarch experts describe the marketplace for seed and seedlings in parts of the country as running into a recurring chicken-and-egg situation—wherein seed suppliers see no incentive to stock seed that people are not buying, and restoration practitioners are not buying seed because it is not sold. NFWF will address the seed availability issue in three ways:

- 1) For grants which are collecting native seed, we will require that grantees have a plan to use this seed in near future restorations, either by themselves or partners.
- 2) Convene two workshops (one for the Midwest and the other in the early spring and late fall geographies) with seed industry specialists, seed associations, and monarch experts to scope out this problem in greater detail and identify potential solutions.
- 3) Foster coordination among professional seed suppliers, grower associations, and large seed buyers.

Strategy 2: Outreach and organizational coordination

2.1 Outreach and Technical Assistance²⁵

The program will foster the distribution of existing best management practices (BMPs), particularly to practitioners engaged in large-scale land management and restoration in rural areas. Dissemination of these BMPs will require outreach, such as traditional media and training workshops, demonstration sites, peer-to-peer engagement, social media or web forums. NFWF will support technical assistance providers who aid producers and other private landowners in the creation of management plans and applications to Farm Bill programs. Likewise, the dissemination of BMPs pertaining to non-working agricultural lands, such as those enrolled in USDA's Conservation Reserve Program, will be a priority.

In addition to agricultural producers, NFWF will support outreach to the managers of habitat on rights-of-way as well as pilot projects on these lands. This sector has significant potential given the large, distributed footprint across the landscape. Progress on this front is gaining traction regarding state and federal departments of transportation, railroads, and within the energy sector (e.g., transmission corridors and pipelines). However, there is a need for technical assistance and coordination to be more readily available for managers and practitioners.

NFWF will continue to support monarch habitat work on tribal agricultural lands or areas primarily for conservation purposes. Often they are strategic in terms of their location and potential for sustaining habitat gains. Tribal holdings in Oklahoma, for example, are situated within the early spring breeding grounds and there are indications that these lands have a higher likelihood of long-term habitat maintenance.

2.2 Organizational Coordination and Capacity²⁶

Coordination among practitioners needs to be strengthened so that information about what works and what does not work is widely disseminated. NFWF plans to foster organizational coordination by supporting networks of people that promote the conservation of monarch butterflies, additional coordinators, and the development of tools to gather and share data among practitioners.

Strategy 3: Research and monitoring

NFWF will invest in research and monitoring to improve the effectiveness of our habitat restoration and management strategy over the lifetime of this business plan. These investments fall into two broad categories: 1) research into key habitat restoration/management topics to develop or improve best practices, determine the best places to work, and to gather information that will help to build consensus regarding habitat goals to conserve monarch butterflies; and 2) monitoring to understand the conservation outcomes resulting from our investments.

3.1 Research into habitat management/restoration to improve best practices²⁷

The program will fund targeted research that directly addresses key management questions regarding best practices for monarch butterflies, including, but not limited to:

- Identification of focal geographies
- Optimal size of habitat patches on a landscape
- Optimal distances between habitat patches
- Ideal seeding rates to promote establishment
- Seed mixes that optimize benefits to monarch butterflies, establishment rates, and cost

Research into these questions will be used to develop or expand best practices, which will be disseminated through the outreach outlined in Strategy 2.

3.2 Monitoring conservation outcomes²⁸

To quantify use of enhanced and restored habitats for monarch butterflies on projects supported by NFWF, we intend to fund a third party to design and conduct field surveys for monarchs at project sites

where habitat has been created. This work will take place in year five of the program when we will have a sufficient number of mature projects to assess—habitat establishment has a 3–4 year lag time from when a grant is awarded until it is suitable for monarch butterflies.

If our intermediate results (e.g., acres of habitat) are being met and we can show that monarch butterflies are using the habitat, we can be confident that we are contributing to the overall monarch population. However, as described above, we are unable to estimate the extent of our contribution to the monarch population at present.

Implementation Risk Assessment

Risk is an uncertain event or condition which, if it occurs, could have a negative effect on a program's desired outcome. We assessed seven risk event categories to determine the extent to which they could impede progress towards our stated business plan strategies and goals during the next 10 years. Below, we identify the greatest potential risks to success and describe strategies that we will implement to minimize or avoid those risks, where applicable.

Economic Risks: The greatest risk to our habitat strategy relates to our goal of achieving a net gain in monarch habitat across the landscape. As commodity prices increase, land tends to be converted to agricultural production. This conversion occurs with farmers planting in marginal areas, extending field edges, and putting USDA's Conservation Reserve Program acres back into working lands. Although the plan includes a strategy to restore and manage habitat, it could be small in comparison to the habitat that will be lost should commodity prices soar.

Scientific Risks: An additional risk to the habitat strategy is the extent to which there is scientific uncertainty about both threats to monarchs and the key strategies necessary for achieving monarch conservation goals. For instance, there have been a couple of recent papers that argue that milkweed on the breeding grounds could be less of a factor in the decline of monarch butterfly populations than previously thought.²⁹ It is possible, for instance, that a lack of adequate sources of nectar to fuel the fall migration is the biggest problem. While this remains a minority view, we are confident that our consistent emphasis on the importance of habitat management and restoration that benefits each phase of the full life-cycle will result in high quality habitat regardless of which season is most limiting.

Another risk is our limited understanding of the importance of insecticides as a threat to the monarch butterfly. Multiple insecticides could adversely affect monarch butterflies. More research on this important topic is needed. Although research is currently being funded and conducted by other institutions, NFWF will stay on top of the latest research findings and adjust our strategies accordingly.

Environmental Risks: Climate change, through warmer temperatures and increased prevalence of severe weather events such as drought, is a risk to the success of our monarch butterfly efforts and NFWF has limited ability to address it. Research suggests warmer temperatures have the potential to affect the timing of monarch butterfly migration, as well as the distributions of native species of milkweed throughout the breeding range.³⁰ However, the movement of milkweed and potential for dissonant monarch flight will play out over longer time periods than the period covered by this business plan. Severe droughts have also been increasing in frequency and can negatively affect monarch population numbers; therefore, to the extent possible, we will target investments in areas anticipated to be less affected by drought and extremes of weather.

Monitoring & Evaluating Performance

Most of the habitat improvements that we intend to fund as part of this business plan require three to four years to mature. During this time, we will be gathering grantee self-reported data on intermediate habitat outcomes for each project year of funding (Table 1), including:

- number of acres restored
- number of acres under improved management
- pounds of milkweed seed collected
- number of seedlings propagated
- number of patches established

The number of acres restored and acres under improved management are direct measures of habitat improvements on the ground. Pounds of seed and number of seedlings are indicative of progress in removing a barrier to restoration efforts that exists in parts of the monarch butterfly's range. We intend to support the collection of 4,100 pounds of milkweed seed and propagate 1.65 million milkweed seedlings. Data on these project metrics will be aggregated annually into a program scorecard. Taken together they will provide information on whether or not the program is making progress, and, importantly, where we can make improvements.

In year five of the business plan, NFWF intends to invest in field surveys to sample monarch butterfly use, or lack thereof, within restoration sites. These data will complement scorecard information and provide NFWF with a more complete picture not only of habitat creation, but also the proverbial “so what”—i.e., whether the species is actually responding to the habitat improvements. Also within the first few years of the business plan, NFWF will work to help establish a common goal for habitat conservation that will allow us to put our efforts into context. This will entail targeted research as discussed in Strategy 3 of the Implementation Plan as well as consensus-building among the scientific and management communities.

Building on the results of the field surveys and work to develop a goal for habitat conservation, the Foundation will contract an independent evaluator to examine the factors that have facilitated and hindered successful program implementation to inform future decision-making and adaptively manage. In some cases these course corrections may warrant increased investment; however, it is also possible that NFWF would reduce or eliminate support if the evaluation indicates that further investments are unlikely to achieve intended outcomes.

Table 1. Core metrics for measuring progress on program focal species and strategies.

Strategy	Metrics	2016 Baseline	2026 Goal
Habitat Restoration	Acres restored	60,678	330,000
Habitat Management	Acres under improved management	11,472	170,000
Increase Native Seed Supply	Pounds (lbs.) of milkweed collected	899	4,100
Increase Native Seed Supply	Milkweed seedlings propagated	558,165	1.65 M
Habitat Restoration	Patches restored	1,332	TBD by year 3

Budget

The following budget shows the estimated costs to implement the business plan activities. NFWF will have to raise funds to meet these costs; therefore, this budget reflects NFWF’s anticipated engagement over the business plan period of performance and it is *not* an annual or even cumulative commitment by NFWF to invest. This budget assumes that current activities funded by others will, at a minimum, continue.

BUDGET CATEGORY	YEARS 1-5	YEARS 6-10	TOTAL
Strategy 1. Increase the Quality, Quantity, and Connectivity of Habitat			
1.1 Habitat Management & Enhancement	\$5.1M	\$4.6M	\$9.7M
1.2 Habitat Restoration	\$9.5M	\$9.2M	\$18.7M
Strategy 2. Outreach and Organizational Coordination			
2.1 Outreach & Technical Assistance	\$4.4M	\$2.5M	\$6.9M
2.2 Organizational Coordination & Capacity	\$2M	\$1M	\$3M
Strategy 3. Research and Monitoring			
3.1 Research to Improve Best Practices	\$1.5M	\$1.5M	\$3M
3.2 Monitoring Conservation Outcomes	\$0.2M		\$0.2M
Program Evaluation	\$0.2M		\$0.2M
TOTAL BUDGET	\$22.7M	\$19M	\$41.7M

Literature Cited

- Batalden, R.V., Oberhauser, K., and A.T. Peterson. 2007. Ecological niches in sequential generations of eastern North American monarch butterflies (Lepidoptera: Danaidae): the ecology of migration and likely climate change implications. *Environmental Entomology* 36:1366–1373.
- Brower, L.P., Castilleja, G., Peralta, A., Lopez-Garcia, J., Bojorquez-Tapia, L., Diaz, S., Melgarejo, D., and M. Missrie. 2002. Quantitative changes in forest quality in a principal overwintering area of the monarch butterfly in Mexico, 1971–1999. *Conservation Biology* 16:346–359.
- Brower, L.P., Fink, L.S., Kiphart, R.J., Pocius, V., Zubieta, R.R., and M.I. Ramírez. 2015. Effect of the 2010–2011 Drought on the Lipid Content of Monarchs Migrating through Texas to Overwintering Sites in Mexico. Pages 117–129 in Oberhauser, K.S., Nail, K.R., and S. Altizer (eds.) *Monarchs in a Changing World: Biology and Conservation of an Iconic Butterfly*. Cornell University Press, Ithaca, NY, USA.
- Brower, L.P., Kust, D.R., Salinas, E.R., García-Serrano, E., Kust, K.R., Miller, J., del Rey, C.F., and K. Pape. 2004. Catastrophic Winter Storm Mortality of Monarch Butterflies in Mexico during January 2002. Pages 151–166 in Oberhauser, K.S. and M.J. Solensky (eds.) *The Monarch Butterfly: Biology and Conservation*. Cornell University Press, Ithaca, NY, USA.
- Brower, L.P., Slayback, D.A., Jaramillo-López, P., Ramirez, I., Oberhauser, K.S., Williams, E.H., and L.S. Fink. 2016. Illegal logging of 10 hectares of forest in the Sierra Chincua monarch butterfly overwintering area in Mexico. *American Entomologist* 62:92–97.
- Brower, L.P., Taylor, O.R., Williams, E.H., Slayback, D.A., Zubieta, R.R., and M.I. Ramírez. 2012. Decline of monarch butterflies overwintering in Mexico: is the migratory phenomenon at risk? *Insect Conservation and Diversity* 5:95–100.
- Caldwell, W. (with input from MJV Partners and Steering Committee). 2016. *2016 Monarch Conservation Implementation Plan*. Monarch Joint Venture.
- Caldwell, W. (with input from MJV Partners and Steering Committee). 2017. *2017 Monarch Conservation Implementation Plan*. Monarch Joint Venture.
- Center for Biological Diversity, Center for Food Safety, Xerces Society for Invertebrate Conservation, and Dr. Lincoln Brower. 2014. *Petition to Protect the Monarch Butterfly (Danaus plexippus plexippus) under the Endangered Species Act*. Submitted to the Secretary of the Interior, August 26, 2014. Available from: <http://www.xerces.org/wp-content/uploads/2014/08/monarch-esa-petition.pdf> (accessed December 12, 2016).
- Commission for Environmental Cooperation (CEC). 2008. *North American Monarch Conservation Plan*. Communications Department of the CEC Secretariat, Montreal, Quebec, Canada.
- Diffendorfer, J.E., Loomis, J.B., Ries, L., Oberhauser, K., Lopez-Hoffman, L., Semmens, D., Semmens, B., Butterfield, B., Bagstad, K., Goldstein, J., Wiederholt, R., Mattsson, B., and W.E. Thogmartin. 2014. National valuation of monarch butterflies indicates an untapped potential for incentive-based conservation. *Conservation Letters* 7:253–262.
- Espeset, A.E., Harrison, J.G., Shapiro, A.M., Nice, C.C., Thorne, J.H., Waetjen, D.P., Fordyce, J.A., and M.L. Forister. 2016. Understanding a migratory species in a changing world: climatic effects and demographic declines in the western monarch revealed by four decades of intensive monitoring. *Oecologia* doi:10.1007/s00442-016-3600-y.

- Flockhart, D.T.T., Wassenaar, L.I., Martin, T.G., Hobson, K.A., Wunder, M.B., and D.R. Norris. 2013. Tracking multi-generational colonization of the breeding grounds by monarch butterflies in eastern North America. *Proceedings of the Royal Society B* 280:20131087.
- Frey, D., and A. Schaffner. 2004. Spatial and Temporal Pattern of Monarch Overwintering Abundance in Western North America. Pages 167–176 in Oberhauser, K.S. and M.J. Solensky (eds.) *The Monarch Butterfly: Biology and Conservation*. Cornell University Press, Ithaca, NY, USA.
- Gustafsson, K.M., Agrawal, A.A., Lewenstein, B.V., and S.A. Wolf. 2015. The monarch butterfly through time and space: the social construction of an icon. *BioScience* 65:612–622.
- Inamine, H., Ellner, S.P., Springer, J.P., and A.A. Agrawal. 2016. Linking the continental migratory cycle of the monarch butterfly to understand its population decline. *Oikos* 125:1081–1091.
- Lemoine, N.P. 2015. Climate change may alter breeding ground distributions of eastern migratory monarchs (*Danaus plexippus*) via range expansion of *Asclepias* host plants. *PLoS ONE* 10:e0118614.
- Lyons, J.I., Pierce, A.A., Barribeau, S.M., Sternberg, E.D., Mongue, A.J., and J.C. de Roode. 2012. Lack of genetic differentiation between monarch butterflies with divergent migration destinations. *Molecular Ecology* 21:3433–3444.
- Morris, G.M., Kline, C., and S.M. Morris. 2015. Status of *Danaus plexippus* population in Arizona. *Journal of the Lepidopterists' Society* 69:91–107.
- Nail, K.R., Batalden, R.V., and K.S. Oberhauser. 2015. What's Too Hot and What's Too Cold? Lethal and Sublethal Effects of Extreme Temperatures on Developing Monarchs. Pages 99–108 in Oberhauser, K.S., Nail, K.R., and S. Altizer (eds.) *Monarchs in a Changing World: Biology and Conservation of an Iconic Butterfly*. Cornell University Press, Ithaca, NY, USA.
- Navarrete, J.-L., Ramírez, M.I., and D.R. Pérez-Salicrup. 2011. Logging within protected areas: spatial evaluation of the Monarch Butterfly Biosphere Reserve, Mexico. *Forest Ecology and Management* 262:646–654.
- Oberhauser, K.S., Ries, L., Altizer, S., Batalden, R.V., Kudell-Ekstrum, J., Garland, M., Howard, E., Jepsen, S., Lovett, J., Monroe, M., Morris, G., Rendón-Salinas, E., RuBino, R.G., Ryan, A., Taylor, O.R., Treviño, R., Villablanca, F.X., and D. Walton. 2015. Contributions to Monarch Biology and Conservation through Citizen Science: Seventy Years and Counting. Pages 13–30 in Oberhauser, K.S., Nail, K.R., and S. Altizer (eds.) *Monarchs in a Changing World: Biology and Conservation of an Iconic Butterfly*. Cornell University Press, Ithaca, NY, USA.
- Oberhauser, K., Wiederholt, R., Diffendorfer, J.E., Semmens, D., Ries, L., Thogmartin, W.E., Lopez-Hoffman, L., and B. Semmens. 2016. A trans-national monarch butterfly population model and implications for regional conservation priorities. *Ecological Entomology* doi:10.1111/een.12351.
- Pierce, A.A., Altizer, S., Chamberlain, N.L., Kronforst, M.R., and J.C. de Roode. 2015. Unraveling the Mysteries of Monarch Migration and Global Dispersal through Molecular Genetic Techniques. Pages 257–267 in Oberhauser, K.S., Nail, K.R., and S. Altizer (eds.) *Monarchs in a Changing World: Biology and Conservation of an Iconic Butterfly*. Cornell University Press, Ithaca, NY, USA.
- Pleasants, J. 2017. Milkweed restoration in the Midwest for monarch butterfly recovery: estimates of milkweeds lost, milkweeds remaining and milkweeds that must be added to increase the monarch population. *Insect Conservation and Diversity* 10:42–53.
- Pleasants, J.M. 2015. Monarch Butterflies and Agriculture. Pages 169–178 in Oberhauser, K.S., Nail, K.R., and S. Altizer (eds.) *Monarchs in a Changing World: Biology and Conservation of an Iconic Butterfly*. Cornell University Press, Ithaca, NY, USA.

- Pleasants, J.M., and K.S. Oberhauser. 2012. Milkweed loss in agricultural fields because of herbicide use: effect on the monarch butterfly population. *Insect Conservation and Diversity* 6:135–144.
- Pyle, R.M. 2015. Monarchs in the Mist. Pages 236–246 in Oberhauser, K.S., Nail, K.R., and S. Altizer (eds.) *Monarchs in a Changing World: Biology and Conservation of an Iconic Butterfly*. Cornell University Press, Ithaca, NY, USA.
- Ries, L., and K. Oberhauser. 2015. A citizen army for science: quantifying the contributions of citizen scientists to our understanding of monarch butterfly biology. *BioScience* 65:419–430.
- Ries, L., Taron, D.J., and E. Rendón-Salinas. 2015. The disconnect between summer and winter monarch trends for the eastern migratory population: possible links to differing drivers. *Annals Of The Entomological Society of America* 108:691–699.
- Semmens, B.X., Semmens, D.J., Thogmartin, W.E., Wiederholt, R., López-Hoffman, L., Diffendorfer, J.E., Pleasants, J.M., Oberhauser, K.S., and O.R. Taylor. 2016. Quasi-extinction risk and population targets for the eastern, migratory population of monarch butterflies (*Danaus plexippus*). *Scientific Reports* 6:23265 doi:10.1038/srep23265.
- Shahani, P.C., de Río Pesado, G., Schappert, P., and E.G. Serrano. 2015. Monarch Habitat Conservation across North America. Pages 31–41 in Oberhauser, K.S., Nail, K.R., and S. Altizer (eds.) *Monarchs in a Changing World: Biology and Conservation of an Iconic Butterfly*. Cornell University Press, Ithaca, NY, USA.
- Stenoien, C., Nail, K.R., Zalucki, J.M., Parry, H., Oberhauser, K.S., and M.P. Zalucki. 2016. Monarchs in decline: a collateral landscape-level effect of modern agriculture. *Insect Science* doi:10.1111/1744-7917.12404.
- Stevens, S.R., and D.F. Frey. 2010. Host plant pattern and variation in climate predict the location of natal grounds for migratory monarch butterflies in western North America. *Journal of Insect Conservation* 14:731–744.
- Stevenson, M. Experts: Mexico Storms Led to Deaths of Millions of Monarchs. The Big Story, August 23, 2016. AP. <http://bigstory.ap.org/article/17089d859f9b479b92a1f7351094886d/storms-damage-trees-mexican-monarch-butterfly-reserve> (accessed December 12, 2016).
- Taylor, C. Monarch Population Status. Monarch Watch Blog, May 4, 2016. <http://monarchwatch.org/blog/2016/05/04/monarch-population-status-27/> (accessed December 12, 2016).
- Vidal, O., López-García, J., and E. Rendón-Salinas. 2013. Trends in deforestation and forest degradation after a decade of monitoring in the Monarch Butterfly Biosphere Reserve in Mexico. *Conservation Biology* 28:177–186.
- Zhan, S., Zhang, W., Niitepöld, K., Hsu, J., Haeger, J.F., Zalucki, M.P., Altizer, S., de Roode, J.C., Reppert, S.M., and M.R. Kronforst. 2014. The genetics of monarch butterfly migration and warning colouration. *Nature* 514:317–321.

Endnotes

¹ For a recent valuation of citizens' willingness to pay for monarch conservation, see Diffendorfer *et al.* (2014), whose survey results indicate that U.S. households would support a \$4.78–\$6.64 billion one-time payment. Monarchs are very accessible, recognizable, and meaningful to people. See Gustafsson *et al.* (2015) for a discussion of the iconic status of monarch butterflies over time.

² This paragraph describes the distribution of migratory monarch butterflies in continental North America in broad terms. At a fine scale there are numerous exceptions. A small portion of western monarch butterflies winter outside California's coastal zone in northern Baja. There are tiny colonies in central and eastern California, Arizona, and Sonora. Likewise, although the vast majority of eastern monarch butterflies can be found wintering within the MBBR, there are small colonies in the southern U.S. along the Gulf coast and the number of migrating monarchs that winter in south Florida (relative to a year-round population) and in the Caribbean is poorly understood.

In the past, the continental divide was thought to mark the boundary between the eastern and western populations, but this is not the case. The division between the populations appears to be much more fluid (Pyle 2015). Genetic analyses that have looked at portions of DNA (i.e., microsatellite markers) have not detected a difference between populations (Lyons *et al.* 2012; Zhan *et al.* 2014; Pierce *et al.* 2015). This implies some degree of interchange between east and west, which has also been strongly inferred from observational data. For example, Arizona-tagged breeding individuals have been recovered from wintering grounds in both California and within Mexico's MBBR. Arizona lies west of the continental divide and there appears to be no geographical boundary determining where a tagged individual might turn up. For example, multiple specimens have been recovered from either California or Mexico that were tagged in Canelo, AZ (Morris *et al.* 2015). There are also a number of records of butterflies from the west that appear to be headed to Mexico or were actually seen crossing the border (Morris *et al.* 2015; Pyle 2015). It is unclear the degree to which there is interchange between the two populations on an annual basis.

For support of the statement that monarch butterfly population trends for the east and west appear to be driven by different factors, see: Frey & Schaffner (2004), Stevens & Frey (2010), Espeset *et al.* (2016).

³ Semmens *et al.* 2016

⁴ For most species the full life-cycle of migration equates to the individual migrant—i.e., the full life of an individual or that individual's life over the course of a year. However, because the monarch butterfly migration is multigenerational, with most individuals living only for a few weeks, the full life-cycle can be considered the predictable movement of monarchs across the continent each year despite the fact that this movement entails a series of butterfly generations. In this plan, the "full life-cycle" refers to this annual, multigenerational movement.

⁵ For more on this topic, see: Oberhauser *et al.* (2016).

⁶ Deforestation has long been recognized as a threat to monarch butterflies (Brower *et al.* 2002; CEC 2008; Brower *et al.* 2012). There has been a great deal of effort to address this issue, yet some communities are still not part of the MBBR and elsewhere within the reserve illegal logging remains a serious concern (Navarrete *et al.* 2011; Vidal *et al.* 2013; Brower *et al.* 2016).

⁷ For winter storms, see: Brower *et al.* (2004), Stevenson (2016), Taylor (2016). For drought, see: Brower *et al.* (2015). And for the effects of extreme temperatures, see: Batalden *et al.* (2007), Nail *et al.* (2015).

⁸ CEC 2008; Pleasants and Oberhauser 2012; Flockhart *et al.* 2013; Stenoien *et al.* 2016; Pleasants 2015, 2017

⁹ The petition was brought by the Center for Biological Diversity, Center for Food Safety, Xerces Society for Invertebrate Conservation, and Dr. Lincoln Brower on August 26, 2014.

¹⁰ The CEC is an intergovernmental organization that was established following the North American Free Trade Agreement “to support cooperation among the NAFTA partners to address environmental issues of continental concern” (see: <http://www.cec.org/about-us/about-cec>).

¹¹ The Trilateral Committee for Wildlife and Ecosystem Conservation and Management facilitates cooperation between the wildlife conservation agencies of Canada, Mexico, and the United States. It was established in 1995 with the signing of a memorandum of understanding among the three countries.

¹² While drafting this business plan, the number of MJV member organizations increased steadily. This number was updated 1/18/2017. For a current list of MJV partners, go to: <http://monarchjointventure.org/about-us/partners>

¹³ Caldwell 2016

¹⁴ Shahani *et al.* 2015

¹⁵ Ibid.

¹⁶ Discussed above (endnote 6). Relevant references: Navarrete *et al.* (2011), Vidal *et al.* (2013), Brower *et al.* (2016).

¹⁷ Oberhauser *et al.* (2015) provide an excellent overview of this topic. In their account they state: “no other single species has garnered such a wide following of personally involved educators, conservation advocates, and citizen scientist contributors.” (p. 13). See also Ries and Oberhauser (2015).

¹⁸ This strategy falls within the MJV’s Goal 1 of “monarch habitat conservation, maintenance and enhancement” (see pp. 5–10 Caldwell *et al.* 2017).

¹⁹ Habitat conservation on agricultural lands for monarch butterflies is Goal 1: Strategy 2: H-10 of the current MJV plan. See p. 9 of Caldwell *et al.* (2017) for references and resources.

²⁰ Habitat conservation on rights-of-way for monarch butterflies is Goal 1: Strategy 2: H-8 of the current MJV plan. See p. 8 of Caldwell *et al.* (2017) for references and resources.

²¹ Habitat conservation on federal, state, and tribal lands for monarch butterflies is similar to Goal 1: Strategy 2 in the widest sense of the current MJV plan, see pp. 7–10 of Caldwell *et al.* (2017). However, in this plan we are more interested in managing and enhancing as well as restoring habitat on these lands rather than promoting these habitat improvements, which appears to be the focus of the MJV plan.

²² Habitat management and enhancement are covered broadly by Goal 1: Strategy 2 of the current MJV plan. See pp. 7–10 of Caldwell *et al.* (2017) for references and resources.

²³ Habitat restoration is covered broadly by Goal 1: Strategy 2 of the current MJV plan. See pp. 7–10 of Caldwell *et al.* (2017) for references and resources.

²⁴ Increasing native seed supply is covered by the MJV’s Goal 1: Strategy 1 of the current MJV plan. See pp. 5–6 of Caldwell *et al.* (2017) for references and resources.

²⁵ Within this section of the plan we will be focused on the same areas as mentioned above under: habitat within agricultural lands, rights-of-way habitat, and federal, state, and tribal lands.

²⁶ This is a need identified by the experts that NFWF consulted during the development of the business plan.

²⁷ Over the course of this business plan, we anticipate the need to support targeted research where key questions can be answered with limited funds.

²⁸ To the extent possible, NFWF will “piggyback” on existing monitoring efforts and adopt standard practices.

²⁹ Ries *et al.* (2015) raise this possibility and Inamine *et al.* (2016) argue more forcefully in favor of it. See Stenoien *et al.* (2016) for a discussion of the underlying data and why the possibility of migration being the largest problem confronting the eastern monarch butterfly population is unlikely.

³⁰ Lemoine 2015