

# The Monarch Butterfly through Time and Space: The Social Construction of an Icon

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*In this study, we explore the social construction of the monarch butterfly as a conservation icon in order to understand how the butterfly has come to be endowed with the power to shape public conversations and potentially alter policy and practice. Our analysis is guided by the sociological concepts of coproduction and boundary objects, which reveal how this butterfly has animated and sustained conversations across diverse organizational boundaries. We find that engagement with narratives of beauty, natural wonder, scientific discovery, conservation imperatives, and civic duty has allowed the monarch to enroll actors in a broad network that gives rise to surprising, emergent properties. These properties make the monarch a powerful communication vehicle and a potent ally in environmental politics. Our analysis of the historical and contemporary construction of the monarch as an icon contributes to ongoing efforts to bring resources from critical social science to bear on the strengthening of science-policy-practice interfaces.*

**Keywords:** the monarch butterfly, boundary object, coproduction, conservation, biodiversity

**T**he monarch butterfly (*Danaus plexippus*) has been much in the news recently. In January 2014, reports came of the lowest numbers of monarch butterflies ever recorded at the overwintering sites in oyamel fir forests in central Mexico (e.g., Taylor 2014, Wines 2014). In February, conservation of the monarch was identified as a core joint commitment of the leaders of Mexico, the United States, and Canada at a North American Free Trade Agreement (NAFTA) summit (Baker and Malkin 2014). During the spring, appeals to plant milkweed (*Asclepias* spp.) to compensate for a changed agricultural landscape were made in numbers and with an intensity never seen before (e.g., initiatives proposed by the David Suzuki Foundation, Make Way for Monarchs, and Monarch Watch). These pleas involved the White House garden, citizen scientists' backyards, governmental agencies, and global agribusiness firms. On 20 June 2014, US President Barack Obama issued a memorandum to create a federal strategy to promote the health of honey bees and other pollinators, among which the monarch butterfly was specifically named (White House 2014). And as 2014 came to an end, the US Fish and Wildlife Service announced that they, as a response to a petition submitted on August 26, 2014, were going to conduct a status review of the monarch butterfly under the Endangered Species Act (USFWS 2014). This insect, undoubtedly the most well-known butterfly in the world, has captured the attention of children, citizens, activists, and politicians.

Several aspects of the monarch's biology have contributed to its iconic status, including its sheer abundance, its annual long-distance migration, and its exclusive association with toxic milkweeds. Although the monarch is native to North America, with semi-independent populations east and west of the Rocky Mountains, self-sustaining populations have been introduced to Australia, New Zealand, and Spain (Zhan et al. 2014). Nonetheless, despite the monarch being a common butterfly, conservation concerns regarding the health of the population east of the Rocky Mountains have been raised because of its nearly unique annual migration, which occurs over thousands of kilometers from southern Canada to central Mexico each fall. Indeed, as far back as the late 1800s, this mass migration was noted with great enthusiasm. For example, in 1885, Dr. John Hamilton wrote about the monarch's fall migration on Brigantine Beach, New Jersey: "The multitude of this butterfly that assembled here the first week in September is almost past belief. Millions is but feebly expressive—miles of them is no exaggeration.... After three o'clock these butterflies, coming from all directions, began to settle on the bushes, and by evening every available twig was occupied. To see such multitudes at rest, all suspended from the lower sides of the limbs, side by side, as is their well-known custom, was something well worth seeing" (Scudder 1893, pp. 48–49). Finally, the intimate association between monarchs and milkweeds has

stimulated the imagination of grade-school children, and the arms race-like coevolutionary interactions between these species have become an important storyline in ecology (e.g., Brower 1969, Dussourd and Eisner 1987). In summary, there is tremendous complexity surrounding the biology of monarchs in space and time: the species's population, its migration, and its evolutionary history as a single entity.

The ability of the monarch to generate public passions, spawn organizations, and capture the attention of world leaders rests on both a biological and a social-historical foundation. Here, we focus on the social construction of the monarch butterfly as an icon, from the midnineteenth century until today, drawing on critical social science to understand and strengthen science-policy-practice interfaces. In referring to *social construction*, we highlight the historical, political, and relational nature of knowledge claims. A more extreme social-constructivist perspective than we are taking would emphasize how the species, its migration, and even the genetic composition of the butterfly are reshaped by anthropogenic drivers such as pesticide use, land-use change, and climate change—but this is not our goal. We argue that the capacity of this charismatic insect to elicit imagery, evoke meaning, and visualize risks derives from social processes. Awareness of the actors, events, and processes that endow the butterfly with these powers allows us to understand something important about the role of science in policymaking, public engagement with science and the environment, and prospects for conservation.

We make use of a diverse range of material—including scientific studies, news articles, historical documents, and current websites—in our analysis. We first present a condensed description of engagement with the monarch during the period of the midnineteenth century to the present, focusing on key actors and notable events. We then reflect on these developments to gain an understanding of the construction and significance of the monarch as an icon. The analysis will be guided by the sociological concepts of *coproduction* and *boundary object*. See figure 1.

### A primer on relevant sociological concepts

The concept of *coproduction* draws our attention to the relational dimensions of knowledge production and the processes through which knowledge comes to be judged as trustworthy or legitimate. In contrast with a simplistic model of knowledge production, communication, and learning, in which one partner is active and knowing and the other is passive and ignorant, coproduction highlights the interplay among diverse sets of actors. We use the concept in two ways: First, we emphasize how differences in statements of facts and values are not essential differences; instead, they derive from social interaction, which creates differences in individuals' understandings of the world and of what constitutes a problem (Gieryn 1983, 1999, Latour 1993, Jasanoff 2004, Lidskog 2014). In other words, viewing the world through the lens of coproduction suggests that there is no single objective and value-free social truth. Second,

coproduction refers to a process of overcoming social and political boundaries in an attempt to create policy-relevant, actionable science (e.g., Palmer et al. 2005, Palmer 2012). In such a multiparty model of learning, the existing knowledge of various actors and their historically derived biases structures possibilities for knowledge production and learning. These practices are, in some sense, shared: All parties internalize the same knowledge as a function of having engaged jointly in information gathering and interpretation. The concept of *coproduction* highlights both the impediments to and the opportunities for achieving a shared understanding.

*Boundary objects* support the coproduction of knowledge. They are concrete or abstract phenomena situated on the borders between distinct social worlds (e.g., organizations, cultures, academic disciplines), and they enable communication and collaboration among actors who share few common reference points (Star and Griesemer 1989). A boundary object is typically characterized by interpretive flexibility, which allows actors to perceive and project varied meanings onto a common reference (Wolf and Klein, 2007). At the same time, a boundary object is sufficiently coherent to initiate and sustain focused dialogue among diverse and sometimes odd bedfellows. Through this dialogue, the various actors reflect on the beliefs and commitments that define their differences, as well as develop shared knowledge, meaning, and intentions. Through a process of diverse actors attaching credibility, significance, and faith to a common reference, a boundary object gains legitimacy and becomes relevant within multiple social contexts at once (Hajer 1995). The boundary object becomes an important focus and symbol with which actors align themselves, and these varied processes of alignment give rise to a network. *Networks* are heterogeneous assemblages of interacting elements that give rise to new and often surprising capabilities (Latour 2005). In the language of systems theory, networks have emergent properties (Allen and Starr 1982).

The concepts of *coproduction* and *boundary object* allow us to think about the monarch as an abstract reference around which a powerful network has formed. This network and the symbol at its center have powers rooted in the capacity to evoke reflexive (i.e., self-critical) thinking and to bring diverse meanings and concerns into dialogue with one another (Beck 1992, Haajer and Wagener 2003). In practice, this power presents opportunities to make effective claims on public resources (e.g., expand investments in conservation and research) and perhaps a capacity to expand public claims on private resources (e.g., introduce new regulations and norms). As such, understanding the construction of the monarch butterfly as an icon serves as a model case of how natural and social processes interact in environmental issues.

### The social construction of a conservation icon

One of the first reports of the monarch butterfly was made by D'Urban in 1857: "He described the butterflies appearing in the Mississippi Valley in 'such vast numbers as to darken



**Figure 1.** (a) A monarch butterfly adult at El Rosario, in the Monarch Butterfly Biosphere Reserve, in Michoacán, Mexico, January 2012. Photograph: Anurag Agrawal. (b) A monarch larva feeding on common milkweed (*Asclepias syriaca*) in a field outside of Ithaca, New York, September 2009. Photograph: Ellen Woods.

the air by the clouds of them” (Brower 1995, p. 306). Shortly thereafter, in 1866, the first study on the monarch migration was published by entomologists Benjamin Dann Walsh and Charles Valentine Riley (Brower 1995). What was known

among scientists from these early reports was that each fall, the monarchs flew south from the midwestern and eastern US–Canadian border and each spring, the monarchs migrated north from the southern United States. Over the last century, knowledge of the monarch has been created and passed forward, collaborations have emerged to preserve the monarch and its migration, and the monarch has been enrolled in arguments regarding land use, biotechnology, biodiversity, and governmental policy. In this section, we will identify the coproduction of knowledge by a range of people, projects, and organizations.

**Knowledge production and education.** Since the first studies in the late nineteenth century, science and scientists have been central actors in the production of knowledge about the monarch butterfly. In the 1940s, Fred and Norah Urquhart initiated their study of the monarch migration in search of where the monarchs went during winter (Urquhart and Urquhart 1976). But their approach immediately complicated the notion of scientists as independent actors by linking them with volunteers working as “research associates.” Therefore, technical understanding of monarchs came with a relationship to an additional category of actor, which is known today as a *citizen scientist*. By involving thousands of noncredentialed volunteers in tagging southward-migrating monarchs in the fall and reporting on subsequent observations of individuals, Urquhart and Urquhart established “the first citizen science project [that was] designed to answer a specific research question (versus inventory and monitoring projects)” (CEC 2009, p. 5). Involving passionate volunteers was a necessity of the specific research objectives of the project, and spin-off collaborations remain operational today. In the 1990s, citizen-science engagement in the monarch butterfly saw an organizational boom. A variety of citizen-science organizations were founded to advance data collection, public engagement with science, environmental education, and conservation efforts targeting butterflies, their habitats, and their migration (see, e.g., Monarch Watch, the Monarch Monitoring Project, and Journey North; table 1).

Since the 1940s, the study of the monarch butterfly and its migration have continued and expanded (see, e.g., Malcolm and Zalucki 1993, Hoth et al. 1999, Oberhauser and Solensky 2004). Five international conferences have been held on monarch butterfly biology and conservation (Oberhauser and Solensky 2004, Monarch Joint Venture 2012). These conferences’ functions have been to (a) share what is known about the monarch butterfly in order to develop a scientific rationale for conservation and protection; (b) identify what is unknown about the monarch in order to set future research priorities; (c) advance conservation planning for the monarchs, as well as for the sustainable livelihoods of local people living among the monarchs, and (d) promote the monarch as a symbol for transnational conservation efforts (Malcolm and Zalucki 1993, Oberhauser and Solensky 2002). Each of these functions happens simultaneously, with shared meanings emerging from the mix of



**Table 1a. Timeline with key events in understanding monarch butterfly populations, regarding science.**

Date	Key event
<b>Late 1800s</b>	Observations and hypotheses about monarch population movements across North America, including Scudder's 1893 book <i>The Life of a Butterfly</i>
<b>1960</b>	Fred Urquhart published <i>The Monarch Butterfly</i> , University of Toronto Press
<b>1975</b>	The overwintering sites were found by science in the highlands of Michoacán, Mexico
<b>1981</b>	The Symposium on the Biology and Conservation of the Monarch Butterfly
<b>1986</b>	The Second International Conference on the Monarch Butterfly
<b>1997</b>	The North American Conference on the Monarch butterfly
<b>2001</b>	The Monarch Population Dynamics Conference
<b>2012</b>	Brower and colleagues (2012a) published statistical analysis demonstrating a decline in the population size of monarchs at the overwintering sites in Mexico
<b>2012</b>	Monarch Biology and Conservation Meeting

**Table 1b. Timeline with key events in understanding monarch butterfly populations, regarding citizen science and monarch butterfly censuses.**

Date	Key event
<b>1952</b>	Fred and Norah Urquhart began recruiting volunteers for monarch observations, which developed into the Insect Migration Association
<b>1975</b>	North America Butterfly Associations start their 4th of July Census
<b>1975</b>	Censuses began in Mexico; the World Wide Federation for Wildlife (WWF) had been involved and responsible for the census since 1994
<b>1990</b>	The Monarch Monitoring Project initiated
<b>1992</b>	Monarch Watch initiated; Texas Monarch Watch initiated
<b>1994</b>	After more than 40 years, the Urquharts' Insect Migration Association ends
<b>1996</b>	Monarch Larva Monitoring Project initiated; Peninsula Point Monitoring Project initiated
<b>1997</b>	Journey North initiated; the Western Monarch Thanksgiving Count initiated
<b>1997–2006</b>	Chincoteague National Wildlife Refuge, a 10-year census project
<b>2001</b>	Monarch Alert initiated; Long Point Bird Observatory started their monarch butterfly census
<b>2005</b>	Monarch Health initiated
<b>2009</b>	Monarch Net initiated

**Table 1c. Timeline with key events in understanding monarch butterfly populations, regarding school.**

Date	Key event
<b>1991</b>	Monarchs in the Classroom initiated
<b>2001</b>	The Monarch Teacher Network of Canada initiated
<b>2008</b>	Monarch Sister Schools Program initiated

activities. The conferences combined research presentations, keynote lectures, and roundtable discussions highlighting the goal of dialogue across social borders. One of the conference reports, for example, noted that “if the conference [the 1997 North American Conference on the Monarch Butterfly] served but one purpose, it was to achieve open and frank discussion among all stakeholders. Communication barriers were brought down and bridges to enhance open discussion and cooperation were built” (USFWS 1999, p. 4).

The participants at these conferences included scientists; representatives from academic institutions; representatives from federal, state, and local government agencies; butterfly enthusiasts; citizen-science and civil-society organizations;

small-scale farmers; and indigenous groups, educators, and others interested in the biology and conservation of butterflies more generally (USFWS 1999, Monarch Joint Venture 2012). To be explicit, the conferences represented specific moments of coproduction, with the monarch as the boundary object that allowed each of these social groups to converse with each other despite different sets of knowledge and interests. In addition, the very active Internet-based electronic mailing list Dplex-L has been a crucial mechanism of communication among diverse monarch enthusiasts for over 15 years. With over 500 subscribers and typically several postings per day, it is a real-time and continuous forum for coproduction.

**Table 1d. Timeline with key events in understanding monarch butterfly populations, regarding policy work and conservation.**

Date	Key event
1977	Monarca AC organized (reorganized in 1985)
1986	The migration phenomenon is “red listed” by the International Union for Conservation of Nature and the WWF; the Butterfly Biosphere Reserve established
1990s	Mexico, United States, and Canada started collaborations to protect the overwintering sites
1996	Monarch Butterfly Sanctuary Foundation (MBSF) established
1997	The Michoacán Reforestation Fund (MRF) established The La Cruz Habitat Protection Project initiated
2005	Monarch Waystation Program established
2006	The Butterfly Biosphere Reserve inscribed in UNESCO's World Network of Biosphere Reserves
2008	The North American Monarch Conservation Plan published; Monarch Joint Venture established; the Butterfly Biosphere Reserve put on UNESCO's World heritage list
2009	MBSF and MRF merge into one organization: the Monarch Butterfly Fund
2013	Make Way for Monarchs established
2014	The North American Leaders Summit in Toluca, Mexico, discussed the monarch butterfly; the White House symbolically planted a pollinator garden; US President Barack Obama issued a memorandum to create a federal strategy to promote the health of honeybees and other pollinators, including monarch butterflies, 20 June 2014; the Center for Biological Diversity, the Center for Food Safety, the Xerces Society, and Dr. Lincoln Brower submitted a petition to list the monarch butterfly as <i>threatened</i> under the US Endangered Species Act, 26 August 2014; the US Fish and Wildlife Service decided to conduct a status review of the monarch butterfly under the Endangered Species Act.

Professional scientists and citizen scientists have been a specific and highly active locus engaged in passing on knowledge of the monarch butterfly to the next generation (see, e.g., Leach 2013). Projects are run in the United States, Canada, and Mexico to promote and facilitate inquiry-based education by offering curriculum materials and professional networking for teachers and schools interested in incorporating the monarch into classroom instruction and enrichment programs (Toronto Region Conservation 2011, Monarch Sister Schools Program 2014, Monarch Lab 2015). In the annual newsletter sent to research associates in the Urquhart studies between 1964 and 1994, there are references beginning in 1967 to school projects focused on tagging and monitoring monarch butterflies (Urquhart 1967). Today, the monarch butterfly is a highly visible element of K–12 curricula in the United States, Canada, and Mexico. The butterfly is used in lessons on biology, ecology, conservation, and geography (e.g., Monarch Lab 2015). The monarch butterfly's strong presence in today's classrooms has made schools one of the most important social contexts for expanding and reinforcing public knowledge of the monarch. By offering schools information and instructional materials—and opportunities to participate in ongoing large-scale science projects—these collaborations among scientists, citizen-science organizers, and educators allow generations of school children and their families to interact with the monarch, simultaneously producing knowledge of multiple kinds: personal learning, scientific data, and conservation planning.

Public awareness of and engagement with the monarch are amplified through the media, including bestselling novels (e.g., Kingsolver 2012), children's books (e.g., Haque and Du

Houx 2003), art exhibitions (e.g., Moving For Monarchs), documentary films (e.g., NOVA), and the use of the butterfly as a logo (e.g., the Non-GMO Project). Originators and collaborations have varied. For example, in 2009, the producers of the US Public Broadcasting Service's NOVA series made an hour-long documentary titled “The Incredible Journey of the Butterflies.” In 2013, the commercial IMAX movie *Flight of the Butterflies* was released, telling the story of the Urquharts' search and discovery of the overwintering sites in Mexico. The World Wide Fund for Nature (WWF) Mexico and Carlos Slim Helu (one of the wealthiest people in the world) collaborated to produce and distribute hundreds of thousands of copies of *Danaids: The Marvelous Monarch Butterfly* in an effort to spread knowledge of and fascination with the monarch butterfly among a wider public in Mexico, the United States, and Canada (Galindo-Leal and Rendon-Salinas 2007). Quite remarkably, over the past 20 years, the *New York Times* has published an article about monarchs frequently, averaging one per month. These diverse and powerful messages and media have embedded the monarch into US culture, and the butterfly now enjoys an iconic status. See figure 2.

**Threats and responses.** Besides facing natural threats such as parasites and drought, the monarch migration has been considered threatened since the overwintering sites were identified by the Urquharts in 1975 (Brower 1995, CEC 2008). The discovery that the monarch butterfly population was concentrated in a very small forested area during the winters raised worries about threats to the entire migration because of unregulated logging (see, e.g., Brower and Malcolm 1991, Malcolm 1993, Brower 1995, Brower and Pyle 2004). This localized deforestation has been regarded as one of the two major threats to the



**Figure 2.** The monarch butterfly has become a teacher of nature, ecology, and conservation. Photograph: Anurag Agrawal.

monarch migration. The other threat derives from agricultural practices in the monarch's summer habitats in the United States and Canada. The arguments as to why agriculture poses a threat to the monarch and its migration have changed over time, but insecticides and herbicides have long been identified as contributing factors (Brower 1995). Genetically modified maize that expresses an insecticidal protein from *Bacillus thuringiensis* (Bt) was the subject of tremendous attention and debate (Christopher Henke, Department of Sociology and Anthropology, Colgate University, personal communication, 19 November 2014), because there was concern over the direct effects of the insecticide on monarchs (e.g., Losey et al. 1999, NRC 2000, Pool and Esnayra 2001, Sears et al. 2001, Shelton and Sears 2001, NRC 2002).

Losey and colleagues (1999) published a paper in *Nature* that, based on a preliminary study, expressed concerns about a nontarget effect of Bt-corn pollen: killing monarch caterpillars. The study resonated among environmental organizations, scientists, and policymakers, resulting in extensive studies on the Bt corn's effect on the monarch (e.g., NRC 2000, Pool and Esnayra 2001, NRC 2002, Leydesdorff and Hellsten 2006). The studies ultimately showed that Bt corn, as it is used in commercial agriculture, is unlikely to harm monarchs. Even so, the discussion contributed to policy legislation on genetically modified crops in both the United States and Europe (Grabner et al. 2001), and the Non-GMO Project adopted the monarch as its symbol, which is used for labeling verified non-GMO foods and products.

Of tremendous current interest is the intensified use of Roundup Ready crops, which have been genetically modified so that they can be sprayed with herbicides such as glyphosate for weed control. Here, the concern is over the effect of glyphosate on milkweed populations in agricultural fields, because milkweeds are the sole host plants for monarchs (Oberhauser et al. 2001, Pleasants and Oberhauser 2013, Flockhart et al. 2014). It has been forcefully argued that if milkweeds are highly reduced in the landscape, monarch populations will also suffer. Despite these concerns, there has been relatively little discussion of the fact that agricultural practices throughout northern North America have dramatically increased the abundance of milkweed and open habitats suitable for monarchs over the past 130 years.

Climate change has also been implicated in the discussion about monarch population viability. Historically, the monarch population has been seen as sensitive to harsh weather. Cold and wet winters and warm and dry summers have more than once been implicated in severe short-term declines in the population (Brower 2004, Zipkin et al. 2012). A future that features increases in extreme weather could threaten the monarch population and handicap its capacity to recover from downturns. The combination of climate change and habitat alterations to the monarchs' winter and summer habitat is therefore presented by some scholars as interacting stressors that could come to pose grave risks to monarchs (Oberhauser and Peterson 2002, Zipkin et al. 2012). These shifting concerns are further examples of how the monarch's iconic status allowed it to serve as a boundary object, becoming a vehicle connecting broader concerns about genetic modification, the ecological effects of herbicides, land-use change, and climate change.

Conservation efforts have been mobilized in response to these threats. Major efforts have been made in Mexico to preserve and replant the forests in which the monarch butterfly overwinters (Joy 1993, Malcolm 1993, Ogarrio 1993). The actors involved in the work have been scientists, citizen-science organizations, governments, environmental activists, and local residents. The Monarch Butterfly Biosphere Reserve was established by a decree signed by the Mexican president in 1986, and the nonprofit conservation organization Monarca, A.C., worked at the same time with local landowners to protect additional areas of the overwintering sites (Malcolm 1993, Ogarrio 1993, Snook 1993). In later years, most of the work has been directed and organized by the WWF. Although efforts to protect, replant, and manage the relevant forests sustainably—as well as to develop a controlled tourism industry in the region—have afforded protection to the monarchs and to local communities, threats from illegal logging persist (see, e.g., Vidal et al. 2013). See figure 3.

In the spring of 2014, requests and demands to replant milkweed to compensate for the changed agricultural landscape were made in numbers and with an intensity never seen before (see, e.g., initiatives proposed by the David Suzuki Foundation, Make Way for Monarchs, and Monarch Watch). These calls to action provide another example of





**Figure 3.** Monarch butterflies in the oyamel fir forests at El Rosario, in the Monarch Butterfly Biosphere Reserve, in Michoacán, Mexico, January 2012. Photograph: Anurag Agrawal.

coproduction, because different groups with different goals act in concert. Examples of the intensification of efforts to preserve and restore milkweed and the monarch's breeding habitat include the newly established organization Make Ways for Monarchs, the focus within the David Suzuki Foundation's project The Homegrown National Park to plant milkweed in home gardens in the spring of 2014, and the WWF Canada's introduction of Monarch Butterfly Week, 5–9 May 2014. Three new scientific studies were part of the interaction between conservation activists and scientific research that coproduced a shared meaning of the eastern monarch population as having a declining trend, mainly caused by a loss of milkweed (Brower et al. 2012, Pleasants and Oberhauser 2013, Flockhart et al. 2014).

Brower and colleagues (2012) examined long-term trends in the monarch butterfly population, on the basis of annual censuses made by the WWF at the overwintering sites in Mexico between 1994 and 2011. The study showed a declining trend in the numbers of monarch butterflies in the overwintering population. Pleasants and Oberhauser (2013) published an additional study in which the possible relations between milkweed abundance and the monarch butterfly population were examined. The study showed a correlation

between the declining numbers of butterflies in Mexico and the declining amount of milkweed in the Midwest of the United States. Despite these correlations, the cause–effect relationship between milkweed declines and monarch abundances is still unresolved. In June, Flockhart and colleagues (2014) published a population model that showed the monarch as most sensitive to habitat changes in their summer habitat, thereby supporting Pleasants and Oberhauser's (2013) suggestion that the decline in monarchs over the last 20 years is a result of the reduction in milkweed.

Two years earlier, Davis (2012) had published a study of the long-term trends in the monarch population on the basis of data from Cape May, New Jersey (1992–2010), and Peninsula Point, Michigan (1996–2010). The study showed that the monarch butterfly population during the summer breeding season was constant over time. The result contradicted Brower and colleagues (2012a). Brower and colleagues (2012b) later criticized Davis's analysis for including material that was “not appropriate for assessing the size of the migratory population” (Brower et al. 2012b, p. 327). They further argued that a correlation in Davis's study would have been unexpected, because “these areas represent peripheral source populations... from regions little affected by the conditions that are negatively impacting the growth of the populations in the main monarch production areas” (Brower et al. 2012b, p. 328).

Nonetheless, stable populations in the summer breeding season suggest that declining milkweed may not be the cause of fluctuations in monarch populations, and Davis's (2012) paper amplifies the importance of studying not only general population trends but also more complex trends within the annual migratory cycle. The degree of decline in monarch population, the extent of historical natural fluctuations in their populations, and the role of particular drivers of monarch populations therefore remain unresolved. In a separate analysis, we explore the ambiguity surrounding knowledge claims about the monarch and, more specifically, how the iconic status of the monarch has come to include, reflect, and contribute to this ambiguity.

In 2014, the many years of mobilization among citizen-science organizations came to resonate in society all the way from international politics to general public audiences. The situation of the monarch butterfly was discussed at the February 2014 summit meeting of Canadian Prime Minister Stephen Harper, US President Barack Obama, and Mexican President Enrique Peña Nieto in Toluca, Mexico. The monarch was explicitly an icon, said to symbolize the partnership between the three countries; simultaneously, the monarch was a biological entity, once again put on NAFTA's and the Commission for Environmental Cooperation's agendas to engage the countries in collaborating on ways to protect the monarch butterflies. Following the summit in Mexico, as an additional response to the demand for attention to the monarch, the White House invited about fifty farmers, beekeepers, nurserymen, scientists, educators, corporate CEOs, and faith-based community leaders to discuss pollinator

decline (among which the monarch butterfly was specifically identified) and food security in North America (Make Way for Monarchs 2014). Both meetings were preceded by open letters that were signed by a mix of actors—including scientists, representatives from citizen-scientist organizations, poets, and environmentalists—and addressed to the North American political leaders.

These examples show how the monarch butterfly has served as a boundary object, engaging, enrolling, and uniting multiple actors in conservation work along the entire migratory route to coproduce a shared sense of biological decline and conservation need.

### Monarch butterfly, a boundary object

By bridging social boundaries, the monarch butterfly has allowed for collaborations that make use of different actors' knowledge of the monarch to coproduce a shared understanding that helps those actors preserve and protect monarch habitats and migration. The bridging character of the boundary object has also allowed for the construction of organizations that—similar to the monarch—are located at the boundaries between social worlds. The monarch with its migration has reached an iconic status, becoming a symbol of nature; environmental health; safe migrations across national borders; spiritual metamorphosis and renewal; and, finally, the souls returning to Michoacán on the Day of the Dead. The monarch has come to unite scientists and citizen scientists, school children and politicians, and organizations and other groups in the common goals of admiring, understanding, and preserving the butterfly and its migration. However, these general and unspecified goals have been understood and operationalized differently when they have been integrated into different social contexts with specific cultures, internal logics, and differing values.

In the world of science, the monarch butterfly is understood through the use of scientific methods to create basic knowledge of the species. For citizen scientists, the monarch's meaning has developed through the admiration of nature's beauty and mystery and the sense of responsibility among humans to preserve the butterfly and its migration. School children have encountered and worked with the monarch as a representative of nature and as a teacher of how nature works. Politicians have defined the monarch as an environmental issue, tied to other environmental and political issues, such as national biosecurity (because of the cross-border effects of actions in different countries).

The flexibility in the interpretation of the monarch has allowed actors to preserve their unique identities and expertise at the same time as they coproduce shared knowledge and gain strength though associating with various partners. By crossing social boundaries, the monarch enables different knowledge forms to grow and to develop in multiple directions.

### Mobilizing the iconic monarch butterfly

The monarch butterfly is implicated in environmental debates that extend beyond its survival of the migration.

Since the narrative about the monarch resonates as credible, accepted, and trusted in many social contexts, its incorporation into new social settings carries along references and allies that are indirectly enrolled as supporters. The process by which the network expands continues, even though new allies may not be fully aligned with the existing narrative at all times. As the narrative expands and gains momentum, there are opportunities for increased power but also for incoherence.

For example, after the Bt-corn controversy in 1999, the monarch butterfly was enrolled as an icon of protecting nature from new technology and industrial agriculture through efforts to prohibit the use of GMOs. When incorporated into the anti-GMO movement, the monarch simultaneously enrolled all actors engaged in monarch preservation (whether or not they supported the anti-GMO movement), because they all supported the common goal of protecting the monarchs. Fifteen years later, the Center for Food Safety, one of the core petitioners seeking to have the monarch formally listed as *threatened* under the Endangered Species Act, is actively seeking to strengthen these connections. Their February 2015 report, *Monarchs in Peril: Herbicide-Resistant Crops and the Decline of the Monarch Butterfly in North America*, points directly to the strategic significance of the monarch and its allies.

The bridge between the monarch and the GMO debate can be understood in parallel with the links being established between monarchs and pollinators. The US Presidential memorandum on pollinators in June 2014 grouped the monarch with honeybees, bumblebees, and other pollinators in a very public manner. This action has introduced the monarch into an international political debate about a group of insects and their relationships to biodiversity loss, food security, and the economic values of ecosystem services. The enrollment of the monarch in this grouping of insects was achieved even though monarchs are rather poor pollinators of milkweed (Fishbein and Venable 1996) and even though the previous perception among monarch researchers has been that “if monarchs became extinct tomorrow, it is likely that the impact on our material well-being would be negligible” (Oberhauser and Solensky 2004, p. vii). The case for identifying the monarch as relevant to pollinator health has been made on the basis of its interaction with milkweed in the landscape of pollinators and nectar flowers, (according to some) a keystone interaction that, if it is preserved, will benefit not just monarch butterflies but also many other pollinators.

The monarch's value as an icon made it a useful boundary object for bringing multiple social groups into the pollinator discussion—and a definition of important pollinators that includes monarchs is an example of coproduced knowledge. The decline of monarchs in this context is no longer primarily a problem that requires conserving the butterfly and its migration in response to intrinsic and ethical values; instead, it has become a problem of food safety, economic tradeoffs, sustainable development, and human survival. With the reconceptualization of the monarch, new arguments and



justifications emerge as to why the monarch should be preserved. What remains to be seen is whether the enrollment of the monarch as a pollinator will succeed; whether this interpretation will be accepted by the monarch's allies; and whether this new identity will be a stable, coproduced understanding of the meaning of monarch butterflies.

## Conclusions

The monarch butterfly's power to mobilize people and to catalyze policy dialogue can be understood as a simple additive function of the various resources, claims, and status of the set of actors that have engaged the butterfly over time. But it is also important to appreciate the synergistic effects among the discrete elements of the network structured around knowing, caring for, and saving the butterfly and its migration. As the network has grown, thickened, and diversified, we observe surprising, emergent properties, such as unexpected alliances among diverse groups. Our goal here has been to support reflexivity among the people and organizations engaged in producing and mobilizing knowledge for conservation and for other social challenges. For every case of social mobilization and coproduction around what many readers will understand to be a noble and progressive cause, such as the conservation of biodiversity, other instances of coproduction and the use of boundary objects can be seen, as in the claims against evolution and anthropogenic climate change. Therefore, understanding the case of the monarch butterfly can help us generalize about the role of coproduction and boundary objects in social and political change.

Symbols and images such as the iconic monarch can gather momentum and attain status in popular imaginations, in commerce, in politics—and in science and conservation—legitimizing the knowledge claims that are channeled through it. These processes are an objective of many marketing efforts and a focus of communications research, but the mechanisms and determinants of what goes viral and which memes are retained over time (and attain iconic status) are not yet well understood. Building partnerships across social boundaries has paid dividends for the monarch and its defenders, and this suggests that commitments to coproduction geared toward what Palmer has called *actionable science* will serve science and conservation well in the future. However, we do not know how to put this magic in a bottle, particularly when it is needed for noncharismatic species and the class of socioecological problems that may demand radical restructuring of the economy–environment relationship (e.g., land use, consumption by the rich). At best, we can report that interpretive flexibility, the capacity for an object to take on and to reflect the values of many different audiences, seems to be a key.

Our collective understanding of the monarch butterfly has been developed (i.e., has been coproduced) in different social contexts, and the identity of the butterfly has been incorporated into a wide range of projects (i.e., it has served as a boundary object linking a wide range of projects). These interactions yield a general storyline of the monarch. The

diffusion and development of this storyline are premised on the credibility, status, and trust enjoyed by the various actors and the network as a whole. At the same time, the power of this storyline and the network itself are the results of the surprising emergent properties that come from the layering and mixing of the knowledge and the commitments of the individual actors.

## Acknowledgments

This work was supported by a grant from the Atkinson Center for a Sustainable Future Academic Venture Fund. We thank the three anonymous reviewers for their comments on the manuscript.

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