

## Harnessing the Power of Citizen-Science

by *Leslie Ries*

What!?! Another article about Monarchs? Yes, there has been a great flurry of activity lately focused on this most amazing species, as noted in a recent article by Priya Shahani on the Monarch Joint Venture. I'll try not to duplicate what has already been described, either by Priya or in another recent article about Ann Swengel examining geographic patterns in the Monarch-Viceroy mimicry complex as seen with NABA's count data (both articles in *American Butterflies* Vol. 18, spring 2010).

Instead, I'll be talking about a recent wave of activity in the scientific community to answer large-scale questions about Monarchs. For instance, are there long-term trends in the abundance of wild Monarchs, and how might these differ among regions? How do environmental conditions experienced by Monarchs during the summer months affect the numbers seen during the fall migration? Answering these questions requires data from an army of observers who can monitor Monarchs at different locations and throughout their annual migration cycle — and is far more effort than any single scientist can accomplish.

It just so happens that every year, tens of thousands of volunteer participants record information on wild Monarchs, which is arguably the best-studied non-pest insect species on the planet. Over a dozen citizen science monitoring programs in North America receive these observations, and data from several programs have already been used to answer a handful of focused questions about monarch migration and biology. Importantly, starting about a year ago, scientists took a major step forward to harness the wealth of citizen-science collected data on Monarchs. Much of the recent activity came through the support of the Council for Environmental Cooperation and later the Monarch Joint Venture; this led to the formation of a group called MonarchNet ([www.MonarchNet.org](http://www.MonarchNet.org)) a network of Monarch monitoring programs.

Before I begin to detail the incredible resources from multiple monitoring networks, I need to (briefly) review the unique biology of the Monarch. The Monarchs in North America are unique among butterflies in completing a vast migratory route, but one that occurs over a series of generations. There are two sub-populations, one east and one west of the Rocky Mountains (with some unknown but probably minimal amount of mixing). Each sub-population overwinters in very specifically located forests, either along the California coast and in a single small region in Mexico. Each spring, individuals migrate from their wintering grounds to seek appropriate milkweed host plants. They expand throughout their range each summer, then that year's final generation migrates all the way back to the same wintering grounds, and the whole cycle begins again.

That Monarchs undertook these mass migrations was obvious for decades, as people observed these showy, beautiful creatures flying en masse in the fall and roosting in great numbers. However, it was only in 1976 that the overwintering grounds of the eastern population were found to be in Mexico. Since that time, the high profile of these fascinating insects has led to an unprecedented effort to monitor all stages of their life-cycle, mostly through the efforts of citizen-scientists.


Almost immediately after finding the overwintering grounds, an effort to monitor population numbers there was begun, and currently continues under the auspices of the World Wildlife Fund (WWF). On the west coast, a parallel program called the Thanksgiving Monarch Counts (TMC) monitors the multiple overwintering sites up and down the coast of California and has been in operation since 1997. This adds to information collected by the California Natural Diversity Database (CNDDDB). As Monarchs begin moving to their breeding grounds in the

spring, citizens are encouraged to report their first sightings of Monarchs (and their milkweed host plants) through a unique online database called Journey North (JN). As individuals lay eggs and caterpillars develop over multiple generations, two unprecedented programs track both the development of eggs and larvae and the critical dynamics of parasitism that can so affect population dynamics. The Monarch Larvae Monitoring Project (MLMP) has volunteers who monitor hundreds of milkweed patches throughout the United States, tracking each egg and caterpillar by instar (an instar is a developmental stage defined by molting — Monarch caterpillars go through five instars before becoming a chrysalis). In addition, some of the volunteers bring eggs to indoor rearing chambers and monitor larvae for the presence of any parasites (usually tachinid flies). Monarchs are also infected by a protozoan parasite called *Ophryocystis elektroscirrha* (OE) that can cripple or kill individuals. Started in 2006, a project called Monarch Health (MH) asks citizens to capture and sample adult Monarchs to determine their parasite load (Monarchs are released after sampling). Last year, over 2400 samples from all over the US were received!

As fall approaches, Monarchs begin moving back towards their winter grounds, and several programs track their progress. Journey North (JN) again collects observations of fall movement and three major roosting sites are monitored weekly each year: Cape May (CM), Longpoint (LP), and Peninsula Point (ON). Finally, individual tags are affixed to adult Monarchs throughout the breeding season, but with a focused effort in the fall to capture the main migrant routes. This program is carried out in the east by Monarch Watch (MW) and in Arizona by the Southwest Monarch Study (SWM). Each winter, overwintering colonies are scoured for tagged individuals. There have been over 11,000 recaptures (from more than one million tags) by Monarch Watch, which has been active since 1992, but only a couple from the much newer Southwest Monarch Study. Each recapture provides information about the Monarchs travels.

Throughout this entire cycle, adult Monarch abundances and distributions are recorded by the several general adult butterfly counts that occur each year. Of course, the most extensive of these programs is NABA's own Butterfly Counts, whose records reach back to 1975. In addition, three states have an extensive network of transects that are counted several times per year by volunteers

(including Illinois, Ohio and Florida). Art Shapiro of the University of California-Davis has established 11 transects across central California and has been monitoring them bi-weekly since 1972. Finally, an ambitious amateur lepidopterist named John Weber has been monitoring the area near his house in Minnesota nearly daily since 1995 and has recorded every butterfly he observes. All of these surveys collect valuable data on the spatial and temporal fluctuations of Monarchs (and other butterflies).

Because this treasure trove of data is nearly untapped in its potential, founding members of MonarchNet were fortunate to receive funding for a series of three workshops at the prestigious National Center for Ecological Analysis and Synthesis in Santa Barbara, CA. These three workshops bring together a combination of Monarch monitoring groups, theoreticians, and statisticians to tackle some of the most challenging questions regarding the biology of migration in general, with Monarch as its focal species. Our first workshop was just held, where we gathered all the available data and defined our most important questions. We developed several research clusters, including those focused on the roles of natural enemies, climate, and habitat on Monarch biology. We are also examining large-scale spatial and temporal patterns for the first time and developing a series of modeling approaches to be able to integrate all the different data sources. Throughout this work, we will determine how human changes to the environment may be impacting Monarchs and how these dynamics shed light on general migration biology. We have two more workshops scheduled (fall 2010 and spring 2011) where we will finalize our analyses and share our results. Expect to hear about the results next spring, when our final workshop is complete! 

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