POLLINATORS AND THE STATE WILDLIFE ACTION PLANS

Voluntary Guidance for State Wildlife Agencies

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Cover: Regal Fritillary (*Speyeria idalia*) gets a meal from a purple coneflower (*Echinacea angustifolia*)
Photo Credit: Laura Hubers/USFWS

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EXECUTIVE SUMMARY

This report is intended for use by state and territorial wildlife agencies in the United States who are currently revising their State Wildlife Action Plans (SWAPs). It describes methods and approaches for incorporating information about the conservation of animal pollinators into the State Wildlife Action Plans. Pollinators perform essential ecosystem services in both managed and wild ecosystems throughout the United States, benefiting humans as well as wildlife species. Funding and technical support are available for pollinator conservation projects in many states. This report describes strategies for managing and conserving populations of pollinator species that can be implemented by the state wildlife agencies and their partners. Pollinator conservation activities can be included in the State Wildlife Action Plans, even in cases where the state wildlife agency does not have direct regulatory authority over pollinators. These actions have the potential to benefit many other plant and animal species, in addition to pollinators.

Simple Steps to Incorporate Pollinator Conservation into the SWAPs

1. Highlight and recognize pollinator species already included in the SWAPs.
2. Highlight and recognize key pollinator habitats already included in the SWAPs.
3. Conduct a status review for one or more pollinator groups.
4. Identify and prioritize habitat conservation activities that also benefit pollinators.
5. Promote the restoration of pollinator habitats in agricultural landscapes.
6. Develop and implement community outreach programs.

Highlighted Pollinator Species in the Existing SWAPs

- Lesser long-nosed bat (*Leptonycteris yerbabuenae)*
- Bumblebees (genus *Bombus*)
- Regal Fritillary butterfly (*Speyeria idalia*)
- Blackburn's sphinx moth (*Manduca blackburni)*
- Mydas fly (Order Diptera, Family Mydidae)

Lesser long-nosed bat covered in pollen. Photo credit: US National Park Service

THE IMPORTANCE OF STATE WILDLIFE ACTION PLANS (SWAPS)

State Wildlife Action Plans (SWAPs), also known as Comprehensive Wildlife Conservation Strategies, are a remarkable set of documents that outline strategic conservation approaches for wildlife and wildlife habitats in each of the fifty U.S. states, the District of Columbia, and five U.S. territories. Each SWAP represents a collaboration between state, federal, tribal, and local conservation partners who have joined together to identify conservation priorities and set an agenda for conservation action. Each SWAP is intended to help guide wildlife conservation activities in a particular state or territory over a five to ten year period, with provisions for revision and updates. SWAPs are designed to help states identify actions that can be taken now to prevent species of wildlife from becoming endangered.

The SWAPs are useful organizing documents for wildlife conservation activities in the individual states. Many of the most important wildlife management activities in the U.S. are already coordinated and directed by the state wildlife management agencies, in collaboration with federal, tribal, local, non-profit, and academic partners. The individual SWAPs provide a clear outline for the management of fish and wildlife populations and habitats within each state. Together, the SWAPs form a comprehensive blueprint for wildlife conservation across the entire United States.

The process of preparing the SWAPs began in 2000, when the U.S. Congress established the Wildlife Conservation and Restoration Program and the State Wildlife Grants Program. As a condition of receiving funding under these programs, Congress requested that all 50 U.S. states, the District of Columbia and five U.S. territories, develop State Wildlife Action Plans by October 1, 2005. Each SWAP was required to characterize the wildlife species needing conservation efforts, identify key habitats for these species, identify threats to species and their habitats, outline strategies for ameliorating those threats and conserving species and their habitats, and describe methods for monitoring and evaluating the results of these actions. States were given the flexibility to customize the details of the plans in order to meet their own unique needs and ecological conditions. The SWAPs produced by each state and territory were then reviewed by the U.S. Fish and Wildlife Service (USFWS) and all of the plans were officially approved in 2006. In accordance with guidance provided by the U.S. Fish and Wildlife Service, every SWAP was required to include the following set of basic elements:

1. Information on the distribution and abundance of wildlife, including low and declining populations, that describes the diversity and health of the state's wildlife
2. Descriptions of locations and relative conditions of habitats essential to species in need of conservation
3. Descriptions of problems that may adversely affect species or their habitats, and priority research and survey efforts
4. Descriptions of conservation actions proposed to conserve the identified species and habitats
5. Plans for monitoring species and habitats, and plans for monitoring the effectiveness of the conservation actions and for adapting these conservation actions to respond to new information
6. Descriptions of procedures to review the plan at intervals not to exceed 10 years

7. Coordination with federal, state, and local agencies and Indian tribes in developing and implementing the wildlife action plan
8. Broad public participation in developing and implementing the wildlife action plan

While Congress and the U.S. Fish and Wildlife Service stipulated that the SWAPs should focus on the species with the gravest conservation needs, the state wildlife agencies were still required to address the full range of diversity of other organisms and their habitat conservation needs in the SWAPs.

The development of the first round of SWAPs represents a significant conservation accomplishment, establishing a set of wildlife management plans that encompass the entire nation. However, the true potential of SWAPs lies in the mandate that states revise them to incorporate new information about fish and wildlife species, their habitats, threats and stressors, and conservation activities. The original set of plans was approved in 2006 and revisions are expected for most plans within 5 to 10 years after that date. With revisions underway or planned in many states, now is the perfect time to introduce new themes and emerging priorities. The Association of Fish and Wildlife Agencies (AFWA) has developed reports on subjects such as climate change and monitoring and evaluation for states that wish to incorporate this information into their SWAP revisions. This document was written to help states integrate information about a key guild of species, animal pollinators, into their revised SWAPs.

TAXONOMIC REPRESENTATION IN THE SWAPS

Each SWAP includes a list of Species of Greatest Conservation Need (SGCN) for a particular state or territory. These lists are generally focused on vertebrate organisms, with birds, mammals, fish, reptiles, and amphibians all well-represented. Other highly diverse groups of organisms such as insects, mollusks, crustaceans, and worms received less attention in the first round of SWAPs submitted in October 2005.

This disparity in the coverage of different taxonomic groups exists for several reasons. Fish, mammals, and birds are immensely popular with hunters, anglers, bird-watchers, wildlife-enthusiasts, and many members of the general public. Dedicated funding is available for the conservation of many of these species, supported by excise taxes on hunting and fishing equipment and private contributions from wildlife enthusiasts. Also, many state wildlife agencies were established for the explicit purpose of conserving fish and game species and do not have the authority to regulate non-vertebrate groups. In other states, certain non-vertebrate groups such as insects fall under the authority of the state Department of Agriculture rather than the state wildlife agency.

Pollinators are an economically and ecologically important group of organisms that were not the explicit focus of attention in the original round of SWAPs. Some groups of pollinators, such as birds, bats, and butterflies, were well covered by many states in the first set of SWAPs submitted in October 2005. In contrast, other groups such as bees, beetles, and flies were less well covered. In the following sections of this report, we will give examples of pollinators that were included in the first round of SWAPs as well as concrete guidance for incorporating pollinator-friendly practices into the revised SWAPs.

INTRODUCING POLLINATORS

Pollination is a mutually beneficial relationship between plants and pollinators wherein the plant provides pollen and/or nectar to the pollinator and the pollinator provides reproductive services for the plant (National Research Council, 2007). Examples of pollinators in the United States include hummingbirds, bats, bees, beetles, butterflies, moths, and flies.

Roughly 75 percent of the 240,000 species of flowering plants world-wide rely on pollinators for flower reproduction (NRC, 2007). This includes many plant species that provide browse or forage for larger wildlife, as well as plant species that provide seeds and fruits to support birds and small mammals. Many of the most popular game species as well as many of the most popular "watchable wildlife" species are thus dependent on animal pollinators for part or all of their food requirements. Pollinators are also crucial to the U.S. agriculture industry, since 130 of the plant species grown as crops in the U.S. rely on animal pollinators to produce seeds and fruit (Klein et al., 2007). Some of these crops include almonds, apples, avocados, blackberries, blueberries, cantaloupes, coffee, cranberries, sweet cherries, cucumbers, raspberries, peaches, pears, squashes, and watermelon (NRC, 2007). Animal pollinators are thus extremely important in meeting consumer demand and contributing to the profits generated from the harvest and sale of many agricultural crops.

Available evidence indicates that certain pollinator species have been declining in the U.S. (NRC, 2007). The best known example is colony collapse disorder in honeybees. Flower-visiting insects account for 50 percent of all known insect extinctions (NRC, 2007). Reduced pollinator populations can result in decreased pollination of plant species that require pollinators for fertilization and reproduction. As a result, the plants corresponding to each pollinator could face population declines or even increased threat of extinction (NRC, 2007).

Declines in pollinator populations can be traced to a multitude of causes, such as intensive agricultural practices, use of certain pesticides, and habitat loss and degradation (NRC, 2007). Some species such as bumblebees and honeybees have experienced declines as a result of the spread of pathogens and disease from commercially produced colonies to native populations (NRC, 2007). Climate change is also expected to provide additional challenges to pollinator populations, ranging from disruption of migratory paths of pollinators such as hummingbirds and bats, to decoupling of plant-pollinator interactions when plants and pollinators respond differently to climate cues.

RESOURCES AVAILABLE FOR POLLINATOR CONSERVATION

Concerns about the status of pollinators in North America have led to the development of a variety of conservation programs focused on these species. Many of these programs are actively looking for new partners and new projects and would be ideal collaborators for the state wildlife agencies. Some of the most active programs are those of the Pollinator Partnership (also known as the North American Pollinator Protection Campaign), the Xerces Society, and the National Wildlife Federation. Visiting the websites of these organizations will provide up-to-the minute information about pollinator species and pollinator conservation. In addition to these conservation programs, dedicated funding sources and in-

kind resources are available from federal and private sources to support pollinator conservation efforts. Funding is available from a variety of sources to help state wildlife agencies and their partners engage in effective pollinator conservation. Certain Farm Bill programs and other grant programs administered through the Natural Resources Conservation Service can fund "on-the-ground" pollinator conservation activities. The National Fish and Wildlife Foundation (NFWF) and private foundations support pollinator conservation activities throughout the United States. Pollinator conservation programs have also been established at several federal agencies, including the U.S. Fish and Wildlife Service (USFWS), the U.S. Forest Service, and the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service. These agencies may be able to provide technical assistance or funding for pollinator conservation projects. Technical assistance for pollinator conservation projects can also be found at many universities, the USDA Bee Lab in Logan, Utah, and the U.S. Geological Survey (USGS).

Potential Funding Sources

Farm Bill Funding for Pollinator Conservation
This report from the USDA and Xerces Society highlights available funding in Table 1.
http://plants.usda.gov/pollinators/Using_Farm_Bill_Programs_for_Pollinator_Conservation.pdf

Funding Opportunities for Pollinator Protection in North America
This report describes pollinator-specific funding from the following organizations:

- National Fish and Wildlife Foundation
- Rasmussen Foundation
- Turner Foundation
- Wallace Genetic Foundation

http://www.cciforum.org/pdfs/NAPPC_Pollinator_Funding.pdf

North American Pollinator Protection Campaign (NAPPC)
The Pollinator Partnership runs the NAPPC project. Their recent grants focus on honeybee health.
http://pollinator.org/nappc/index.html

National Fish and Wildlife Foundation (NFWF) Plant Conservation Initiative
The Native Plant Conservation Initiative is a national program that protects, enhances, and restores native plant and pollinator communities on public and private lands. Since 1995, the grant program has awarded over $6.1 million in federal funding to 304 plant conservation projects.
http://www.nfwf.org/Pages/npci/home.aspx

USDA Natural Resources Conservation Science (NRCS)
The NRCS division of the USDA runs a variety of grant programs that could be applied to pollinator-related work.

Conservation Innovation Grants (CIG)
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/cig/

Wildlife Habitat Improvement Program (WHIP)
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/whip/

Environmental Quality Improvement Program (EQIP)
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/

US FWS Wildlife and Sportfish Restoration Program (WSFR)
WSFR administers the State Wildlife Grant Program that can be used to obtain funding for pollinator conservation.
http://wsfrprograms.fws.gov/Subpages/AboutUs/AboutUs1.htm

POLLINATORS IN THE SWAPS

Although animal pollinators perform many important ecological functions, pollinators were not the subject of direct conservation attention in the original set of SWAPs. Despite this fact, many pollinators were still included in the original set of SWAPs, including species of hummingbirds, bats, bees, butterflies, moths, and flies, all of which are considered important pollinators. For example:

- 230 different species of butterflies are mentioned in 40 of the 56 total SWAPs.
- 36 SWAPs mention one or more moth species, some of which are known pollinators.
- 49 different SWAPs mentioned a total of 64 different bat species, although only a few of these are confirmed pollinators.
- 18 distinct hummingbird species were included in 24 SWAPs.
- Only 11 SWAPs cited flies, mentioning 11 different species.
- Only 10 SWAPs mentioned bees, although these states included a total of 31 bee species.

Bombus terrestris
Photo credit: Laura Perlick/USFWS

A summary of these results can be found in Table 1 of Appendix A.

SIMPLE STEPS TO INCORPORATE POLLINATOR CONSERVATION INTO THE SWAPS

Because pollinator species perform essential functions to maintain healthy ecosystems and also help provide food for humans and wildlife, we suggest that states identify and incorporate pollinators into their SWAPs. The literature on pollinator conservation provides some concrete suggestions for those states that are interested in incorporating information about pollinators in their SWAPs. Simple steps to accomplish this goal might include the following. Note that several of these steps can be carried out even in cases when a particular state wildlife agency lacks the authority to manage certain types of pollinators (such as insects).

1. **Highlight and recognize pollinator species already included in the SWAPs.** Many animal pollinator species were included as Species of Greatest Conservation Need in the first round of SWAPs, even though these species may not have been explicitly recognized as pollinators. The species accounts in the section that follows provide information about several of the pollinator species that have already been included in the initial SWAPs. Individual states could develop similar accounts for pollinator species that are already mentioned as Species of Greatest Conservation Need in their SWAPs and highlight their status as pollinators.

2. **Highlight and recognize key pollinator habitats already included in the SWAPs.** Certain landscapes support large numbers of native bees, wasps, butterflies, or other pollinator taxa. In particular, sand barrens, early successional woodlands, prairies, grasslands, and wet meadows are important areas of habitat for many pollinator species. Activities that protect or conserve these habitats will likely benefit many pollinator species. Protection of pollinator habitats within agricultural landscapes has been shown to benefit crop species as well as native plants, so the protection of even remnant areas of pollinator habitats within a mostly altered landscape can be a beneficial activity for pollinators.

3. **Conduct a status review for one or more pollinator groups.** This action would involve a state-wide review of the conservation status of all species within a particular group of pollinators. The review could be highly formal, as with a species listing process, compiling all available evidence about the population trends in particular pollinator groups. Or the review could utilize an expert judgment approach, basing its conclusions on the current consensus among specialists who are studying pollinators in a particular state. One prime group of pollinators which could be reviewed in many states are the bumblebees (Order Hymenoptera, family Apidae, genus *Bombus*). Bumblebees are a good candidate for inclusion in the SWAPs for several reasons. First, there is a relatively modest number of bumblebee species in North America, about 40 species total with a manageable number of species in each state. There are also several excellent field guides already available for the identification of U.S. species of bumblebees prepared by the Xerces Society, Pollinator Partnership, USDA Forest Service, and others. For difficult identifications, there are also multiple scientists in the U.S. with expert knowledge about the taxonomy of these insects. Other possible groups for focus could include carpenter bees, which are important floral visitors and pollinators of many flowering plant species; or feral honeybee colonies, which have experienced recent population declines.

4. **Identify and prioritize habitat conservation activities that also benefit pollinators.** Individual pollinator species require specific foraging and nesting habitats nearby in order to maintain a stable and healthy population. Some natural areas and habitat features such as hedgerows, abandoned fields, dead wood, bare soil or sand, and matured forest trees and shrubs can provide appropriate nesting and/or foraging habitats for multiple pollinator species. These areas could be the focus of land protection, conservation, and restoration efforts that promote healthy pollinator populations. States can also use protected conservation lands such as open spaces, wetlands, and state forests to encourage the growth of pollinator populations.

5. **Promote the restoration of pollinator habitats in agricultural landscapes.** Through programs of the NRCS and other agricultural conservation groups, pollinator conservation measures can be undertaken in agricultural settings to increase pollinator populations. These measures benefit wildlife and native plant species as well as the food crops that receive enough pollination to produce ample crop yields. There are a series of guides available from groups such as the Xerces Society and Pollinator Partnership that can help state wildlife agency personnel and their partners identify pollinator-friendly farming practices that can be implemented on agricultural lands. Many

of these practices also help to create habitat for other organisms such as birds, small mammals, reptiles, and amphibians. In addition, many pollinator-friendly best management practices for pesticide use, water use, and habitat restoration can be utilized by homeowners to promote population growth of various pollinators on their properties.

6. **Develop and implement community outreach programs.** Often times, citizens do not have enough information to recognize when their activities may be harming pollinators. In addition, common misperceptions may prevent people from valuing the presence of pollinators. For example, the layperson may assume that all bees sting when in reality hornets and wasps are more likely to sting; most bees only sting if they are purposefully agitated. Also, the general public does not have enough knowledge of foraging and nesting requirements to successfully and productively promote those habitats. Individual states and their conservation partners could develop educational and community outreach programs to spread basic knowledge of pollinators throughout the community. Existing pollinator education programs developed by the Xerces Society, Pollinator Partnership, and the National Wildlife Federation could be used as models for the development of a statewide pollinator education program.

HIGHLIGHTED POLLINATOR SPECIES IN THE EXISTING SWAPS

Even though most states did not specifically include pollinators as a focus group for the first round of SWAPs, they did include a number of pollinator species in their documents. The following species were identified as Species of Greatest Conservation Need in multiple SWAPs and are known or likely providers of pollination services in their respective territories. For purposes of illustration, one species was chosen from each group of organisms mentioned in Appendix A: the species include lesser long-nosed bat, Bumblebee, Regal Fritillary butterfly, Blackburn's Sphinx moth, Mydas fly, and Ruby-throated hummingbird. Each species is described below in detail in terms of identification, range of habitat, and pollination services. To review the territory of each species, see Appendix B. The Mydas fly does not have a current, reliable map of its territory and is therefore omitted from Appendix B.

Lesser long-nosed bat (*Leptonycteris yerbabuenae)*

The lesser long-nosed bat is a medium-sized bat, averaging 8 cm long and weighing between 15 and 25 grams, found in both Central and North America (Cole et al., 2006; Arroyo-Cabrales et al., 2008). The lesser long-nosed bat's tongue is almost as long as its entire body (USFWS, 2012). As obvious from its name, the bat possesses a long, narrow snout with a small triangular "nose-leaf," which is a fleshy leaf-shaped structure on the nose of many bats use for echolocation (Cole et al., 2006).

Leptonycteris yerbabuenae is mainly found in semi-arid grassland, scrub, and forests. This bat can tolerate temperatures above 100° F, although it cannot survive in more temperate temperatures below 50° F (Carpenter et al., 1967). For this reason, it is found year-round in Mexico, Guatemala, El Salvador, and Honduras. Interestingly, despite the close proximity to the United States border, only a small number of lesser long-nosed bats migrate to southern California, Arizona, and New Mexico during the warm summer months (Cole et al., 2006). Bats that migrate to the north breed between November and

December, while bats that remain in southerly locations breed between May and June. The gestational period lasts about six months and newborns remain with their mothers for approximately two months. Typically the young are weaned and begin to fly roughly four weeks after birth (Cole et al., 2006). The average longevity of the lesser long-nosed bat is approximately eight years (Cole et al., 2006).

The lesser long-nosed bat tends to live in colonies of several thousand individuals that are usually found in caves and abandoned mines (Cole et al., 2006). As nocturnal animals, their diet consists mainly of night-blooming plants, such as the Organ Pipe cactus (*Stenocereus thurberi*). They also specifically contribute to the pollination of columnar cacti species (Garza et al., 2007). Other main food sources for the lesser long-nosed bat include agaves and saguaro plants (Fleming et al., 1993).

The foraging behavior of *Leptonycteris yerbabuenae* is partially dependent on the sugar concentration of their diet (Ayala-Berdon et al., 2011). Bats seek to maintain a consistent energy level; therefore, they compensate for poor levels of sugar concentration in nectar by reducing flight time and increasing their feeding time (Ayala-Berdon et al., 2011). They will visit more flowers per night in order to maximize sugar consumption when the sugar concentration is low in their food sources. This results in increased pollination of visited flowers (Ayala-Berdon et al., 2011). On the other hand, when bats have access to food sources with high sugar content, they will increase flight time and distance which allows for an increase in plant gene flow (Ayala-Berdon et al., 2011).

Eastern Bumblebee (*Bombus impatiens*)
Photo credit: Bob Peterson

The lesser long-nosed bat is currently listed as endangered due to a variety of threats to its population (USFWS, 2012). Two challenges facing bat populations include the disturbance of occupied roost sites and the destruction of roosts during the seasons when bats are not present (Richardson, 2005). Furthermore, large expanses of suitable foraging habitats must be maintained within proximity to roosts to allow for efficient foraging. Fragmentation of foraging habitat, land use changes that eliminate or reduce forage plant populations, and the placement of "barriers" between roosts and foraging areas may have adverse effects on the use of roosts in the vicinity (Richardson, 2005).

Bumblebees (genus *Bombus*)

The genus *Bombus* encompasses roughly 250 total species found throughout the world, with greatest diversity in the Northern Hemisphere (Williams, 1998). These insects are relatively large in size, averaging approximately 2 to 3 cm in length, and are easily recognizable by their trademark black and yellow coloring and furry bodies.

Bumblebees are eusocial, living in colonies of roughly 50 individuals, consisting of a single queen bee and many worker bees (Williams, 1998). Bumblebees operate according to a distinct reproductive division of labor, overlap of generations and cooperative care of offspring (Williams, 1998). After a

queen bee mates in autumn, she overwinters until spring when she emerges from hibernation. She then begins to build a nest, which is typically underground or directly on the ground surface. Sometimes, she will adopt an old mouse nest or a similar feature rather than building a nest from scratch. Initially, the queen will harvest pollen and nectar herself, which she brings into the nest to create an environment that will allow for her eggs to hatch. Once the eggs have hatched to larvae, they will utilize the pollen and nectar pouches that the queen created. The larvae remain in their respective cells until they pupate and finally become a fully developed colony of adult bees. The newly adult bees will consist of both worker females and reproductive males. Worker bees then take on all further foraging and nest-building duties. These nests and colonies will last only for one season and will produce new queens in the fall. These new queens will mate, overwinter, and subsequently build new nests come springtime (Massachusetts Audubon, 2012).

BUMBLEBEE FIELD GUIDES

There are several field guides to help identify the various bumblebee species. Many of these resources are available online.

Carol Ann Kearns; James Thomson. 2001. The Natural History of Bumblebees: A Sourcebook for Investigations. University Press of Colorado, Boulder.

Colla, S., L. Richardson and P. Williams. 2011. Bumble Bees of the Eastern United States. U.S. Forest Service and Pollinator Partnership.
Available from http://www.fs.fed.us/wildflowers/pollinators/documents/BumbleBeeGuideEast2011.pdf

Koch, J., J. Strange and P. Williams. 2012. Bumble Bees of the Western United States. U.S. Forest Service and Pollinator Partnership.
Available from http://www.fs.fed.us/wildflowers/pollinators/documents/BumbleBeeGuideWestern2012.pdf

Xerces Pocket Guides

Evans, E. 2009. Pocket Guide to Identifying the Rusty Patched Bumble Bee *Bombus affinis*. The Xerces Society.
Available from http://www.xerces.org/wp-content/uploads/2009/02/affinis_pocketid.pdf

Evans, E. 2009. Pocket Guide to Identifying the Western Bumble Bee *Bombus occidentalis*. The Xerces Society.
Available from http://www.xerces.org/wp-content/uploads/2009/02/occidentalis_pocketid.pdf

Evans, E. 2009. Pocket Guide to Identifying the Yellow Banded Bumble Bee *Bombus terricola*. The Xerces Society.
Available from http://www.xerces.org/wp-content/uploads/2009/02/terricola_pocketid.pdf

Bumblebees are known to display "flower constancy," meaning that they will revisit the same patches of flowers for multiple days. The furry hairs on their body, called pile or pubescence, assist in the pollination process (Massachusetts Audubon, 2012). The pile will trap individual pollen grains, causing them to stick to the bee's body. Bumblebees are responsible for both intentional and accidental pollination (Stout et al., 1998). Because of the pile covering their bodies, bumblebees will often

incidentally accumulate pollen on their bodies. This pollen is then deposited on other flowers, leading to accidental pollination.

With intentional pollination, bumblebees will efficiently collect pollen from visited flowers and then use a process known as buzz pollination to deposit it elsewhere. Buzz pollination is a unique behavior in which bumblebees move their flight muscles rapidly so that their entire body vibrates, causing pollen to dislodge from the anther of a flower (Rosenthal, 2008). This behavior has been shown to improve the length, weight, and diameter of certain fruits (Serrano et al., 2006). Because bumblebees have the ability to perform buzz pollination, they are generally more efficient at pollinating flowering plants that have tubular anthers where the pollen is difficult to dislodge. Some flowering plant species requiring buzz pollination from pollinators for maximum pollination and fruit yields include tomatoes, blueberries, cranberries, and eggplant.

Populations of several species in the genus *Bombus* have declined in recent years. This decline in populations can be attributed to many factors, including habitat degradation, habitat fragmentation, and inadequate habitat supplies such as nesting or foraging sites. Habitat fragmentation may reduce the effectiveness of bumblebee pollination. For example, *Bombus veteranus* has been shown to visit flowers in fragmented areas less frequently than undisturbed habitats (Goverde et al., 2002). Bumblebees do not travel long distances to forage, so if there is a nesting site without enough food for forage, the colony will be weakened. The same outcome is true if there is good foraging without a nesting site nearby. Declines in bumblebee populations could result in reduced pollen dispersal, increased inbreeding, and decreased genetic variability for plants that rely on bumblebees for pollination (Goverde et al., 2002).

Regal Fritillary butterfly (*Speyeria idalia*)

The Regal Fritillary butterfly is easily identified by its vibrant orange coloring, black markings, and white spots. It also has dark hindwings, which help distinguish it from related fritillary species such as the Great Spangled Fritillary (*Speyeria cybele*) (Brock, 2003). Females tend to be slightly larger than males, with most individuals having between a 2.7 to 4.1 inch wingspan (Selby, 2007).

This butterfly is known as a “prairie-specialist” because of its nesting habitat in tall grasses and prairie ecosystems in the east-central United States. The larvae feed almost exclusively on various species of violets, while the adult diet is composed of nectar from plants such as milkweed, clover, goldenrods, and thistle (Selby, 2007). The Regal Fritillary is univoltine, producing a single generation per year (Selby, 2007). Females lay 1,000 to 2,000 eggs in late August to early September (Vaughan et al., 2005). The eggs begin hatching by late September and continue hatching into early October, followed by larvae which overwinter until spring. When hibernation ends, the larvae begin to feed on violets. In late May, the larvae pupate and become full adults. This process is followed by the start of mating season in late June (Selby, 2007).

Land management techniques have important implications for the Regal Fritillary. Swengel (1996) explains that as a prairie specialist the Regal Fritillary is particularly vulnerable to prescribed burning, which has a negative effect on its populations. He also found that the use of haying as a habitat

maintenance technique had much more favorable results on fritillary populations than did burning. A severe loss in grassland habitat has also led to a decline in the Regal Fritillary population over the years (Powell et al., 2006). The butterfly's range previously extended from Maine to Colorado with populations in 18 states east of Illinois. Small pockets of populations are now found in only three eastern states: Pennsylvania, Indiana, and Virginia with the primary range being in the east-central U.S. (Powell et al., 2006). The Fritillary's conservation status is currently considered vulnerable (Selby, 2007).

Blackburn's sphinx moth (*Manduca blackburni)*

Blackburn's sphinx moth is a representative of the family Sphingidae, a family that includes many important pollinator species. Adults of *Manduca blackburni* have a grayish-brown coloring with orange spots down either side of the abdomen and an average wing span of five inches. Caterpillars can either be bright green or gray (USFWS, 2012). The larval diet consists of tomatoes, tobacco, eggplant, and plants in the nightshade family, while adults feed mostly on nectar of native plants (State of Hawaii DLNR, 2005).

This moth was believed to be extinct, until a few small populations were rediscovered in 1984 (Black, 2012). The moth is native to Hawaii and was originally found on six of the Hawaiian Islands (Black, 2012). The moth is now seen mostly on the island of Maui. Its habitat includes coastal, lowland, and dryland forests in areas with 50 inches of annual rainfall or less (USFWS, 2012).

The threats responsible for the moth's near extinction include a loss of habitat, introduced ants and parasitic wasps that prey on the eggs and caterpillars, and the loss of its native host plant *Northocestrum subcordatum*. *N. subcordatum* is a dryland forest tree commonly known as Aiea or Halena (USFWS, 2012). The moth has been considered an endangered species since its rediscovery in the 1980's (Black, 2012).

Mydas fly (order Diptera, family Mydidae)

The Mydas fly is a representative of the family Mydidae, a family which consists of approximately 400 species of flies, 51 of which occur in North America (Camp, 2005). The family Mydidae includes some of the largest flies in the United States, some of which can approach 2 inches in length (Camp, 2005). The family Mydidae has a worldwide range within temperate, tropical, and subtropical regions. Species of the family exhibit a broad range of habitat tolerances, from arid environments to tropical rainforest and temperate deciduous forests (Arnett, 2000).

Mydas fly Photo credit: Michael Hodge

Despite the Mydas fly adult's preference for flower nectar, its larvae are considered a predator that feed on the larvae of other insect species, such as beetle grubs. Certain species of Mydas flies also mimic wasps, with wings, coloration, and body shape similar to that of a wasp (Barnes, 2008).

Ruby-Throated Hummingbird (*Archilochus colubris*)

The Ruby-Throated Hummingbird is a familiar bird in many U.S. states and is the only species of hummingbird that nests east of the Mississippi river in North America. It also has the largest breeding range of all North American hummingbirds (Cornell Lab of Ornithology, 2012). This hummingbird can be found throughout the eastern United States as well as the southeastern Canada.

The average Ruby-Throated hummingbird is 7 to 9 cm long with an 8 to 11 cm wingspan and an average weight of 2 to 6 grams (Cornell Lab of Ornithology, 2012). They have a long, straight, and narrow bill. They are also sexually dimorphic based on coloring, meaning that only the males have the red collar for which they are named (National Geographic, 2012). Female ruby-throats tend to be slightly larger than males. Both sexes have black heads, black wings, a grayish-white underbelly, and a metallic-green back. Their wings beat up to 53 to 55 times per second (Cornell Lab of Ornithology, 2012).

Ruby-throated hummingbird at cardinal flower at
John Heinz National Wildlife Refuge in Philadelphia, PA
Photo credit: Bill Buchanan/USFWS

Their preferred habitat includes deciduous and pine forests, forest edges, woodlands, meadows, orchards, and gardens (Cornell Lab of Ornithology, 2012). Females prefer to build their nests in tall, mature deciduous trees such as oak, birch, or poplar (Cornell Lab of Ornithology, 2012). As migratory birds, they winter mostly in Central America (Harris et al., 2007). They can also be found wintering in South America and even as far south as the West Indies. Individual birds must fly at least 500 miles over the Gulf of Mexico to reach these overwintering sites. In order to prepare for this trip, the hummingbird is capable of doubling its body mass by consuming insects before migration (National Geographic, 2012).

These birds are solitary rather than social animals. They are also polygynous, which means that they do not form breeding pairs, and males are not involved in the breeding process beyond mating (National Geographic, 2012; Cornell Lab of Ornithology, 2012). Females lay 1 to 3 eggs per brood and lay twice each summer season. The chicks then leave the nest when they are 3 to 4 weeks old (National Geographic, 2012). The average life span can range anywhere between 5 to 9 years; however, it is closer to 5 years for males and 7 years for females (National Geographic, 2012).

The Ruby-Throated Hummingbird is an omnivore with a diet consisting of nectar from flowers as well as small insects and spiders (National Geographic, 2012). Some studies have shown that these birds have a demonstrated preference for orange and red tubular-shaped flowers (Cornell Lab of Ornithology, 2012). Predators of the hummingbird include other insect-eating birds and animals such as lizards, snakes, hawks, and domestic cats. Their conservation status is currently ranked as a species of least concern (Cornell Lab of Ornithology, 2012).

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APPENDIX A

Table 1. Breakdown of pollinators mentioned throughout SWAP reports.

Organism Group	Number of SWAPs to Mention Group	Number of Species in SWAPs
Bats	49	64
Butterflies	40	230
Moths	36	256
Hummingbirds	24	18
Bees	10	31
Flies	11	11

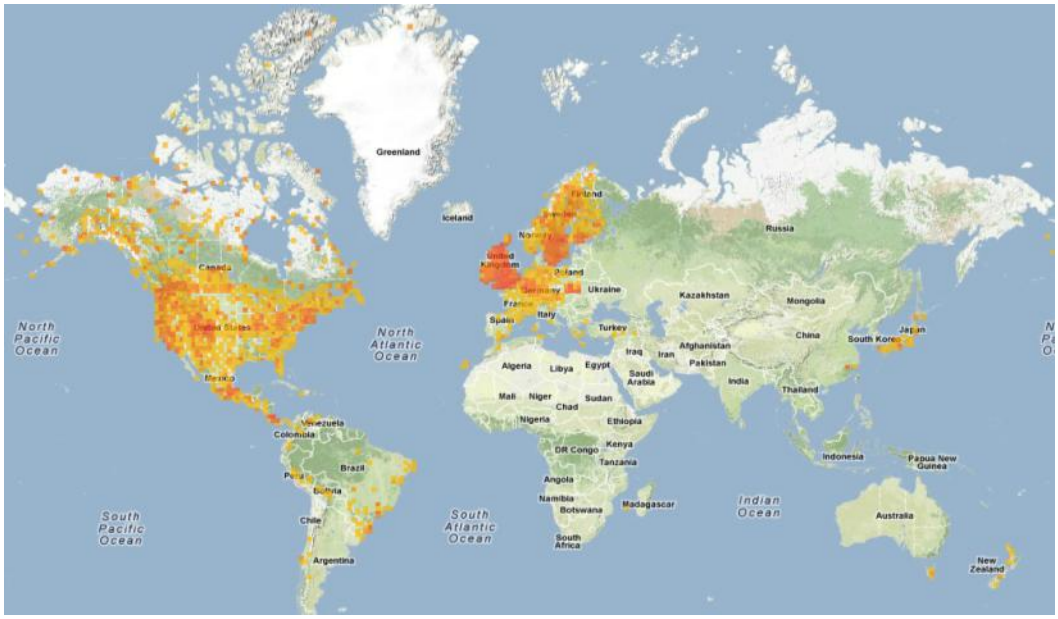
APPENDIX B

Territories of Highlighted Pollinator Species

Lesser long-nosed bat

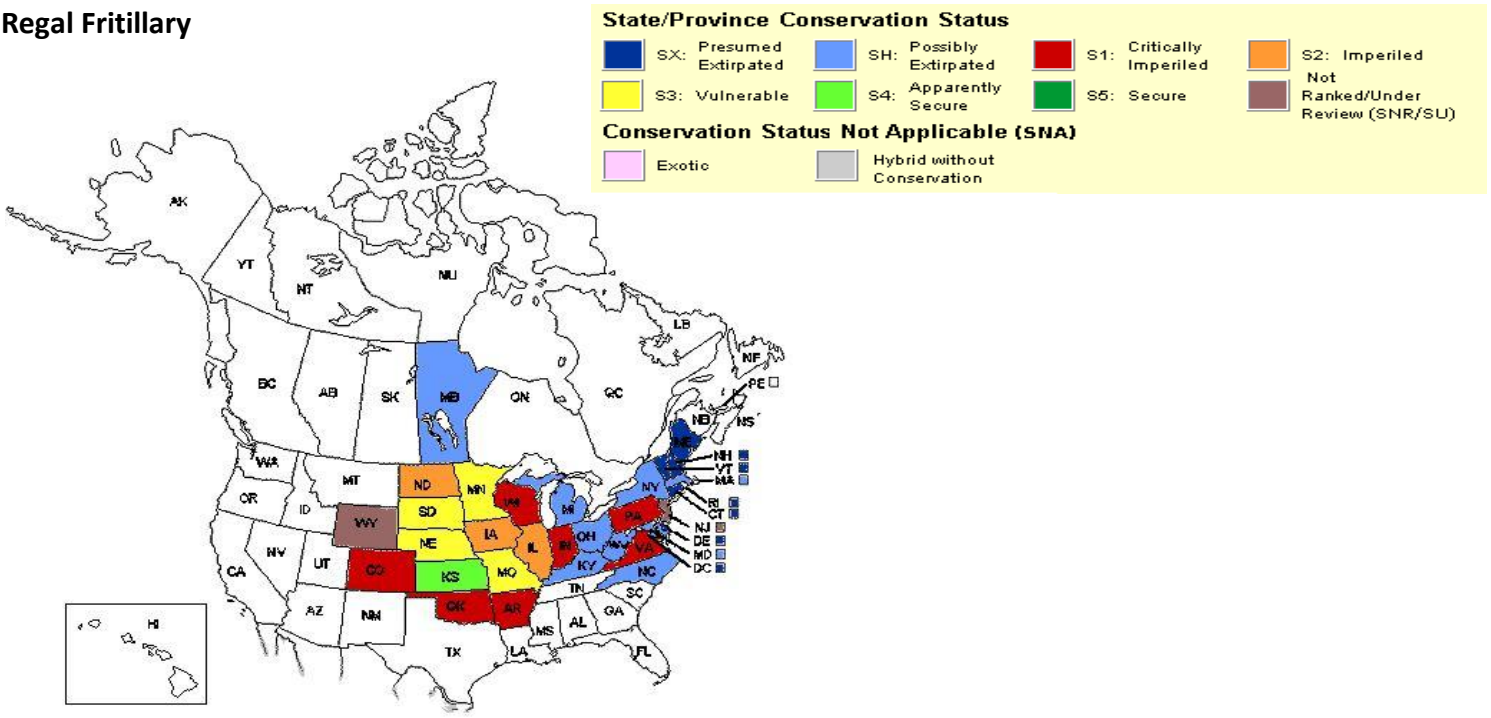
Maplink, Tele Atlas. 2013. "*Leptonycteris yerbabuenae*: Lesser Long-nosed Bat." Accessed 11 February 2013, available from Encyclopedia of Life, http://eol.org/pages/308539/maps.

Bumblebees



Maplink, Tele Atlas. 2013. "*Bombus*: Bumblebees." Accessed 11 February 2013, available from Encyclopedia of Life, http://eol.org/pages/104136/maps.

Regal Fritillary



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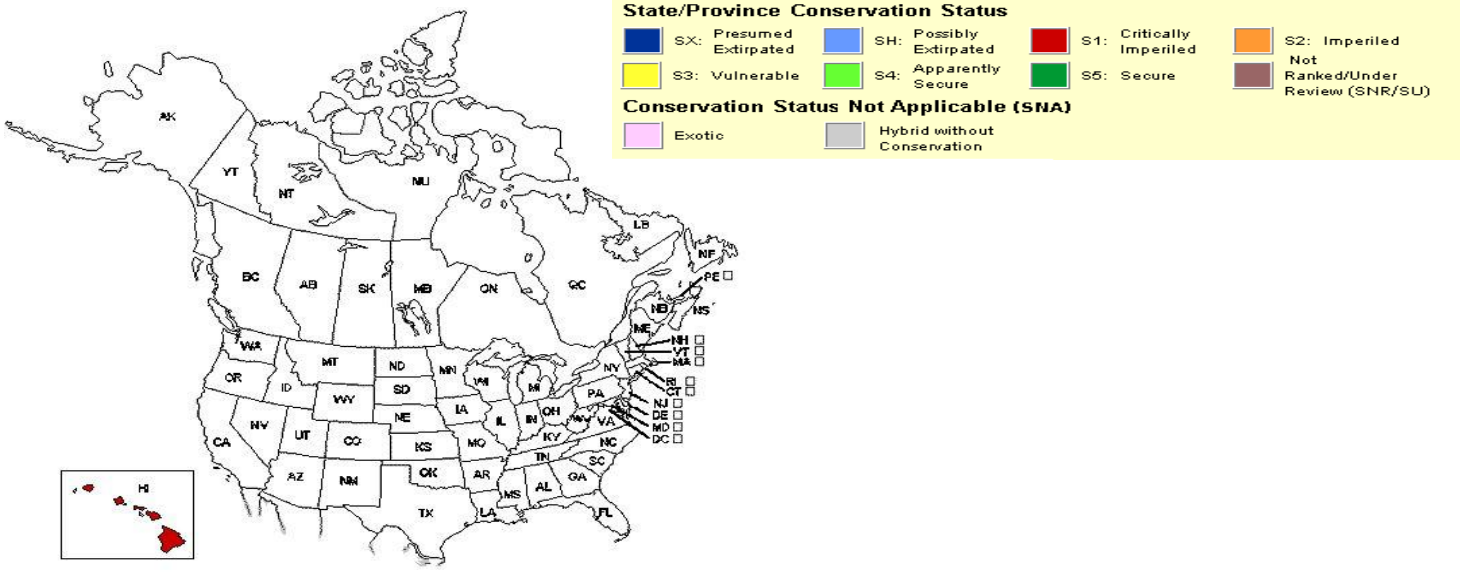
Blackburn's Sphinx Moth



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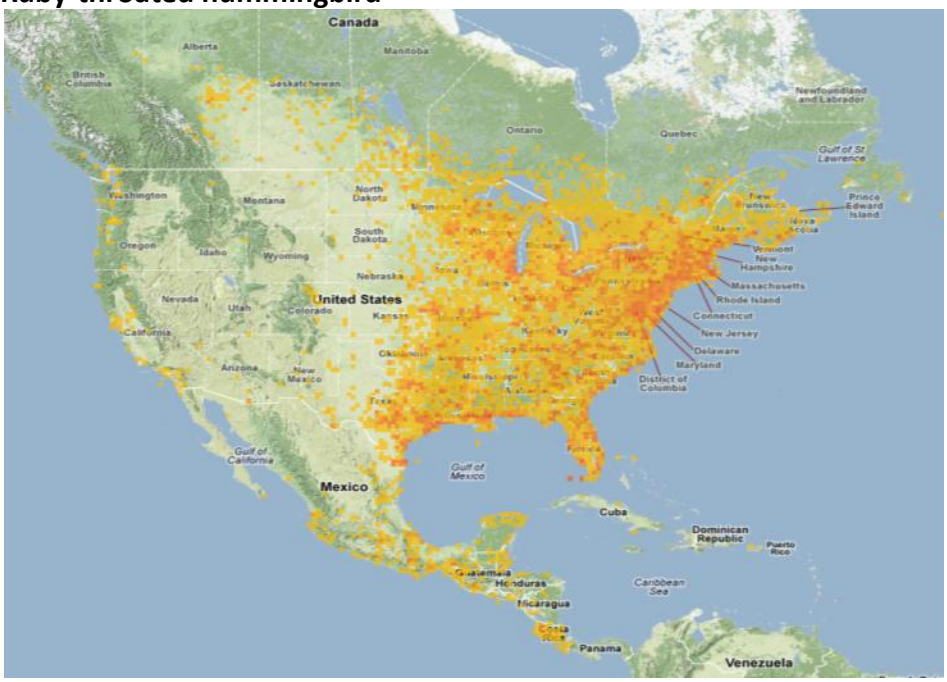
Ruby-throated hummingbird



Maplink, Tele Atlas. 2013. "*Archilochus colubris*: Ruby-throated Hummingbird." Accessed 11 February 2013, available from Encyclopedia of Life, http://eol.org/pages/916798/maps.