Insects as flagship conservation species

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Summary
Insect conservation has generally received less public attention than vertebrate conservation. Less is known about threats to invertebrates, and invertebrates generally have less public charisma than vertebrates and thus engender less concern. We argue that an additional reason is that invertebrates are rarely used as flagship conservation species, and that increased focus on invertebrate conservation in public campaigns would benefit this important group of species and conservation efforts in general. We describe conservation efforts focused on three groups: charismatic insects, endangered insects, and insects that provide important ecological services. In each of these cases, we provide a case study that illustrates ways in which these efforts have wide-reaching conservation and education impacts. Our goals are to expand insect conservation efforts and to motivate entomologists and conservationists in general to utilize appropriate insect species to garner support for conservation efforts.

Keywords
Insect conservation; flagship species; monarch butterfly; Danaus plexippus; Karner blue butterfly; Lycaeides melissa samuelis; ecological services; pollinators

Introduction
A common strategy for minimizing current and future biodiversity losses is to focus on one or a small number of species that help identify or improve conservation problems (Thomas, 1972; Wilcox, 1984; Jarvinen, 1985). These species, often called surrogate species, can serve several different purposes (Caro and O’Doherty, 1999). Indicator species are used to assess environmental conditions (Landres et al., 1988); for example, the presence of specific aquatic invertebrates helps indicate water quality. Umbrella species help define a habitat or community of species to protect (Wilcox, 1984); the range of the migratory wildebeest (Connochaetes taurinus) helped define boundaries for a conservation area in Tanzania (Grzimek and Grzimek, 1959). Finally, flagship species are used to generate public support and funding for conservation goals beyond the
needs of the specific species (Dietz et al., 1994). Some flagship species, like the giant panda (*Ailuropoda melanoleuca*), a symbol of the World Wildlife Fund, are used to generate support for nature globally (Caro and O’Doherty, 1999), while others, like the Komodo dragon (*Varanus komodoensis*) that inhabits a few Indonesia islands, are used to attract tourists and generate conservation funds in a specific area (Walpole and Leader-Williams, 2002). While historically most flagship species have been large mammals, some much smaller species, for example butterflies, have been successful flagship species (New, 1997).

More focus on insect flagship species could serve two important goals. From a broader perspective, utilizing this large and ubiquitous group in conservation efforts can effectively draw attention to conservation needs in general. Additionally, it is important to draw more attention to insect conservation needs per se. The scarcity of insect flagship species means that few people think about their importance and conservation needs. While extinctions of and threats to land vertebrates are reasonably well-documented (e.g. Pimm and Raven, 2000; Baillie et al., 2004), extinction rates of other organisms, which comprise about 99% of the world’s species, are rough guesses, at best (e.g. Dunn, 2005; Berenbaum, 2008). There is some question about whether the forces that threaten vertebrates threaten insects with similar levels of intensity. Some features of insect biology, such as their requirements for smaller habitat areas to support relatively large populations (Blackburn and Gaston, 1997) and high rates of reproduction and dispersal, may make insects less prone to extinction. However, some characteristics may make them prone to factors that are unlikely to affect vertebrates, such as narrow habitat specialization and requirements for specific hosts that may themselves be threatened. The protection afforded to insects under the United States Endangered Species Act is less generous than that afforded to vertebrates; distinct populations of invertebrates cannot be protected, nor can any group that has the potential to be an agricultural pest during any life stage (Black, 2008). Because citizens can play a key role in securing protection for species through legislation and habitat protection, increasing the public’s knowledge of and concern for insects can be an important strategy in securing more equal protection for this group (e.g. Berenbaum, 2008).

Our focus is on conservation efforts that have targeted insect flagship species. We describe conservation efforts focused on three groups: charismatic insects, endangered insects, and insects that provide important ecological services. In each of these cases, we provide a case study that illustrates ways in which these efforts have wide-reaching conservation and education impacts. Our goals are to expand insect conservation efforts and to motivate entomologists and conservationists in general to utilize appropriate insect species to garner support for conservation efforts.

**Charismatic species**

Insects are generally not perceived in a positive light, but rather as crop pests, carriers of disease, poisonous, or simply pesky (e.g. Berenbaum, 2008). They might thus seem unlikely charisma candidates. However, butterflies provide an exception to the
unfavorable view of insects (e.g. Vane-Wright, 2008), and are thus appropriate flagship species. Butterflies are often beautifully colored, easy to observe as they fly and nectar from flowers, and do not bite or sting. They are familiar to many people because they are fairly common across a variety of habitat types, and this familiarity can be an important conservation tool.

The monarch butterfly (\textit{Danaus plexippus} L.) provides one of our best examples of the conservation impacts of a non-threatened species (see Figure 1). In fact, it is likely that no other non-pest insect has attracted as much attention (Oberhauser and Solensky, 2004). Monarch adults and larvae are both recognized by many people. They are widespread and fairly common, and have unique and well-known attributes, such as their long distance migration, involvement in a fascinating mimicry complex, and relationship with milkweed. The monarch is the state insect, butterfly or emblem of seven states in the United States, one Canadian province, and one Mexican state. Children study monarchs in school, conservationists are concerned about impacts of human activities on monarchs, and citizens, government agencies and conservation organizations are engaged in a variety of programs designed to alleviate these impacts. Citizen scientist volunteers throughout North America track their migration and breeding, and their involvement in these research efforts not only provides data that are relevant to conservation decisions, but also helps to develop a corps of citizens that educate and advocate on behalf of the organisms they study (Oberhauser and Prysby, 2008). These efforts benefit other organisms through conservation education; habitat protection, restoration or creation; and alleviation of human activities that degrade habitats, such as pesticide applications.

The long distance migration of monarchs, from summer breeding grounds in temperate regions of the United States and Canada to wintering habitat in central Mexico and coastal California (e.g. Brower, 1995), requires a series of habitat types that are regularly occupied over the course of a year. In the summer, these habitats range from pristine prairies in the Upper Midwestern United States and Canada to small gardens, roadside ditches, field edges, and fallow agricultural fields. In the fall, monarchs require access to nectar sources and nighttime resting spots, and their wintering locations must provide specific microclimatic conditions that are found in wooded groves near the Pacific Ocean, and forested mountain-tops in the Transvolcanic Range of central Mexico. Protection and creation of these habitats will benefit many organisms besides monarchs. For example, of the 423 vascular plants that are found in the Monarch Butterfly Biosphere Reserve (MBBR) in Mexico, 32% are Mexican endemics, and Cornejo-Tenorio et al. (2003) argue that this is a center of diversification for several groups. Preservation and augmentation of nectar resources along the migratory flyways will also benefit other pollinators.

\footnote{Many monarch citizen science programs exist in North America, including the Monarch Larva Monitoring Project (www.mlmp.org), Monarch Watch (www.monarchwatch.org), and Project Monarch Health (www.monarchparasites.org). Others have broader foci that include monarchs, such as the North American Butterfly Association (www.naba.org), Journey North (www.learner.org/jnorth) and several Butterfly Monitoring Networks.}
Figure 1. Monarch butterfly (*Danaus plexippus*) © Kurt Adolfson, www.bluedotimages.com

Figure 2. Karner blue butterfly (*Lycaeides melissa samuelis*) © Kurt Adolfson, www.bluedotimages.com
The attention to monarchs has resulted in conservation efforts at global, continental, national, state and local scales, despite the fact that the species is not threatened. At a global scale, the UNESCO (United Nations Educational, Scientific and Cultural Organization) Convention concerning the Protection of the World Cultural and Natural Heritage named the Monarch Butterfly Biosphere Reserve in Mexico as a World Heritage Site in 2008. This Reserve joins a list of 878 sites whose cultural and natural heritage is deemed to have outstanding universal value. While this recognition conveys no official protection, it clearly indicates a value recognized on an international level.

On a North American scale, the Commission on Environmental Cooperation (CEC), a trilateral commission that complements the environmental provisions of the North American Free Trade Agreement (NAFTA), has supported the development of the North American Monarch Conservation Plan (Oberhauser et al., 2008), with the aim of maintaining healthy monarch populations and habitats throughout the migration flyway. Officials from the United States Fish and Wildlife Service, the United States National Park Service, the Canadian Wildlife Service, the Canadian Parks Agency and the National Commission of Natural Protected Areas in Mexico have supported this plan, and have designated 13 wildlife preserves (four in Mexico, five in the US, and two in Canada) as protected areas that comprise a “Trilateral Monarch Butterfly Sister Protected Area Network” to support international preservation and restoration of breeding, migration and winter habitat for monarchs. The endorsement of the Monarch Conservation Plan by agencies within all three North American governments illustrates their embrace of monarch habitat protection. Additionally, state and local government bodies, as well as private and non-governmental enterprises, have access to a coherent set of recommended actions that will benefit monarchs and the myriad of organisms with which they share habitats.

At a national scale, the monarch is listed as a species of special concern under the Canadian Species at Risk Act (SARA), and the government of Mexico has protected 56,259 hectares of land in the area in which monarchs overwinter. In addition to these specific protections, a variety of government and non-government agencies and organizations directly and indirectly support monarch conservation in all three North American countries.

Endangered species

Many successful flagship species exhibit decreasing population numbers or endangered status (Dietz et al., 1994) due to habitat degradation or loss. They often require a unique habitat or microhabitat, and are sensitive to ecological disturbances. Official status, such as being listed as endangered or threatened, often increases funding resources for research and habitat management, but because insects are less likely to receive these official designations, few insects have become flagship species as a result of their endangered status.
The Karner blue butterfly (*Lycaeides melissa samuelis* N.) is one example of an endangered flagship insect (see Figure 2). This butterfly has successfully engendered public support for conservation due to its aesthetic appeal and connection to an imperiled ecosystem. The Karner blue is a small, attractive butterfly that historically lived in oak-pine savanna or pine barren habitats from the northeastern United States to southeastern Minnesota (U.S. Fish and Wildlife Service, 2003). Oak savannas and pine barrens are unique ecosystems; in the Midwestern United States they are generally part of a transition zone between western prairie and eastern deciduous forest. Oak or pine trees predominate in their canopy cover of 10 to 80%, a shrub layer may or may not be present, and the understory consists of grasses and forbs. These ecosystems require disturbances, such as fires or drought, which prevent development of closed canopy woodland or shrub land (Nuzzo, 1986). A common understory plant in these savannas and barrens is wild lupine (*Lupinus perennis* L.) the host plant of the Karner blue. While wild lupine can grow under closed tree canopies, it is unable to flower in these conditions (Boyonoski, 1992) and is thus dependant on disturbances that maintain an open or semi-open tree canopy. Oak savannas are one of the most threatened United States ecosystems, with only 0.02% of their pre-settlement area remaining (Nuzzo, 1986). As its habitat has been destroyed and degraded over the last few decades, a corresponding dramatic decline of Karner blue butterfly populations has occurred, and it was listed as a federally endangered species in 1992. Conservation efforts to save Karner blues have focused on maintaining or improving native ecosystems (Andow et al., 1994; U.S. Fish and Wildlife Service, 2003), an approach that will benefit many other species in oak savanna and pine barren habitats.

Recovery efforts for the Karner blue butterfly have involved many organizations working alone and in partnership. For example, through the Wisconsin Statewide Habitat Conservation Plan, the Wisconsin Department of Natural Resources has led a grassroots approach to develop a large scale conservation plan, organizing traditional conservation groups, working in conjunction with non-traditional conservation groups, such as the Department of Transportation and paper and power companies. A total of 26 partners are working to apply this plan to over 250,000 acres of Karner blue habitat (Watermolen et al., 2000; U.S. Fish and Wildlife Service, 2003). In Ohio, the local Karner blue butterfly population was extirpated in the late 1980’s or early 1990’s (Andow et al., 1994). In 1988, the Toledo Zoo and The Nature Conservancy joined resources to reintroduce Karner blues to Ohio. The Zoo captively rears the butterflies and releases them on 250 acres of oak savanna habitat owned and restored by The Nature Conservancy. It has released over 2000 butterflies with positive population effects, as well as benefits to many other species dependant on the same habitat. The Ohio Nature Conservancy has noted that the oak savanna restoration has also helped increase populations of badgers, red-headed woodpeckers, lark sparrows, and the state endangered frosted elfin and persius duskywing butterflies (The Nature Conservancy, 2008).

Conservationists have utilized the story of the Karner blue butterfly to increase conservation education efforts. For the 25 year anniversary of the Endangered Species Act,
the National Wildlife Federation (NWF) initiated the “Keep the Wild Alive” campaign, choosing 25 endangered species to profile, including the Karner blue. The campaign emphasizes education and local conservation initiatives, including the NWF species recovery fund which provides financial support for local conservation efforts to support conservation of imperiled species. Additionally, several local and state efforts officially recognize and celebrate the Karner blue butterfly’s presence. The small town of Black River Falls, Wisconsin is adjacent to Karner blue habitat and hosts an annual summer festival celebrating this butterfly with activities such as habitat tours and a butterfly learning center. In 1992, New Hampshire named the Karner blue butterfly as its state butterfly, and it became the official butterfly of the town of Queensbury, New York in 2001 (Mlot, 2007). Such actions draw attention to the conservation needs of the Karner blue butterfly and other organisms, particularly insects.

Insects that provide ecological services

There is a growing recognition of the value of the services derived from their ecological functions that insects provide to human well-being (Kremen and Chaplin-Kramer, 2005; Losey and Vaughan, 2006, 2008). These wide-ranging services include pollination, protection from pests, decomposition, food for wildlife, and recreation through activities such as insect observation. Losey and Vaughan (2006, 2008) have calculated values for many of these services, and provide an informative comparison of conservation efforts that focus on ecological services with those that focus on endangered status (Losey and Vaughan, 2008). They argue that the commonness and positive economic impact of insects that provide ecological services make them excellent candidates for flagship species. Commonness may make insects more familiar and less threatening, and thus better able to overcome the “charisma-challenges” (Berenbaum, 2008) that generally characterize insects. Additionally, if landowners are aware of the benefits provided by insects, they may conduct land management activities that benefit insects, provided that they are aware of strategies that will accomplish conservation.

Here, we focus on conservation efforts directed toward pollinators (see Figures 3-5). Pollinators have clear economic and even survival importance to humans. Three-quarters of all flowering plants, including most species of food crops, rely on pollinators for fertilization, and decreases in wild pollinator populations could have severe impacts on natural and managed ecosystems. Pollinators are estimated to provide over $57 billion worth of services in the United States (Losey and Vaughan, 2006), and $217 billion worldwide (Gallai et al., 2008). Many organizations are promoting pollinator conservation in a variety of ways that could have broad conservation effects. The Xerces Society, dedicated to invertebrate conservation (Xerces Society, 2008), and state extension agencies (e.g. Krichik, 1998; Riedl et al., 2006) have published a variety of information sheets for the public that describe simple strategies for supporting pollinators. These range from strategies for avoiding mortality through pest management; supporting pollinators with appropriate plantings in rural, suburban and urban
Figure 3. Bumblebee (upper row, left, *Bombus* spp.); Figure 4. Sweat Bee (upper row, right, Family Halictidae, Subfamily Halictinae); Figure 5. Sweat Bee [lower row, *Agapostemon virescens* (Fabricius)]. All figures: © Kurt Adolfsen, www.bluedotimages.com
yards; and providing shelter. The North American Pollinator Protection Campaign (NAPPC) is an alliance of pollinator researchers, conservation and environmental groups, private industry, and state and federal agencies in Canada, Mexico and the United States (The Pollinator Partnership, 2008). NAPPC organizes local, national, and international projects involving pollinator research, education and awareness, conservation and restoration, special partnership initiatives, and policies.

In late 2006, the United States National Research Council, at the request of NAPPC, published a report that recognized the downward long-term population trends for many North American pollinators and called for increased efforts to monitor pollinators and improve understanding of their basic ecology (NRC, 2006). While much of the current data on pollinator decline focuses on the non-native honeybee (*Apis mellifera*), the report also notes declining numbers for several wild bee species, especially bumblebees, as well as some butterflies, bats, and hummingbirds. The report recommends support for research aimed at the sustainable management of these populations, as well as actions that encourage landowners to make habitats more “pollinator friendly” by growing native plants and limiting pesticide use that could affect pollinators.

The efforts of NAPPC and other groups focused on pollinator conservation have recently paid off at the national level. The US Farm Bill passed in 2008 includes measures that will help shape USDA programs to protect and enhance the habitat of native and managed pollinators. These include recommendations for pollinator friendly plantings in field borders, hedgerows and shelterbelts; corridors to connect pollinator habitat patches; and grants for research that will address the impacts of pesticides on pollinators.

The efforts of organizations addressing pollinator conservation have also included a variety of public outreach efforts, ranging from pollinator postage stamps to school curricula. Through these efforts, increasing numbers of people are aware of the importance of pollinators to our survival. This awareness of the absolute necessity of a natural ecological process carried out, in the main part, by insects, can only benefit natural system conservation.

**Capturing the imagination of public and harnessing resources toward habitat conservation**

There are many ways to increase public interest in insect conservation, and thus habitat conservation in general. Insects have the distinct advantage of being familiar, common and almost everywhere that humans live. While a lack of understanding about the importance and vulnerability of insects means that they are rarely used as flagship conservation species, increased involvement of the public with insects could make these organisms important in many more conservation efforts.

One way to increase public interest in insects is to expose people to their beauty through photographs. Insects are small, and thus some of their incredible beauty may be difficult to discern easily. The current availability of excellent and relatively inexpensive cameras with macro capabilities addresses this problem. Photographic exhibits,
portrayal of insects in popular and educational media, and classes focused on insect photography could increase the public’s awareness of the beauty of insects.

Whenever possible, scientists should communicate the relevance of their research and ways in which individuals can promote insect conservation. There are many excellent examples of such communication focused on K-12 teachers and students. Three large North American programs (Monarchs in the Classroom, Monarch Watch and Journey North) as well as many smaller ones promote monarch conservation and study in classrooms (MonarchLab, 2008; Monarch Watch, 2008; Journey North, 2008). The Monarch Waystation program run by Monarch Watch (2008) explicitly promotes monarch and pollinator-friendly habitat gardens in schools. Other excellent examples include the NAPPC pollinator curriculum (The Pollinator Partnership, 2008) and the Entomological Association of America President’s prizes for outstanding achievement by elementary and secondary teachers who use insects as educational tools (Entomological Association of America, 2008). Partnerships with media groups, non-profit organizations and government agencies can also help spread the word about the importance of insects, their vulnerability to the same factors that threaten vertebrates, and their interesting life histories.

One way to engage the public in natural phenomena is to involve them in research. A growing number of citizen science projects, many of which focus on insects, do this, and spreading the word about these projects and their findings to as broad an audience as possible will be important. The conservation efforts on the part of volunteers in citizen science projects focused on monarchs provide one example (Oberhauser and Prysby, 2008). Project Butterfly Wings (Florida Museum of Natural History, 2008) volunteers, who include members of 4H groups in Florida, document butterfly species observed in their gardens and other local areas; volunteers in the Lost Ladybug Project (Cornell University, 2008) search for native coccinellid beetles; and cooperators in national parks and other protected areas North and Central America are using malaise traps to count insects (Insect Diversity Project, 2008). Whenever possible, entomologists should try to engage the public in their research. Through their engagement with citizen science and other research programs, citizens can make positive contributions to research, and in the process, are likely to become strong conservation advocates.

Conclusion

Even though most flagship species have historically been large mammals, an increasing amount of attention has been directed to smaller species, including insects. Entomologists and conservationists need to encourage the use of insect flagship species in order to draw attention to the importance of this group and their conservation needs. The descriptions and case studies of charismatic and endangered insects, and those that provide ecological services, illustrate how the use of a flagship species can have wide-reaching conservation and education impacts. We encourage entomologists and conservationists to interact with the public and campaigns that garner support for insect conservation efforts.
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References


