



Migratory Dragonfly Partnership
Report of Accomplishments
2011 to 2015

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TO THE U.S. FOREST SERVICE INTERNATIONAL PROGRAMS
.....

March 2016



Overview

Dragonfly migration in North America is an understudied phenomenon. Significant questions remain about key overwintering locations, the southern extent of migration, triggers and pathways for migration, and the degree and causes of differences in the intensity and timing of migration. Formed in 2011, the Migratory Dragonfly Partnership (MDP) combines research, citizen science, education, and outreach to provide answers about dragonfly migration in North America. This knowledge is a foundational step in conserving these species and the habitats they rely on. With the help of citizen scientists, the MDP employs the **following four-part strategy**:

- Research to understand connectivity among migratory dragonfly populations
- A tri-national network of citizen science volunteers
- Participant engagement through outreach and education
- Collaboration across North America to promote the conservation of dragonflies and their migration

OUR FOUR-PART STRATEGY

RESEARCH



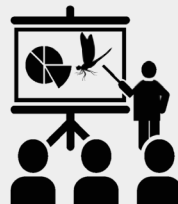
- 1 Determine annual cycle of migration in dragonflies & connectivity among populations

CITIZEN SCIENCE



- 2 Build a network of monitors to track migratory dragonflies

EDUCATION



- 3 Provide trainings & resources to engage participation in MDP initiatives

COLLABORATION



- 4 Develop effective partnerships from Canada to Mexico to foster cross-border conservation

Members of MDP consist of dragonfly experts, nongovernmental programs, academic institutions, and federal agencies from the United States, Mexico, and Canada. MDP has used citizen science and direct research to study North America's migrating dragonflies and education and outreach to promote conservation of their wetland habitats.

Effective study of migration requires long-term, coordinated reporting by large numbers of people across a wide geographic range. Accordingly, MDP's core focus is to track the movements of five migratory dragonfly species in North America by building a network of monitors in Canada, the U.S., and Mexico. Guided by that aim,

MDP's three main initiatives have involved over 1,000 volunteers and generated valuable data since 2011:

- **Dragonfly Pond Watch:** Participants visit the same pond or wetland regularly throughout the year and note the presence, emergence, and behaviors of any of the five focal species.
- **Migration Monitoring:** Participants monitor the timing, duration, and direction of travel of migrating dragonflies, and note any additional behaviors observed in a migratory flight, such as feeding or mating.
- **Stable Isotope Project:** Seasonal information collected from citizen scientists through Pond Watch is combined with the analysis of isotopic fingerprints in dragonfly specimens to ascertain the most probable place of origin of dragonflies for each month of the year. The distance and direction a dragonfly traveled from the pond where it emerged as an adult can also be determined.

Thanks to these citizen science observations and related research by MDP scientists, we have a greater understanding of key migration routes, the intensity of annual movements, and the timing of the repopulation of northern breeding grounds. MDP continues to reveal details of this amazing process, while raising awareness of the plight of freshwater habitats and their importance to humans and wildlife.

A short course participant displays a Common Green Darner. Photo: Alexa Carleton.



Program Accomplishments

Establishing an Active Collaboration

In the span of only a handful of years, MDP has moved from being an exciting concept to a successful, active collaboration. Working with volunteers and professionals from Saskatchewan, Canada, to Tabasco, Mexico, we have increased awareness of issues in dragonfly migration and conservation among thousands of people, including the public and staff of federal, state, and regional natural resource agencies. We have created high-quality publications on dragonfly migration, life history, identification, and habitat needs that are both accessible to the public and useful for natural resource professionals. We leveraged external funding to create new tools to increase participation in MDP projects through development of a smartphone app. Most importantly, we have engaged thousands of enthusiastic volunteers and dozens of natural resource organizations across North America in citizen science projects which have generated tens of thousands of observations of migratory dragonfly species. With an established and growing network of monitors throughout North America, and analysis of the first few years of monitoring data, we are poised to expand our work in the coming years, so that we can fully explain—and protect—this amazing phenomenon.

SUCCESS OF THE DRAGONFLY POND WATCH PROJECT

Reported since 2012: 6,029 observations.

Participants embrace the novelty of long-term observation at local ponds. These observations are providing answers about the origins of migratory dragonflies.

COLLECT DATA



- 1** Visit the same pond site throughout the year, identify dragonflies, and record data

LOG ON



- 2** Create an account and register your Pond Watch site

OBSERVE



- 3** Make regular visits to your pond site and record and submit additional observations

COLLABORATE



- 4** Connect with other volunteers in your area to observe dragonflies



The Variegated Meadowhawk is a common migrant in the western U.S. Photo: Dan Jackson.

What Have We Learned?

Given the wide geographic scope of dragonfly migration, citizen science observations are critical to further our understanding of this remarkable behavior. By reviewing published and unpublished information on dragonfly migration, and working with thousands of volunteer monitors across North America, we are gaining a better understanding of the flight paths of migratory dragonflies and the timing and intensity of their annual movements in different parts of the continent. Early results indicate that the timing and intensity of migration flights varies annually within and between species. We've gained many insights into the timing and location of migration and aspects of species' life histories.

FALL MIGRATION

Timing, intensity, and relative species composition of dragonfly migration varies annually, even among species known to be regular migrants. The earliest and latest reports of migratory flights differ between and within species and years by as much as one month.

- Migration activity/intensity peaks in September, though the peak week varies from year to year, and can continue in southeastern Mexico at low levels through late November.
- Migration begins several weeks earlier in the east than in the west; this appears to be the trend for spring migration as well but the pattern is less clear at this point.
- Common Green Darner is the most frequently reported migrant in the eastern USA and Canada, but Wandering and Spot-winged Gliders comprise a greater proportion of migrants in southeastern Mexico. This may suggest that more Common Green Darners are overwintering in the southern U.S., but additional research is needed.
- Large flights that follow the East or West Coast or the Great Lakes may assemble at staging areas located farther inland or upland.
- Time of year and apparently appropriate weather conditions are not a guarantee of migration activity, even in a locality where migration has been seen within recent days.
- Migrants in the east continue farther south than Veracruz in Mexico, but how much further south and the location of dragonfly overwintering grounds are unknown.

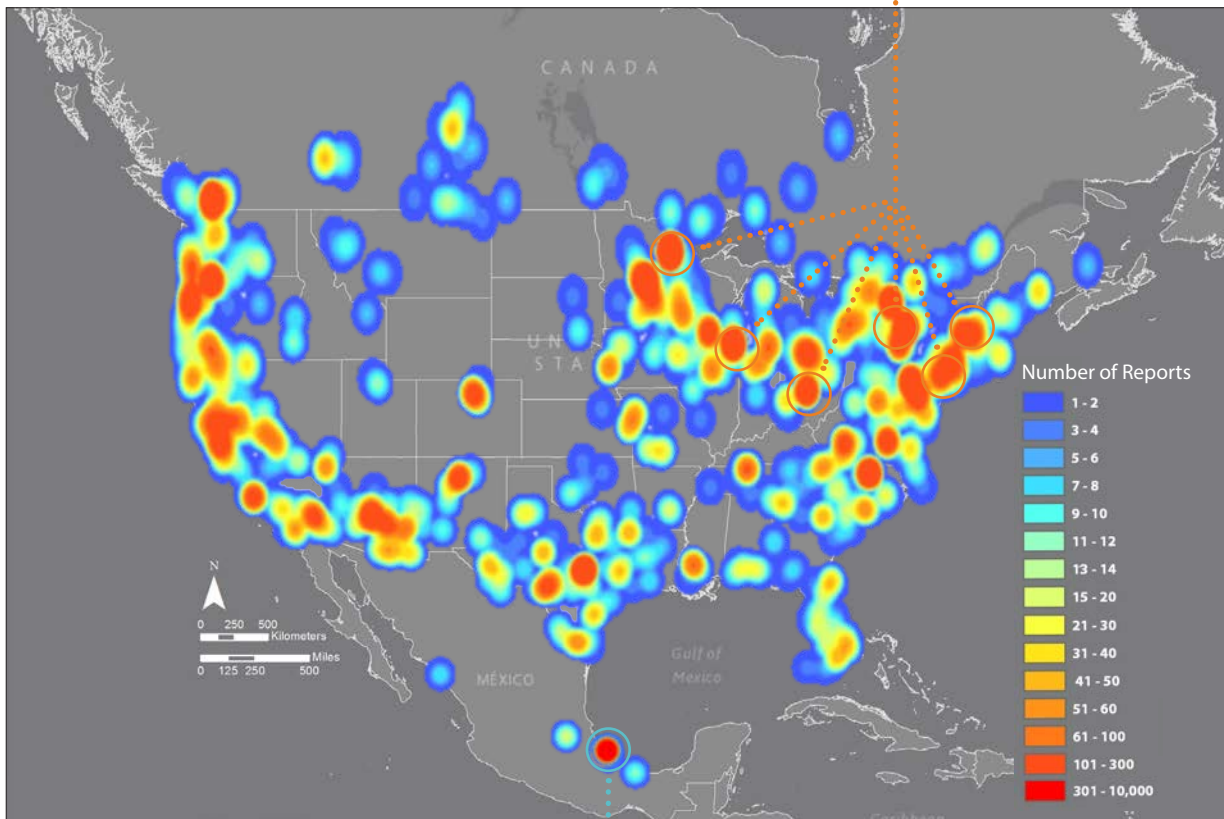
Our Reach Grows: Dragonfly Monitoring Throughout North America

DRAGONFLY POND WATCH & MIGRATION MONITORING

The MDP engaged more than 1,000 volunteers who contributed over 10,000 observations to Migration Monitoring and Pond Watch initiatives from more than 1,400 localities in Canada, Mexico, and the U.S.

HAWK WATCH PARTNERS IN CANADA AND THE U.S.

Thanks to our collaboration with the Hawk Migration Association of North America, additional migration monitoring observations from Hawk Watch sites throughout northeastern North America are revealing annual migration routes.



PARTNERS IN MEXICO

Capacity building with Pronatura Veracruz enabled staff to monitor dragonfly migration for three years at the Rio de Rapaces. Extending training offerings to dragonfly enthusiasts in Mexico expanded our ability to engage Spanish-speaking audiences and facilitate increased participation in projects.

SPRING MIGRATION

- Northward movement appears to be governed by spring temperatures; as temperatures warm, migrants are seen soon after, especially in the east. Although a cold snap will halt their activity, movement north resumes almost immediately upon warming.
- The spring migration doesn't happen in large flights but is more diffuse in space and time than fall migration, but may occur at times in large directed flights, as we have seen for Common Green Darner and Variegated Meadowhawk.
- MDP analyzed citizen science data of first flight dates for Common Green Darner for 13 states in the USA (Connecticut, Georgia, Indiana, Maine, Maryland, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Vermont, and West Virginia), and determined latitude, longitude, and degree days for each month associated with each record. Findings from this work include:
 - First flight dates were strongly positively correlated with latitude and negatively correlated with degree-days confirming the strong influence of warming temperatures on the northward movement of migratory dragonflies.
 - Common Green Darners travel an average of 27.5 km per day (17.1 miles per day) during northbound migration, and advance their first flight date by four days for every additional degree-day.

USING STABLE ISOTOPE TECHNOLOGY TO UNDERSTAND THE MOVEMENT AND LIFE HISTORY OF MIGRATORY SPECIES

Unlike other insect migrants such as the monarch butterfly, migratory dragonflies do not overwinter in dense groups. Their extreme mobility and difficulty of capture means that traditional mark-recapture studies are not possible. To address the challenge of following dragonflies on their journey in order to understand the ecology and behavior of migration, MDP researchers have used a stable isotope approach to infer the movements and natal origins of individual Common Green Darners. Isotopes are present in the water where a dragonfly develops and remain locked in the adult wings and cast-off skin (exuviae) of the final-stage nymph forever afterward. By measuring the ratios of stable hydrogen isotopes in the wings and the exuviae, we now have a clearer picture of the geographic scale of dragonfly migration. Examining stable hydrogen isotope ratios in exuviae allowed us to calibrate a latitudinal “isoscapes” map and to infer the natal origin of a dragonfly and the direction and distance of its movement as an adult.

Analysis of stable hydrogen isotope ratios in 852 adult Common Green Darner wings and 75 exuviae and teneral (newly emerged) specimens collected in the eastern USA, Mexico, and the Caribbean with citizen science data of annual first flight dates from 13 U.S. states revealed the following:

- The strong positive relationship between isotope ratios in exuviae and wings of teneral Common Green Darner adults and the known annual isotope ratios in water across eastern North America demonstrate that this is a valid method that can be used to determine emergence locality. In addition, specimen age does not affect isotope signature, allowing us to expand our dataset with material from museum specimens that date back to 1874.



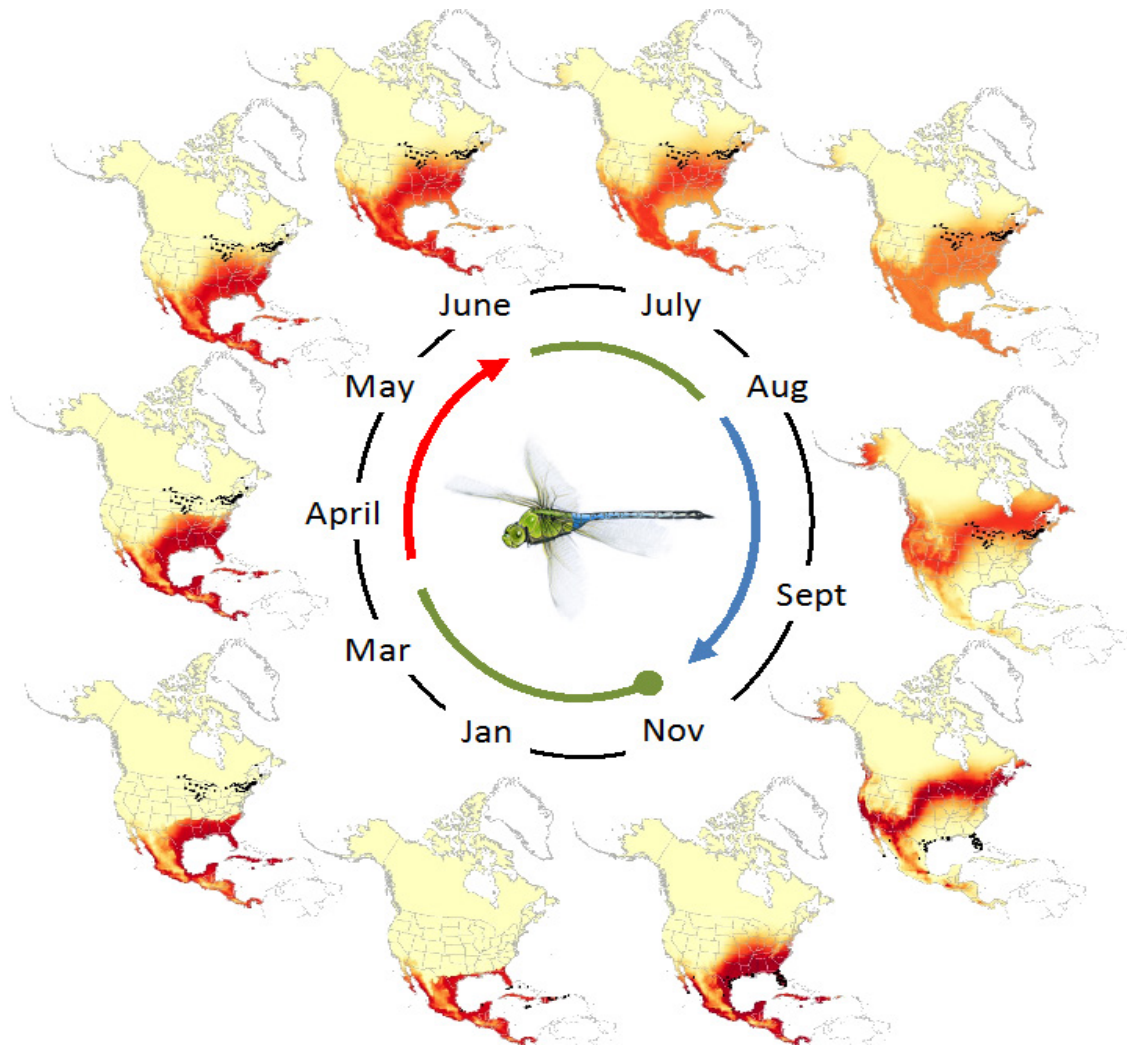
A young participant holds a dragonfly exuvia (cast-off skin of the aquatic nymph), as she learns about the dragonfly life cycle during an environmental education event in Chichicaxtle, Mexico. Photo: Elisa Peresbarbosa-Rojas.

- Common Green Darners emerge locally in the southern USA (Florida, Georgia, and Alabama) for most of the year. Migrant dragonflies that originated in northern wetlands appear in southbound flights in August and September in many areas of North America, and both residents and migrants are present in the southern USA in winter. Isotope patterns further indicate that most migrants do not survive the winter to return north. However, it appears that a small number may overwinter and return north the following spring. A few of the Common Green Darners collected in Wisconsin, New York, and Vermont in April and May originated in the north; because it is still too early and cold at this time of year for resident nymphs in northern wetlands to have broken their winter diapause (dormancy) and completed development to adults, this raises the possibility that at least some could survive winter in the south and make a round-trip migration.
- Adult Common Green Darners collected in the far northern reaches of their range in early spring originated in the far south (southern U.S., Mexico, and the Caribbean), meaning that they were migrant adults traveling north to breed. Those collected in late summer in the same sites originated in the far north; this population represents the residents emerging locally.
- Collecting exuviae allows timing of adult emergence to be assessed. The appearance of exuviae at wetlands in the eastern USA echoes the pattern of adult movement. Exuviae appear successively from south to north in spring and then are found in widely scattered locations in mid-summer. More exuviae appear in the north in late summer, and by late October exuviae records are present only in the southernmost states. This reflects the completion of development of overwintering resident nymphs beginning in the south in spring and continuing north as temperatures rise, and development and emergence of both residents and migrants in the summer. Nymphs hatched from eggs laid by northbound spring migrants develop rapidly and emerge in late summer as adults that will then migrate south. Both residents and migrants reproduce in winter in Florida, and at least some of the migrants' offspring return north in the spring.
- First flight dates collected from citizen science data show that the northern limit for the origin of migratory Common Green Darner in North America is 47° N, a line of latitude that runs through several U.S. states and Canadian provinces: Washington, Idaho, Montana, North Dakota, Minnesota, Michigan, Ontario, Quebec, Maine, and New Brunswick.



- This study supports the hypothesis that the Common Green Darner undergoes a multi-generational migration during their annual cycle. A spring generation migrates north, breeds, and then dies; the offspring of this generation then make the return trip south and the cycle repeats. Each generation likely travels around 3,000 km, a similar distance covered by monarch butterflies each autumn in eastern North America.

MDP's stable isotope initiative revealed the annual cycle of migration in the Common Green Darner. Photo by Ken Slade; Flickr [Creative Commons License 2.0](#).



Annual cycle of migration in the Common Green Darner dragonfly inferred from analysis of stable-hydrogen isotopes. Darker colors within the maps indicate the most probable origin of dragonflies at wing sampling sites represented by black dots. In January, migratory Common Green Darners occupy sites as far south as the Caribbean and appear to breed locally in these southern sites. Dragonflies arriving at northernmost breeding ponds in March appear to originate from the extreme southern part of the range, but originate further north as the breeding season progresses from April–July. By September, dragonflies at northernmost ponds are all locally produced, suggesting that migrants from southern origins have died and only their offspring remain. Similarly, dragonflies sampled at southern ponds all originate at northern range limits, supporting the idea that migrant offspring are the only ones to make the southbound trip. By November, most offspring that made the southbound migration have died. The cycle repeats itself in March when the offspring of the southbound generation emerges to once again migrate north. Graphic developed from research courtesy of MDP partners with the University of Maryland (Colin Studds), the Smithsonian Conservation Biology Institute (Peter Marra), and the Vermont Center for Ecostudies (Kent McFarland).

Who Have We Reached?

We have reached tens of thousands of people through our citizen science network, outreach and education events, publications and resources, our website, and social and traditional media, such as newspaper articles and radio interviews. When we speak to the public and to media, we discuss the importance of dragonflies to terrestrial and aquatic ecosystems, note their ability to help control pest insects, and make the case that their habitat is vital not only for their survival but for the conservation of myriad other species, including migratory birds and waterfowl.

CITIZEN SCIENTISTS JOIN IN

- Participation in MDP citizen science programs has increased steadily since their inception in 2012. By the end of 2015, more than 1,000 volunteers contributing to Migration Monitoring and Pond Watch projects reported over 10,000 observations from more than 1,400 localities in Canada, Mexico, and the U.S.—an increase of 44% in registered citizen scientists and 43% in website reporting since 2014.
- In 2014, Scistarter.org named Pond Watch as one of the 10 top “Citizen Science in the Classroom” projects (of 800 projects registered on their site).
- Volunteer retention and engagement continue with monthly e-newsletters, Citizen Science annual reports, and year-end surveys.

Comments from Short Course and Year-end Survey Participants

“The dragonflies are lucky to have such good friends.”

– MDP Year-end Survey 2015

“A wonderful presentation. I feel that not only would I enjoy participating, but feel I may now be competent to do so!”

– Participant, Minnesota Short Course

“Thank you so much for sharing your knowledge and enthusiasm. Great short course, great presenter!”

– Participant, Illinois Short Course

“I like the array of projects you’ve pioneered and I refer students and teachers to them all the time.”

– MDP Year-end Survey 2015

“I have used your website as an educational source. I have changed my gardening habits. I observe more and try to garden in a manner that encourages habitats for dragonflies etc. I feel if I support the tiniest creatures they will in turn support larger wildlife. You reach and affect more than you realize.”

– MDP Year-end Survey 2015

TOP 10 PROJECT

POND WATCH



TOP 10 CLASSROOM PROJECT

IN 2014, SCISTARTER.ORG
NAMED POND WATCH
AS ONE OF THE 10 TOP
"CITIZEN SCIENCE IN THE
CLASSROOM" PROJECTS

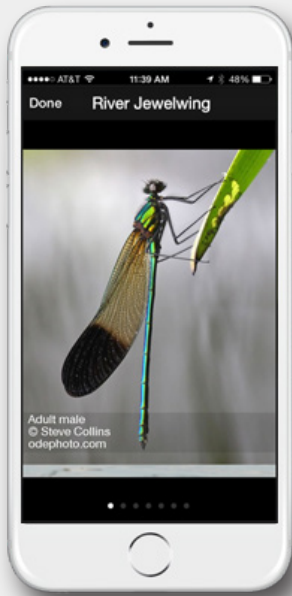
ONLINE, ON PAPER, AND ON YOUR PHONE: MDP EDUCATIONAL MATERIALS MAKE ID EASY

- MDP's dynamic website serves as a centralized dragonfly migration reporting site where citizen scientists can input data on dragonfly movements (<http://www.migratorydragonflypartnership.org/>).
- We also developed a field guide for citizens for use in identifying migratory dragonfly species and a protocol booklet detailing all MDP citizen science projects, so that data collection is consistent and in a format that can be analyzed to better understand this phenomenon.
- An additional resource publication was developed to help landowners create their own backyard ponds to attract dragonflies with the added benefit of serving as a local Pond Watch site.
- MDP citizen scientists and other interested dragonfly enthusiasts are now able to identify and find dragonflies in their area with the release of the new Dragonfly ID app. Dragonfly ID is increasing volunteer interest in MDP programs and is elevating MDP's reach to new audiences in the naturalist community. Funding to support app development was obtained from two private individuals, the Dragonfly Society of the Americas, and the Xerces Society. Since its launch in September 2015, the Dragonfly ID app has been well-received by users:
 - Over 2,200 people have downloaded the app. Usage statistics indicate the majority of app users are from the U.S. (90%); Canada and the United Kingdom represent 7% of users.
 - The MDP website experienced a large spike in page visits following the e-newsletter announcement for the Dragonfly ID app.

THOUSANDS OF PEOPLE ENGAGED

- From 2012 through 2015, we reached at least 3,500 people directly through over 55 workshops and presentations given across Canada, the United States, and Mexico. These events were attended by the public, school children, members of environmental education programs (Master Naturalist, Master Gardener), and staff of federal, state, and regional natural resource agencies.
- We reached thousands more through online and hard-copy distribution of MDP Dragonfly Habitat Guidelines and Pond Watch postcards, and by registering MDP volunteer projects on CitSci.org and Scistarter.org.

MOBILE APP



29,000
SCREEN VIEWS



*“Powerful and unique tool for Odes”
[5 stars out of 5]: “I’m a birder who
has recently been bitten by the ‘bug’.
This app is fantastic for someone like
me.”*

– Dragonfly ID App user

↓ 2,224
DOWNLOADS

90% U.S.
7% CANADA

*“First app of its kind a great success”
[5 stars out of 5]: “Information on
identification with fantastic pictures
provides easy learning for beginners
and advanced dragonfly enthusiasts. I
would highly recommend this [app].”*

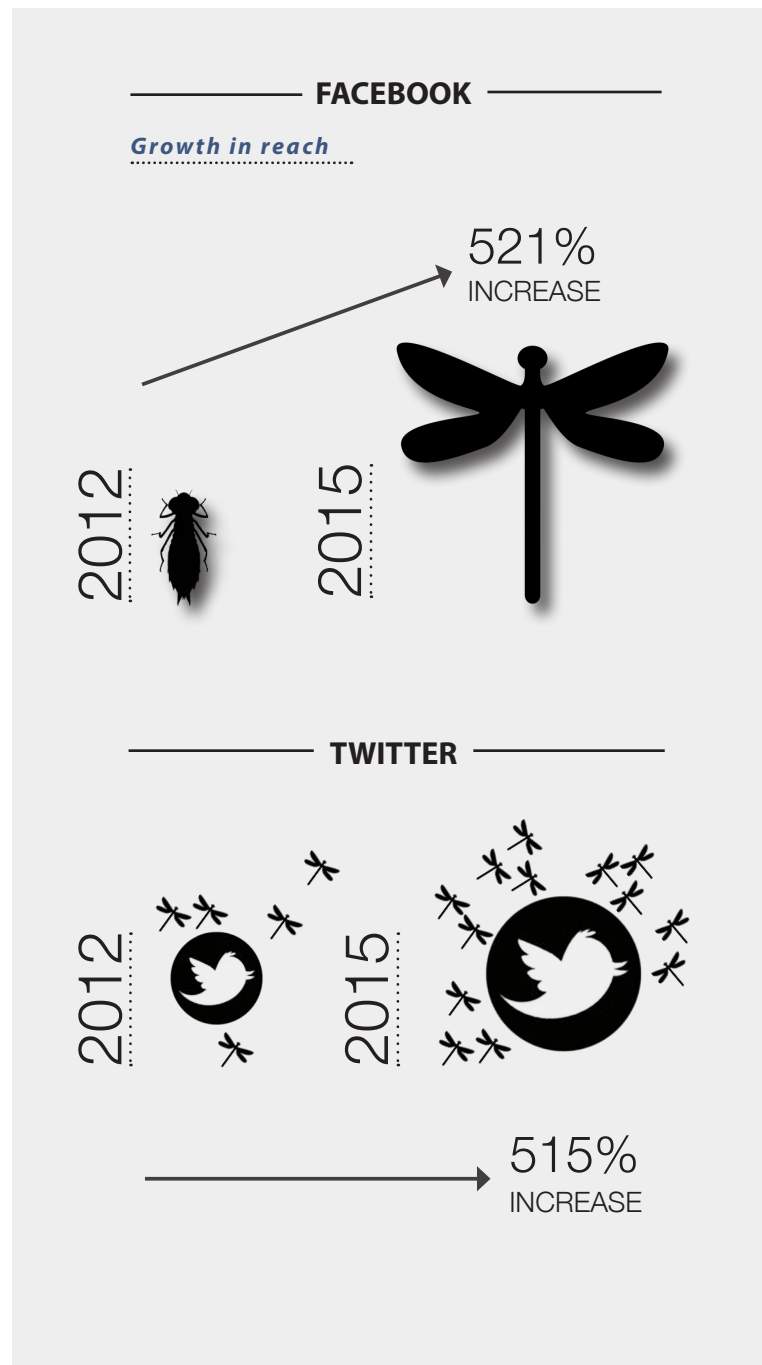
– Dragonfly ID App user

- The mailing list for MDP’s monthly e-newsletter has over 4,250 recipients (a 54% increase in sign-ups since 2014), many of whom share each newsletter with their own Facebook feeds.
- The MDP Facebook page is nearing 1,400 “likes”, a 40% growth increase since 2014. The current demographic of our Facebook fans breaks down as 55% female and 43% male representing 45 countries, the top 10 being the USA, Canada, Mexico, Spain, Italy, the Netherlands, and a tie among India, Brazil, Indonesia, the United Kingdom, and Colombia.
- MDP’s Twitter account (@Dragonfly_MDP) has 123 followers; a 51% increase since 2014.
- Scientific audiences:
 - We reached more than 550 people via presentations at conferences such as Dragonfly Society of the Americas, Society for Freshwater Science, the Entomological Society of America, at universities, and meetings of the Canada/Mexico/U.S. Trilateral Committee for Wildlife and Ecosystem Conservation and Management, and Hawk Migration Association of America.
 - To frame the work of MDP as the partnership was launched, MDP steering committee member Dr. Mike May wrote a comprehensive review of the current state of our knowledge about dragonfly migration in North America: “A critical overview of progress in studies of migration of dragonflies (Odonata: Anisoptera), with emphasis on North America”. This review was published in the *Journal of Insect Conservation*, a peer-reviewed journal in the field of conservation science with international scope and audience (February 2013, Vol. 17, issue 1, pp. 1–15), and has reached larger audiences because Dr. May exercised the option to publish the paper as Open Access.

- Spanish speakers:
 - All of our citizen science resources are currently available in both English and Spanish. Since 2012, we have delivered five workshops in Mexico (in Tabasco, Veracruz, Quintana Roo, and the Yucatán).
 - In order to make it easier for citizen scientists in Mexico to report their findings to MDP, all data entry fields for Pond Watch and Migration Monitoring on the MDP website are now available in Spanish.

MEDIA COVERAGE: TELLING THE MDP STORY

- Citizen science bloggers and science writers elevated MDP’s reach with posts and stories that reached hundreds of thousands of readers and followers by highlighting MDP projects in 2015:
 - *Discover Magazine* featured a blog on the top five animal migration studies that need the help of citizen scientists and through a twitter post (700,000+ followers).
 - The Public Library of Science (PLOS) featured a Citizen Sci blog to highlight citizen science projects: “Dragonfly Watch – Find Those Fast and Furious Insects”.
 - SciStarter featured MDP’s Migration Monitoring citizen science project during their migration themed promotional campaign (reaching more than 15,000 people through their homepage, newsletter, and blog and on partner sites, including the National Science Teachers Association and PLOS).
 - *Scientific American* put out a call in their citizen science blog to “Join a growing citizen science community working together to increase knowledge about North America’s five main migratory dragonfly species”.
- An interview with MDP committee member Dennis Paulson on the public radio show “A Way to Garden” discussed the importance of dragonflies, migration, and MDP: <http://bit.ly/1TkZgTO>.
- A video produced by the Austin Texas Advanced Computing Center at the University of Texas explores MDP’s citizen science program and the evolution of the website as a data collection portal with interviews from MDP Vice Chair John Abbott. Watch it on YouTube, at: <https://www.youtube.com/watch?v=fq0MQihiasU>.
- The Hawk Migration Association of North America publishes an annual article written by MDP on the season’s migration data and the role of Hawk Watch observatories in its newsletter.

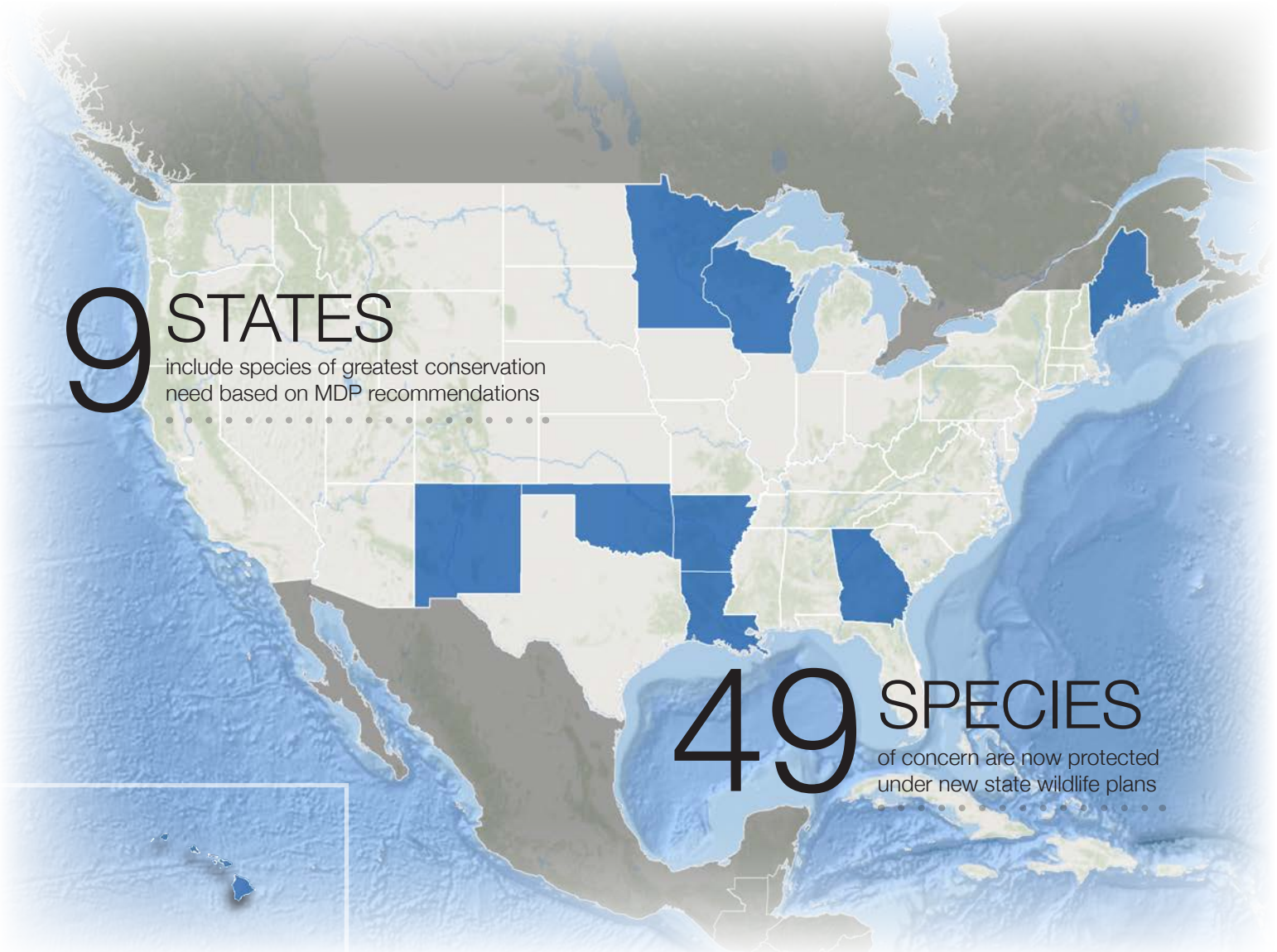


PROMOTING DRAGONFLY CONSERVATION BY U.S. STATE AGENCIES

Dragonflies are valuable indicators of water quality, are a key component of aquatic and terrestrial food chains, and comprise an important part of our natural biological diversity. Multiple North American dragonfly species are at risk, and because even common species may become rarer as their habitats are lost, MDP provided recommendations to state fish and wildlife agencies in the U.S. to accurately represent odonates in their State Wildlife Action Plans.

- Twenty-four states were contacted in 2015 and as a result of MDP recommendations 49 additional odonate species are now included for protection in nine state wildlife plans. States including recommended at-risk odonates: Arkansas, Georgia, Hawaii, Louisiana, Maine, Minnesota, New Mexico, Oklahoma, and Wisconsin.

Map of states which include MDP's recommended species of greatest conservation need.





The new Pond Watch pond at Pronatura's observatory in Chichicaxtle is one of three registered Pond Watch sites in Mexico, and serves as an educational and outreach tool to teach participants about the ecology and life history of dragonflies. Photo: Elisa Peresbarbosa-Rojas.

NEW PARTNERSHIPS STRENGTHEN MDP

We have engaged a variety of partners to help implement our successful programs. These include organizations and individuals from Mexico, USA, and Canada.

- Three years of capacity-building through MDP empowered Pronatura Veracruz staff to conduct dragonfly migration monitoring full-time during their Rio de Rapaces (the annual fall raptor migration, which they have monitored for many years and during which they have regularly seen dragonfly migrations), provide training courses to different audiences, and incorporate dragonflies into local environmental education activities.
 - Pronatura developed and taught MDP trainings and workshops in Tabasco, Veracruz, Quintana Roo, and the Yucatán.
 - In 2015, Pronatura staff installed a new pond next to their raptor observatory in Chichicaxtle to serve as a long-term Pond Watch monitoring site and a venue for workshops providing outreach and education to local children and adults.
- The Hawk Migration Association of North America board voted in 2013 to incorporate dragonfly monitoring formally into their Hawk Watch database. In 2015, after three years of dragonfly data collection, 20 observatories and 58 observers have contributed 2,600 observations to MDP.
- At the invitation of Dr. Leslie Ries (National Socio-Environmental Synthesis Center; SESYNC), MDP has joined the working group of her multi-year NSF-funded project addressing challenges and methods for analyzing data collected from a variety of invertebrate-focused citizen science projects.

- State-level Master Naturalist organizations have embraced the education and volunteer opportunities offered through MDP workshops and citizen science projects, and members of many programs, especially in Texas and Minnesota, have become active volunteers and agents of further outreach.
- The Dragonfly Society of the Americas provided partial financial support for development and maintenance of the new mobile app.
- The Minnesota Dragonfly Society, a newly formed nonprofit organization created by individuals who participated in the statewide dragonfly census several years ago, is an active proponent of MDP. They have incorporated information about migration and MDP projects in the many educational events they conduct around the state, and are investigating additional regionally focused projects as opportunities for partnerships with MDP.
- Inspired by educational and citizen science opportunities provided by MDP projects, Dr. Karen Oberhauser's lab at the University of Minnesota has developed a new dragonfly curriculum that can be used by elementary school and middle school students to learn about dragonflies and guide students in studying their migration.

Lessons Learned and Key Next Steps

We have used adaptive management in data collection and analysis and in our volunteer management practices. We strive constantly to retain and work productively with current volunteers and partners while gaining new partners and project participants. With a large enough number of records from a sufficiently broad geographic scope, we are also learning more about how best to visualize and analyze the data, and dealing with the challenges inherent in the range of resolution and information content in volunteer-generated observations. Specific lessons learned and subsequent next steps include:

MIGRATION

- Data gaps exist for the local phenology (life history) of migratory species as well as physiological attributes of migratory dragonflies. Next steps:
 - Incorporate a study on the local phenology of migrants by creating a field guide to exuviae and incorporating monitoring of exuviae, with an initial focus on Common Green Darner, into Pond Watch, informed by current research by MDP steering committee member Dr. Mike May.
 - Revise and refine material on the stable isotope study as a manuscript to be submitted to a peer-reviewed journal in 2016.
- Relationships between and presence of overwintering resident versus migrants in southern locations of the USA are not clear. Next steps:
 - Develop and implement targeted studies in southern California, Arizona, Texas, and Florida, making observations throughout the year at a limited number of selected sites.
- The level of information in migration reports varies greatly, including whether individual species and/or their abundances are reported, and there is some overlap between Migration and Pond Watch reports, especially in the spring. Next steps:
 - Work with a biostatistician to formulate data analysis methods and identify and address any gaps or issues in current data collection methods.



Common Green Darners lay eggs in Pronatura's new Pond Watch pond just a few months after installation. Photo: Pilar Gonzales.

CONSERVATION

- There is currently no evidence to suggest that the main migratory dragonfly species are rare or endangered, but population abundance data, and therefore population trends, are lacking. The reliance of these species on wetlands and other freshwater habitats place their long-term survival at risk. Many other non-migratory dragonfly species that use the same habitat may be at risk. Next steps:
 - Work with NatureServe to update their conservation status assessments for all odonates.

CITIZEN SCIENCE

- Two-way communication and interactive citizen science tools are key in recruiting and maintaining volunteers. To foster this, we issue an annual survey to participants to gain insights into volunteer attitudes and needs, and we added a member list and shared localities option to the MDP website to make it easier for members to interact with each other. Next steps:
 - We are exploring ways to make the website more interactive and encourage more cross-member conversations among Facebook fans and website users. We will continue to share data and findings with the public and scientific audiences, including practitioners of citizen science, via newsletters and journal publications.



The next generation of dragonfly monitors learn how to identify the common migratory species at Pronatura's observatory in Chichicaxtle, Mexico. Photo: Elisa Peresbarbosa-Rojas.

- Support maintenance of the Dragonfly ID app and seek external funding for the development of a data submission app that will allow field reporting of citizen science observations.
- Materials and workshops in Spanish have been well received, and having resources available in Spanish has made it easier for additional volunteers and partners to participate. Next steps:
 - Additional Spanish-language resources are needed. A field guide to the dragonflies of Mexico does not currently exist. With the creation of their new pond, Pronatura staff has become more familiar with their local dragonfly fauna and are developing a guide for dragonflies in their area. Work continues to make the entire MDP website available in Spanish.
- Our network of monitors has grown steadily, but gaps in data reporting still exist in northern Canada, much of Mexico, and parts of southeastern and west-central USA. Next steps:
 - Continue to expand network of monitors across North America, with an emphasis on expanding our partners and monitoring networks in Mexico; continue to engage the public, schools, Master Naturalist programs, federal and state agency staff, and others about the importance of dragonflies, their habitat, and how individuals can engage in citizen science.

Continuing the Migratory Dragonfly Partnership

MDP has been successful in advancing understanding of dragonfly migration and in engaging a constituency of citizen scientists. These people are actively collecting useful data and learning about the landscapes that dragonflies inhabit. As individuals revisit wetlands and ponds annually, they may become advocates for these habitats and the wildlife that rely upon them. In just a few years, MDP has created an effective network of partners and volunteers, supported by our high-quality resources in education, outreach, and identification. We have engaged thousands of enthusiastic participants across North America whose efforts have already given us insights into dragonfly migration and life history. The educational materials that accompany participation in MDP projects have raised awareness not only about migration but also about the threats and conservation needs of this group of remarkable insects. We have established systems that will help us engage larger numbers of people in these efforts at an overall lower cost. With a state-of-the-art citizen science website, training materials in two languages, and externally funded mobile apps that will allow easier access to our identification materials and facilitate reporting, we have set the stage for the next phase of this project. As our work expands in the coming years, we will be able to fully explain the process of dragonfly migration in North America, and implement more cross-border conservation actions to protect dragonflies and conserve and restore the habitat they need to survive.



The aptly-named Wandering Glider, an accomplished flier and global migration champion, crosses continents and oceans seeking freshwater to mate and lay eggs. Photo: Ken Slade; Flickr [Creative Commons License 2.0](#).



**MIGRATORY
DRAGONFLY
PARTNERSHIP**

628 NE Broadway, Suite 200
Portland, Oregon 97232 USA
Telephone: 855.232.6639 | dragonfly@xerces.org
www.migratorydragonflypartnership.org



Additional image credits

Front: Cover photo: Common Green Darner's lay eggs in a wetland (Mike Rollinger, Flickr [Creative Commons License 2.0](#)).

Inside: (Page 1) Magnifying glass (Gabriel Ardiles, The Noun Project); dragonfly (Edward Boatman; The Noun Project); binoculars (Stephen West; The Noun Project); clipboard (Seth Taylor; The Noun Project); classroom (Krisada; The Noun Project); perched dragonfly (Icon made by Freepik; www.flaticon.com); map (ESRI); pinpoint (Dilon Choudhury; The Noun Project). (Page 3) clipboard Seth Taylor; The Noun Project); mouse (Camila Bertoco; The Noun Project); grass (bryn mackenzie; The Noun Project); perched dragonfly (Icon made by Freepik; www.flaticon.com); binoculars (Stephen West; The Noun Project). (Page 10) grass (bryn mackenzie; The Noun Project); perched dragonfly (Freepik; www.flaticon.com). (Page 11) Dragonfly ID App screen shot (BirdsEye Nature Apps, LLC); phone (Eugene Dobrik; The Noun Project). (Page 12) Common Green Darner nymph (John Abbott); dragonfly (Edward Boatman; The Noun Project).

Back: Wandering Glider (Chrissy McClaren; Flickr [Creative Commons License 2.0](#)).

