

MIGRATORY DRAGONFLY PARTNERSHIP

ANNUAL REPORT 2013



Submitted to the USFS International Programs
from the Xerces Society for Invertebrate Conservation
March 2014



*Working to Understand and Conserve
North American Dragonfly Migration*

The Migratory Dragonfly Partnership uses research, citizen science, education, and outreach to understand North American dragonfly migration and promote conservation of dragonflies and their wetland habitats.

MDP steering committee members represent a range of organizations, including:

Ontario Ministry of Natural Resources; Peggy Notebaert Nature Museum; Pronatura Veracruz; Rutgers University; Slater Museum of Natural History, University of Puget Sound; Smithsonian Conservation Biology Institute; Wild Basin Creative Research Center, St. Edward's University; U.S. Forest Service International Programs; U.S. Geological Survey; Vermont Center for Ecostudies; and the Xerces Society for Invertebrate Conservation.

The Migratory Dragonfly Partnership

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Front and Back Cover Photographs

Common Green Darner (*Anax junius*) female lays eggs.

Photograph © Walter Chadwick.

SUMMARY

The Migratory Dragonfly Partnership (MDP) is a collaboration formed in 2011 among scientists, non-governmental organizations, academic institutions, and federal agencies across North America to better understand the greatly under-studied phenomenon of dragonfly migration. Effective study of migration requires long-term, coordinated reporting by large numbers of people across a wide geographic range. MDP is using research, citizen science, and education and outreach to engage nature centers, parks, wildlife refuges, bird watchers, and the general public in education and field activities to monitor the five main migratory dragonfly species in North America during their fall and spring flights, and at local ponds throughout the year. Our educational events and materials also highlight the importance of conserving both wetland habitats and vulnerable dragonfly species.

The MDP has already built an international network of about 600 volunteers, who monitor and report on dragonfly migration flights as well as the seasonal life history of the five main migratory dragonfly species in North America (Common Green Darner, *Anax junius*; Wandering Glider, *Pantala flavescens*; Spot-winged Glider, *P. hymenaea*; Variegated Meadowhawk, *Sympetrum corruptum*; and Black Saddlebags, *Tramea lacerata*). We are also increasing our efforts to engage new partners with similar interests, such as the Hawk Migration Association of North America, with whom MDP collaborated for the first time in 2013; and additional environmental and academic organizations in Mexico and Canada, including Pronatura Yucatán and Espacios Naturales y Desarrollo Sostenible (ENDESU). MDP projects, outreach, and data-gathering activities were greatly strengthened and expanded in 2013, and we are already gaining new insights into migration from the data that have been collected so far. Project details and accomplishments are detailed below.



The Common Green Darner (*Anax junius*). The most reported migrant flying past North American HawkWatch Observatories in 2013. (Photo © Dan Jackson.)

PROJECT ACCOMPLISHMENTS

Website

There are over 570 users registered on the MDP web site, and we are seeing peaks of new registrants each spring and fall. This suggests that our outreach materials are reaching a wide audience, and that people are motivated to increase their activity during spring and fall migration.

Updates, Revisions, and Additions

A variety of modifications, additions, and improvements were made to the web site in 2013, based on feedback from volunteer users and steering committee members. New features implemented in 2013 include:

- ⇒ Creating separate data entry portals for Pond Watch and Migration Monitoring
- ⇒ Creating a Shared Localities function; this allows a single site to be “adopted” for monitoring and reporting by multiple users. This function was specifically requested by nature centers, wildlife refuges, and other organizations that had created Pond Watch volunteer teams at one or more sites on their lands
- ⇒ Creating a Member List visible to registered MDP web site users. Default information displayed includes name, city, and state, and members can opt to share their e-mail as well. This functionality was added in response to member requests for greater connectivity among volunteers
- ⇒ Creating a Current Events box on the home page
- ⇒ Adding links to MDP Facebook, Twitter, and YouTube accounts, and a button to subscribe to the e-newsletter
- ⇒ Adding a link to OdonataCentral (<http://www.odonatacentral.org>), and beginning the process of joining the OC database to the MDP database (to be completed in May 2014). This will allow MDP to access all records of migratory species entered via the OdonataCentral web site
- ⇒ General reorganization of resources to improve user-friendliness



A well-known western migrant, the Variegated Meadowhawk (*Sympetrum corruptum*) amazed on-lookers in coastal towns throughout Washington and Oregon who witnessed their southward migration in the fall of 2013. (Photo © Dan Jackson.)

Exploring Development of a Smartphone Application

In 2013, the developer of the popular and widely used eBird smartphone apps BirdLog and BirdsEye (David Bell) approached MDP co-chair John Abbott regarding the development of similar apps for MDP. Mobile apps are popular tools that have been used with great success by other citizen science projects. Smartphone applications provide interactive tools for naturalists that people have come to expect, and could help us increase both general reporting as well as participation among a younger demographic. We are continuing conversations regarding costs and functionalities to determine whether this app development is feasible.

Database Management

Xerces is working to create a template that can be used by multiple different partner organizations to upload large batches of data (i.e., seasonal migration reports from HawkWatch observatories, Pronatura Veracruz, etc.) without requiring extensive re-formatting on our part. We are also constantly monitoring dragonfly listservs and Facebook pages to abstract any reports of migratory dragonfly species, and to enter these into the MDP database. This is a very time-consuming process, but is an important source of data that shouldn't be overlooked. In 2013, we collected 810 records of migratory species from e-mail listservs and over 1720 from a variety of web site postings.

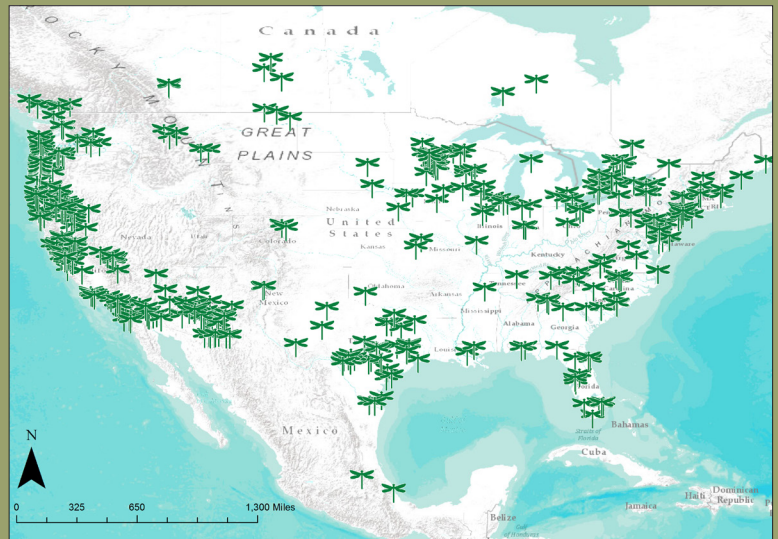


The eBird BirdLog smartphone app created by David Bell; a potential platform for a migratory dragonfly application for MDP volunteers. (Screenshots from www.birdseyebirding.com.)

Box 1: Dragonfly Migration Flights & Pond Watch Observations in 2013

Citizen Scientists: Over 570 MDP users submitted 1720 Migratory and Pond Watch records to the website in 2013, over twice the number submitted in 2012. The number of migratory flights observed in 2013 increased by 700 percent compared to the previous year, while Pond Watch submissions rose by 100 percent.

Data: Data gathered in 2013 spanned the continent, from Saskatchewan and British Columbia, Canada to the Mexican state of Hidalgo, and from the San Juan Islands of Washington to Monhegan Island, Maine. Volunteers reporting the seasonality of dragonfly movements at these sites across North America are informing hypotheses about the timing and location of migration and our understanding of the relationship between migrant and resident populations within a species.



Map of website and listserv reports throughout North America in 2013. In 2013, Variegated Meadowhawks assembled in great numbers to fly south along the west coast of the US. (Map by Michele Blackburn.)

Short Courses

Over 250 participants attended migratory dragonfly short courses and presentations around the US and Canada in 2013. Locations included:

- ↪ Sherburne Wildlife Refuge, Zimmerman, Minnesota, April 2013
- ↪ Northland Arboretum, Brainerd, Minnesota, April 2013
- ↪ Peggy Notebaert Nature Museum, Chicago, Illinois, May 2013
- ↪ Vermont Center for Ecostudies, Norwich, Vermont, June 2013
- ↪ Hawk Mountain, Kempton, Pennsylvania, September 2013
- ↪ Point Blue Conservation Science, Petaluma, California, September 2013
- ↪ Long Point Bird Observatory, Port Rowan, Ontario, September 2013
- ↪ Annual Conference of the Texas Master Naturalists, New Braunfels, Texas, October 2013

The short course in Vermont was the first one that was also broadcast as a GoogleHangout, which allowed additional participants to view the course in real-time or watch the recorded version afterwards.

Short courses remain extremely popular and well-received, and we will continue to offer these as we are able with existing funding. We are also exploring the creation and delivery of live interactive webinars as well as making recorded short course modules available on the web site.



Celeste Mazzacano leads a Migratory Dragonfly Short Course in Petaluma, California. (Photo © Judy Adler.)



Hawk migration at the Cansaburro, Mexico Banding Station (Photo © Elisa Peresbarbosa Rojas.)

Outreach

Social Media

- ⇒ **Facebook:** An MDP Facebook page was created at <https://www.facebook.com/MigratoryDragonflyPartnership?ref=hl>. The Project Coordinator posts notes, updates, and items of interest about migration and dragonflies on a weekly basis. Members also post comments, questions, and photographs. This page has currently been “liked” by 543 people.
- ⇒ **Twitter:** An MDP Twitter account was created at [@Dragonfly_MDP](https://twitter.com/Dragonfly_MDP). The Project Coordinator disseminates announcements, events, and items of interest about migration and dragonflies on a biweekly basis. This account currently has 56 followers, and tweets are frequently “favorited” or “shared” by users. We plan to use this more intensively in 2014 to promote communication and coordination among our volunteer monitors.
- ⇒ **YouTube:** An MDP YouTube account was created at <https://www.youtube.com/user/MigratoryDragonfly>. This site houses training videos on how to use different aspects of the MDP web site, as well as recorded presentations of short courses and webinars. We plan to use this site more extensively as a training tool in 2014.

Bird Observatories

In March 2013, the Project Coordinator sent a one-page synopsis about the MDP to selected bird observatories located in regions of high dragonfly migration activity. The Senior Monitoring Biologist at Hawk Mountain (Laurie Goodrich), who is also a Board member of the Hawk Migration Association of North America, presented this to the HMANA Board, and the Board subsequently decided to formally add dragonfly counts to the HawkWatch database. MDP worked with Laurie Goodrich and the HMANA database manager to create a modified monitoring protocol for HawkWatchers and add the appropriate sections to the reporting database.

Through summer of 2013, this new partnership with MDP was announced to HMANA members via organizational blogs and newsletters, and instructions for how to opt in to dragonfly monitoring were posted on the HMANA web site. As a result, 18 HawkWatch sites on the eastern seaboard, the Midwest, and Ontario, Canada formally incorporated dragonfly counting into their fall monitoring, contributing a total of 850 records to the MDP database. This successful partnership continues in 2014; organizers of the 40th annual HMANA conference (Rochester, New York, April 2014) have invited the MDP Project Coordinator to give a formal presentation on dragonfly migration and the HMANA partnership, and the Project Coordinator will also be using feedback received from the 2013 HawkWatch participants to revise the data collection protocol to increase ease of incorporation by bird observatories.

MDP has also been contacted independently by several bird observatories at which counters have routinely collected information on migrating dragonflies out of personal interest, often for as much as a decade, and we have been able to incorporate those records into the MDP database.

Because many birders are also enthusiastic dragonfly watchers, MDP will continue working with bird-related groups in 2014 to explore additional partnerships, such as the Midwest Landbird Migration Monitoring Network, and to strengthen existing partnerships.

Master Naturalists

Master Naturalist programs are adult natural resource outreach and service programs created at the state level and administered through University Extension programs and State Fish & Wildlife agencies. Participants receive a set number of basic instruction hours on a variety of natural resource-related topics from experts in the field, and are subsequently required to provide a certain number of annual volunteer hours in approved projects and to participate in continuing education. Master Naturalist-type programs currently exist in at least 30 states, and their requirement for ongoing participation in volunteer projects makes them a logical partner for MDP.

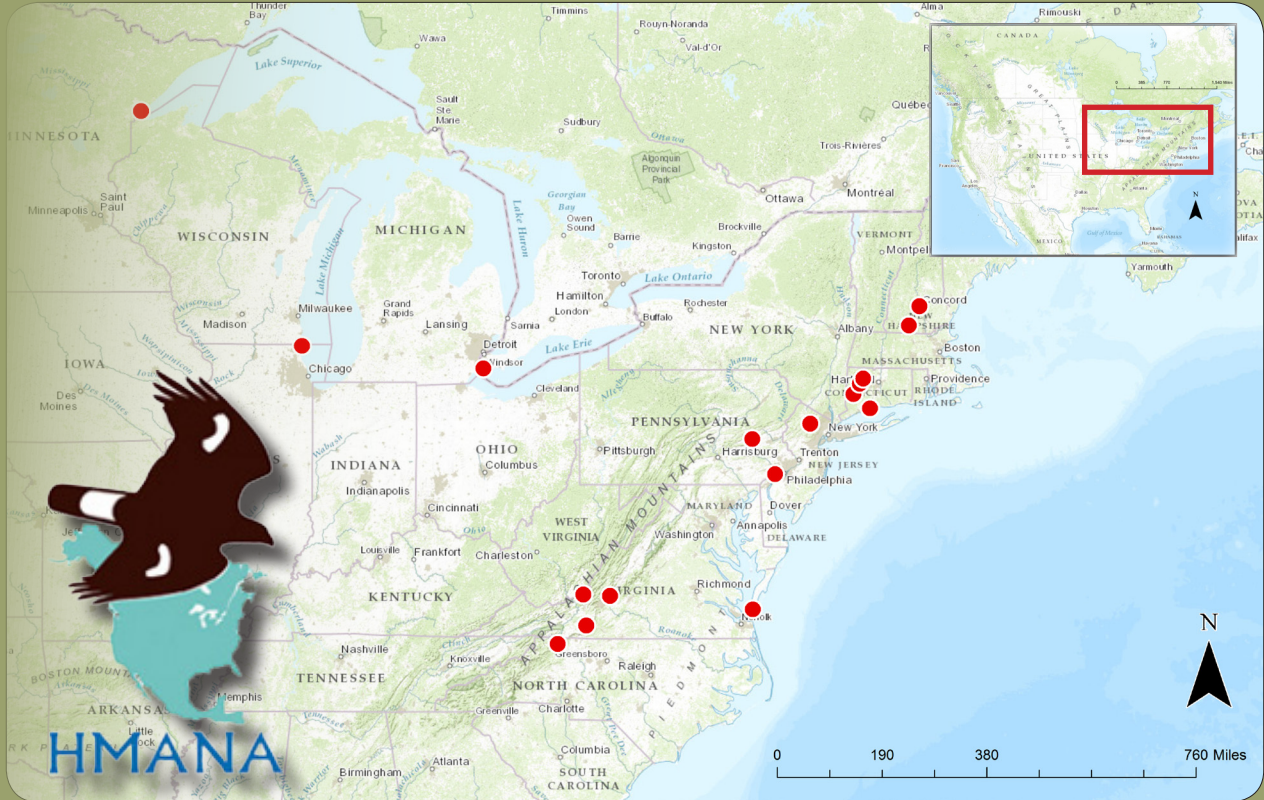
Master Naturalist volunteers have been enthusiastic participants in short courses during the past two years, even in the absence of targeted outreach. In 2012, we began offering certificates of completion to participants who needed to document continuing education hours. In 2013, surveys of short course attendees showed that one-third of the 34% of total respondents who indicated an affiliation with a volunteer organization were Master Naturalists. More targeted outreach to selected Master Naturalist groups also resulted in an invitation for MDP to present a session at the annual Meeting of the Texas Master Naturalists (the oldest and largest Master Naturalist group in the US) in October 2013. In April 2013, a chapter of the Minnesota Master Naturalists helped organize, and participated in, a short course at the Sherburne National Wildlife Refuge in Zimmerman, MN. By the end of the course, all the ponds on the refuge had been adopted by volunteer monitoring teams, and in 2013, Sherburne County had the highest number of records submitted to MDP from any county (266).

Targeted outreach to state-level and chapter coordinators of Master Naturalist groups across the US will continue in 2014.

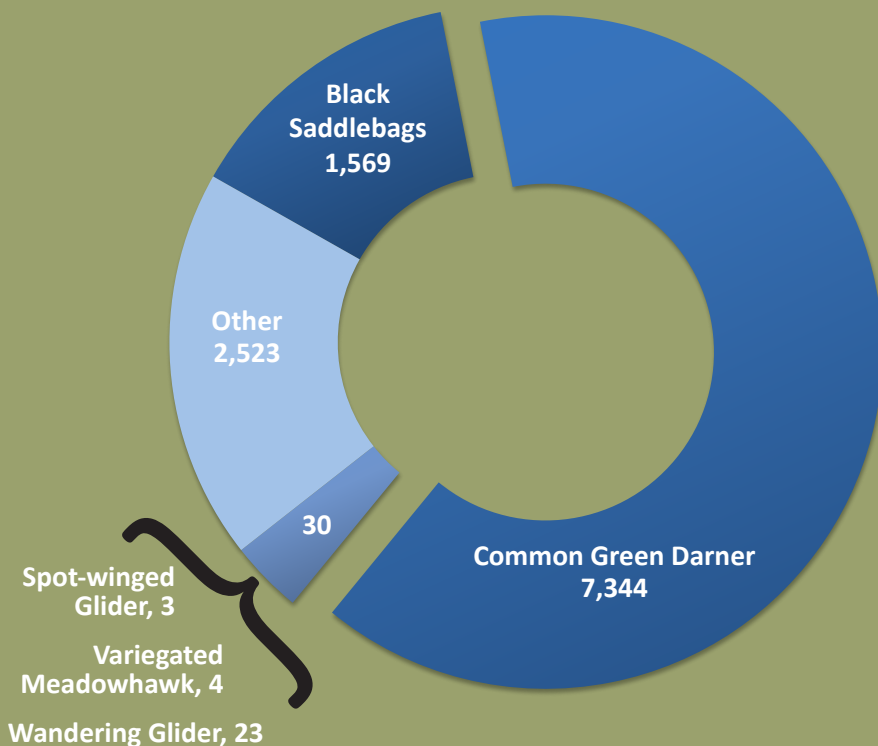


Wandering Glider (*Pantala flavescens*) observed by MDP citizen scientist, Dan Jackson. (Photo © Dan Jackson.)

Box 2: Participating HawkWatch Sites in 2013



Map of participating HawkWatch Observatories that collected dragonfly migration data in 2013. (Map by Michele Blackburn.)



- ✧ **HawkWatch Observers:** 31 Individual HawkWatchers collected dragonfly migration data.
- ✧ **Observatories:** 18 observatories participating include locations on the east coast of the US and two Mid-western states, as well as one location in Ontario, Canada.
- ✧ **Numbers:** HawkWatch observers reported almost 11,500 dragonflies passing through their sites from August through October 2013.
- ✧ **Who did they see?:** The majority of dragonflies seen migrating were Common Green Darner and Black Saddlebags. Other species seen were Twelve-spotted Skimmer and Autumn Meadowhawk. A small proportion of flights were made up of Wandering Glider and Spot-winged Glider; with a few sightings of Variegated Meadowhawk, an eastern vagrant.

Friends Organizations of National Wildlife Refuges

MDP has just begun to realize the power of National Wildlife Refuge Friends groups. These groups came into being in the 1930s, and there are currently about 200 Friends groups around the US. Friends groups support the mission of the US-FWS and often provide critical connections with the public through outreach and education programs. In 2012, MDP worked with Friends of the Tualatin Wildlife Refuge in Oregon to conduct a migratory dragonfly short course, and the Friends group of the Sherburne Refuge mentioned above co-organized the course in Zimmerman, MN in conjunction with the Minnesota Master Naturalists. Wildlife refuges often have excellent habitat for dragonflies, yet as is true for so many invertebrates, information about the resident odonate fauna is often minimal or lacking. Pond Watch is an ideal tool for place-based education and service learning at wildlife refuges, and based on our previous local successes, MDP will work to greatly expand our outreach to, and partnerships with, Refuge Friends organizations in 2014.

Conferences

Trilateral Committee for Wildlife and Ecosystem Conservation and Management

In May 2013, the MDP presented at the Species of Common Concern table at the XVIII Meeting of the Canada/Mexico/US Trilateral Committee for Wildlife and Ecosystem Conservation and Management in Shepherdstown, West Virginia, on 13–17 May 2013. Presenters included Scott Hoffman Black, (MDP chair; Xerces Society); Elisa Peresbarbosa-Rojas (MDP steering committee, Pronatura Veracruz); and Irving Chavez (Pronatura Veracruz). The presentation was well-received and MDP has been invited to present again at the XIX Meeting of the Trilateral Committee in Querétaro, México, on 26–30 May 2013.

Society for Freshwater Science

The Project Coordinator gave an invited presentation on dragonfly migration and the MDP at a special Applied Odonatology session organized at the annual meeting of the Society for Freshwater Science in Jacksonville Florida, May 2013.

Dragonfly Society of the Americas

The Project Coordinator gave a presentation about MDP progress at the annual meeting of the Dragonfly Society of the Americas in Prince Albert, Saskatchewan, August 2013.

Additional Presentations

Dennis Paulson discussed dragonflies, migration, and the MDP during an interview on the public radio show A Way to Garden (archived podcast at <http://awaytogarden.com/dragonflies-and-damselflies>).

The Project Coordinator presented the webinar “Dragonflies: Life history, ecological roles, conservation, and habitat needs and the Wetland Reserve Program” on 1 August 2013 to a national audience of Natural Resource Conservation Service biologists and regional naturalists. This presentation was done at the request of NRCS biologists, who list the topics they’d most like to see addressed in webinars each year. The webinar was also open to the public. The live presentation was “attended” by 121 participants, 21 of whom received continuing education credits. The webinar is archived on the NRCS online Science & Technology Training Library at <http://tinyurl.com/ltmpoob>, and it is available on the MDP YouTube page (<http://youtu.be/v1LiBs8lgFs>) and linked on the MDP web site.

Colin Jones (MDP steering committee, Ontario Ministry of Natural Resources) gave a presentation on dragonfly migration at the Canadian Migration Monitoring Network conference in November 2013.



A dragonfly emerges at a Pond Watch Site in Minnesota. (Photo © Peg Serani, Naturalist, Northland Arboretum and MDP volunteer.)

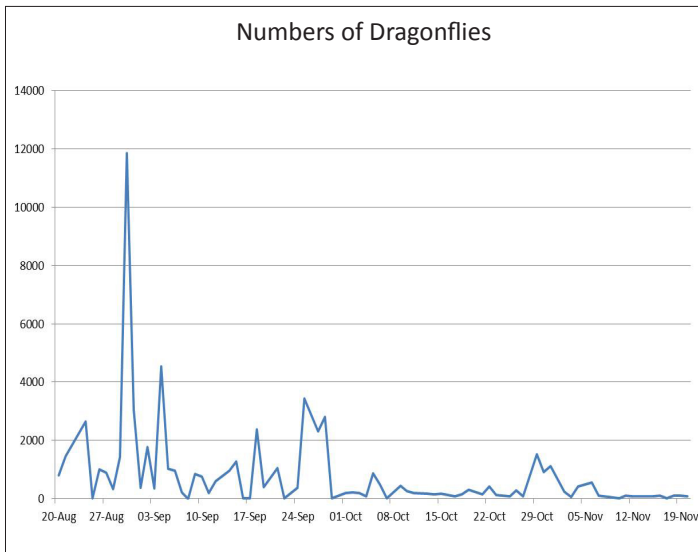
MDP in Mexico

Migration

After two years of working with odonate experts on the MDP steering committee, MDP partner Pronatura Veracruz is now engaging in extensive targeted monitoring of dragonflies during their annual Rio de Rapaces raptor migration event. The effectiveness of past capacity-building is evident in the fact that in 2011 and 2012, only 32 hours of dragonfly monitoring time was clocked, whereas in 2013, dedicated Pronatura staff engaged in 146 hours of dragonfly monitoring from August through November. This monitoring

resulted in total counts being made of 23,489 dragonflies in August; 26,650 in September; 8,652 in October; and 2,072 in November at the Pronatura observatory in Chichicaxtle. At their observatory in Cardel, 10,631 dragonflies were counted in August; 3,335 in September; 3,996 in October; and 1,325 in November.

Little overlap was seen between peak migration dates for raptors vs. dragonflies, with the exception of Mississippi Kites, which is of interest as these birds are known to feed on dragonflies as they migrate. The times of day at which high numbers of migrating dragonflies were seen also varied greatly from day to day, although a general trend seemed to be an increase through the morning hours through 12:30 pm, then a decrease through the afternoon, although high numbers were noted on some occasions in the early evening (around 6 pm). The majority of migrants observed in 2013 were either Spot-winged or Wandering Gliders; this is in contrast to 2012, when large flights of Common Green Darners were seen, and indicates that migratory activity may vary from year to year even among species known as regular migrants.



Number of dragonflies counted flying past the Pronatura observatory tower in Chichicaxtle, Veracruz during the 2013 migration season.

Spanish-language Resources

Staff of MDP partner Pronatura Veracruz worked with the Project Coordinator in 2013 to translate the MDP field guide into Spanish. The field guide is currently being formatted as a spiral-bound booklet and will be available in hard copy and as a PDF on the MDP web site. Pronatura staff and the Project Coordinator are working currently to translate the entire web site into Spanish.

Environmental Education

Pronatura staff has been conducting dragonfly-related outreach activities on a regular basis with schoolchildren and at local environmental education events. They also plan to install a dragonfly pond at their observatory in Chichicaxtle to use as an environmental education tool.

Expanding MDP Programs in Mexico

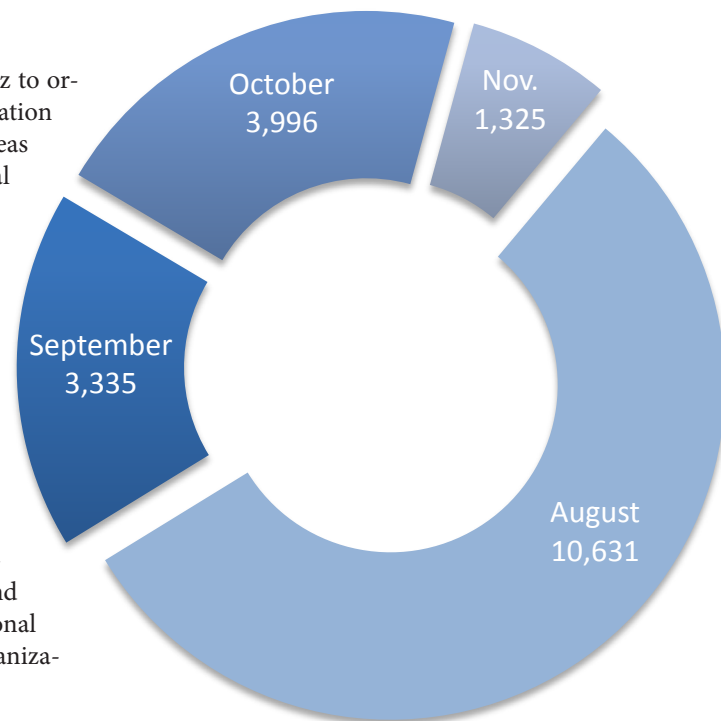
The Pronatura Veracruz director is a vital member of the MDP steering committee, and the organization has been a strong and successful partner in MDP projects. Based on this fruitful partnership, MDP is working to expand our partnerships in Mexico and engage more people in dragonfly monitoring. In 2013, we began working to find new partners, especially in geographic areas where we lack information about dragonfly migration.



Pronatura Veracruz staff lead environmental education events about dragonflies for children in the area. Photo © Elisa Peres-barbosa-Rojas.

We are currently working with Pronatura Veracruz to organize full-day workshops on dragonflies and migration in Tabasco and the Yucatán in July 2014. These areas are of particular interest as they represent a logical extension of the migrants' pathway after passing through Veracruz, and they are known sites of active bird migration. In addition, these regions have abundant wetlands that may be used by resident members of migrating species as well as by migrating (and potentially overwintering) individuals.

Our main partners for these workshops are Pronatura Veracruz, Pronatura Yucatán, and Espacios Naturales y Desarrollo Sostenible (ENDESU). Through these workshops we will reach out to new audiences among area universities, entomologists, non-profit organizations, and the general public. We are also exploring additional potential partnerships with individuals and organizations in the Baja and Sonora region, to investigate the continued southward movements and potential overwintering grounds of our main western migrant, the Variegated Meadowhawk.



Total number of dragonflies counted flying past Cardel, Veracruz from August to November 2013.

Publications

Scientific Papers

In February 2013, a monograph written by MDP steering committee member Mike May on the current state of our knowledge about dragonfly migration was published in the *Journal of Insect Conservation* (May, M. 2014. A critical overview of progress in studies of migration of dragonflies (Odonata: Anisoptera), with emphasis on North America. *Journal of Insect Conservation* 17(1): 1-15; available at <http://link.springer.com/article/10.1007%2Fs10841-012-9540-x?LI=true>). Dr. May is currently working on a new paper that reviews the phenology of *Anax junius* (Common Green Darner), one of the most regular migratory species in North America.

Monthly E-Newsletters

Respondents to the 2012 annual survey of volunteers indicated a strong desire for more communication between MDP and our volunteers. One immediate result of that request was the implementation of monthly e-newsletters, the first of which was e-mailed to all short course participants and registered MDP web site users in March of 2013. Newsletters are sent out in the 4th week of each month, and include links to the MDP web site, Facebook and YouTube pages, and Twitter feed, and an option to subscribe was added to the MDP web site. All newsletters are available through the archives on the MDP web site at <http://www.migratorydragonflypartnership.org/index/newsletters>. Our distribution list has grown from 366 people in March 2013 to 1492 people in March 2014. Monthly newsletter titles are presented below:

- ⇒ March 2013. Dragonfly Pond Watch: MDP's most popular citizen science project gears up for spring
- ⇒ April 2013. Migratory Dragonfly Short Courses: Engaging volunteers in citizen science
- ⇒ May 2013. Return of the Common Green Darner in North America
- ⇒ June 2013. Connecting with volunteers: Increasing our understanding of migratory connectivity
- ⇒ July 2013. Four Wings, Will Travel: Partnerships in migration monitoring
- ⇒ August 2013. Migration season ramps up in North America: The stages of migration

- ⇒ September 2013. West Coast migrants (finally) on the move
- ⇒ October 2013. Dragonfly Migration in Mexico (Migración de libélulas en México)
- ⇒ November 2013. Settling in for Winter
- ⇒ December 2013. Site Sharing - A new way to connect with other MDP volunteers
- ⇒ January 2014. MDP Participant Survey - Ensuring continued success in dragonfly migration monitoring
- ⇒ February 2014. Onward and Upward - Annual Meeting Establishes 2014 Goals

Annual Report to Volunteers

Volunteer engagement and retention is critical to the success of MDP projects. Studies indicate that citizen scientists are most engaged when they are kept apprised of how their data are being used, how their role fits into the big picture, and what advances in knowledge are being made. With this in mind, in March of 2013 we issued the first volume of Taking Flight, an annual report to MDP volunteers that summarized the events of 2012 and introduced new projects and changes planned for 2013 (available at http://www.migratorydragonflypartnership.org/uploads/ROOT/File/MDP_Citizen_Science_Newsletter_2-26-2013_Websec.pdf). We also use photos taken by volunteers throughout the year in the report, and note the individuals who submitted the most observations for the year. We are currently finalizing the newest issue of Taking Flight, which will be sent to volunteers at the end of March 2014 in lieu of the regular monthly e-newsletter.

Protocols Manual

In early 2013, the manual “Monitoring Dragonfly Migration in North America: Protocols for Citizen Scientists” was revised to reflect updates in projects, protocols, and the MDP web site. This manual is provided to short course participants and is available as a PDF on the MDP web site at http://www.migratorydragonflypartnership.org/uploads/ROOT/File/MDP-Monitoring_Protocols.pdf. The manual is undergoing revisions again in 2014 to ensure that it is up-to-date.



Volunteers in Minnesota look for nymphs that have overwintered in a local wetland. (Photo © Celeste Mazzacano.)

Project Flyer

In early 2013, the MDP volunteer projects flyer was revised to reflect updates in projects, protocols, and the MDP web site. This flyer is used extensively in outreach to potential partners, is provided to short course participants and is available as a PDF on the MDP web site at http://www.migratorydragonflypartnership.org/uploads/ROOT/File/MDP-citizen_science_projects.pdf. The flyer is undergoing revisions again in 2014 to ensure that it is up-to-date.

Habitat Guidelines

The new resource publication “Dragonflies and Damselflies: Creating Habitat in Your Own Backyard” was developed in 2013 and is currently being formatted as a full-color brochure, to be included in short course resource packets and made available as a PDF on the MDP web site. We anticipate that the final brochure will be available by May 2014.



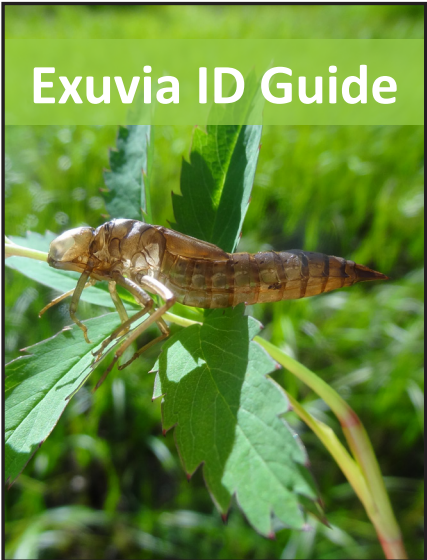
Citizen Scientist and odonate expert Kathy Biggs has been attracting dragonflies and damselflies to her backyard pond in California for 18 years. (Photo © Celeste Mazzacano.)

These guidelines provide a background on dragonfly life history and ecology and discuss the ecological importance of dragonflies in wetlands, the conservation benefits of created ponds to odonates, and the role of such ponds in environmental education. Clear steps are then provided for the creation and maintenance of backyard habitats. The guidelines were written to be applicable across North America and will be translated into Spanish in 2014.

Guide to Exuviae

In order to better understand the life history and phenology of migratory dragonflies in North America, the MDP steering committee decided in 2013 to add volunteer monitoring and reporting on exuviae to the Pond Watch project, as the presence of exuviae of the target species is unequivocal proof that the dragonflies are breeding at that site. Collected exuviae can also be used for stable isotope analysis.

In the course of developing a new field guide for exuviae, it was discovered that there was too limited a sample in-hand of intact exuviae of the species in question to be used, as these are fragile, easily damaged after collecting, and not the usual target of most odonatists. In addition, the consensus among steering committee members was that exuviae identification of any target species except for the distinctive Common Green Darner would be problematic and highly prone to error. For this reason, it was decided to focus exclusively on monitoring and collecting Common Green Darner exuviae. Steering committee co-chair and odonate expert John Abbott has developed flat imagery showing *Anax junius* exuviae from multiple different angles, as well as an online 3-dimensional Virtual Object that can be opened and manipulated in QuickTime (<http://www.migratorydragonflypartnership.org/index/virtualImage?taxon=junius&sex=exuvia>). The new exuviae guide will be completed in 2014 and made available as a resource during short courses and as a PDF on the MDP web site. While the final document is in process, we will issue an interim protocol that describes how to find, collect, preserve, and photograph exuviae, so volunteers can be collecting specimens for later identification when the field guide is available.



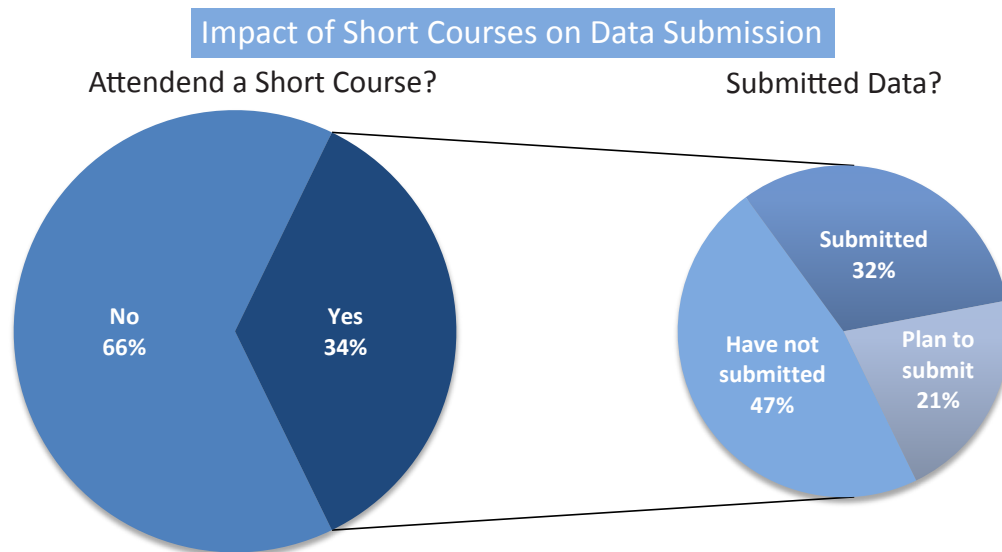
Exuvia ID Guide

MDP Volunteer Projects

Managing Volunteers

During 2013, the number of MDP volunteers as well as the number of Pond Watch and Migration records submitted to the MDP web site increased by more than 2.5 times compared to 2012. In order to maintain communication with volunteers, solicit feedback about MDP short courses and online resources, and inform adaptive management processes, MDP administers two types of surveys: one immediately following each day-long short course, and an annual survey sent at the end of each year to all short course participants and registered users of the MDP web site.

Surveys of short course participants: In 2013, 114 participants completed surveys across all short courses given. Most course participants are older than 46 years, and a higher proportion are women (60% female and 40% male). One-third identify as being associated with a volunteer organization, and over one-third are educators or environmental professionals. Survey results consistently indicate high levels of satisfaction and learning. Ability to identify dragonflies is still a concern for course participants, as they express a desire for additional training and help, though in all cases attendees self-report an increase in their dragonfly identification skills and knowledge after the workshop. We will be implementing on-line identification quizzes in 2014 to help volunteers bolster their identification skills.



When short course attendees were asked about their participation in projects and data submission, over 50% indicated they have already submitted observations or plan on submitting data in the future.

Year-end survey: The survey link is sent to all web site users and all 2012 and 2013 short course attendees. Of those that responded, 66% had not attended a short course; of the 34% that did, 47% had not submitted data, 32% had submitted data, and 21% planned to submit data but hadn't yet. Demographics include a good mix of volunteers, full-time employed, and retired people. We are seeing a high satisfaction level in general among volunteers for the programs. Changes that participants would like to see and/or that would make them more likely to participate include online training (31%), online quizzes (27%), ease of data entry (15%), connecting with others (14%). We are working to address these comments and make improvements and additions in all of those areas in 2014.

Projects

Migration Monitoring

The number of migratory observations reported in 2013 increased by 700 percent compared to the previous year. Migration season arrived with flights of Swamp Darners (*Epiaeschna heros*), which is known as a sporadic migrant and was seen on the east coast in early August, followed by reports of migrating Common Green Darners, Wandering Gliders, and Spot-winged Gliders. Migratory activity was more delayed on the west coast, with flights of Variegated

Meadowhawks first observed in Washington at the beginning of September. Although delayed in comparison to the east, the western migration was much heavier in 2013 than in 2012. The increased numbers of MDP volunteers in 2013 provided more concerted monitoring and will allow us to follow migratory activity in different regions more closely across the span of several days, enabling more investigation into timing, duration, and location of flights, and the relationships with climate.

Pond Watch

Pond Watch continues to be the most popular MDP program. Feedback we have received that helps explain this includes the straightforward nature of the project, the appeal of place-based learning and ability to engage volunteers (at wildlife refuges, arboretums, nature centers, etc.), application to needed hours for natural resource volunteer program participants, ease of involving children, and ability to participate regardless of where in North America one lives. The ability to enter records of non-migratory species via our partner web site OdonataCentral (www.odonatacentral.org) also appears to be attractive, as it means that even if migrant species are rare or occasional, any odonates observed at a site can still be reported as data for another citizen-science project.

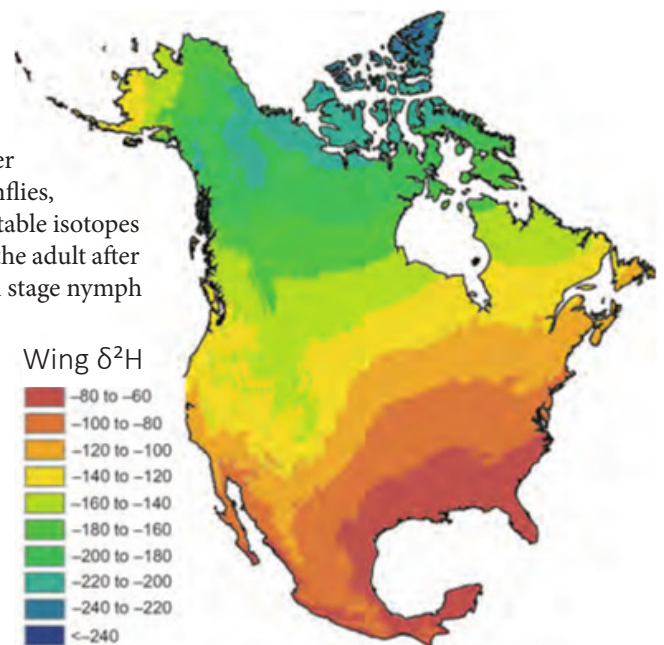
In 2013, the number of Pond Watch records submitted doubled compared to 2012. The greatest number of Pond Watch reports are for Common Green Darner, and the fewest reports have been for Black Saddlebags and Variegated Meadowhawk. Maps showing the current distribution of Pond Watch records for each target migratory species are available online via the following links:

- ↪ Pond Watch and Common Green Darner: <http://bit.ly/1mukwqh> (contains all Pond Watch Data (species combined) with layers for each month; also contains CGD layers separated by month)
- ↪ Black Saddlebags Pond Watch map: <http://bit.ly/1mulAKP>
- ↪ Spot-winged Glider Pond Watch map: <http://bit.ly/1mullPj>
- ↪ Variegated Meadowhawk Pond Watch map: <http://bit.ly/1mumbMw>
- ↪ Wandering Glider Pond Watch map: <http://bit.ly/1mulSkO>

Stable Isotope Analysis

Background

The ratio of different stable hydrogen isotopes occurring in water that falls as rain or snow varies predictably with latitude. Because living organisms incorporate the hydrogen isotope “signature” of the waters in which they live and feed, stable isotopes have been used to track other migratory organisms, such as birds (using feather samples). For dragonflies, an isotopic signature can be generated by measuring the ratio between stable isotopes of hydrogen, traces of which remain locked into both the wing tissue of the adult after emergence and in the nymphal exuviae (cast-off exoskeleton of the final stage nymph left behind when the adult emerges). By comparing the wing hydrogen isotope ratio of the water body where the insect was captured, we can learn how far a captured dragonfly has moved from its emergence site. Stable isotope analysis will increase our understanding of the points of origin of dragonflies in a mass flight, better delineate southern and northern endpoints of migration, and help distinguish migratory individuals from residents. Hobson et al. 2012 (A dragonfly [$\delta^2\text{H}$] isoscape for North America: a new tool for determining natal origins of migratory aquatic emergent insects) created a function for deuterium fractions in dragonfly wing tissue vs. rainfall deuterium. This means we now have a dragonfly wing deuterium isoscape for North America, and this basemap is being used in the analysis of wings from *Anax junius* collected across eastern North America.



Proposed dragonfly wing $\delta^2\text{H}$ model isoscape for North America, after Hobson et al. 2012.



Darner exuvia (Photo © Alexa Carleton.)

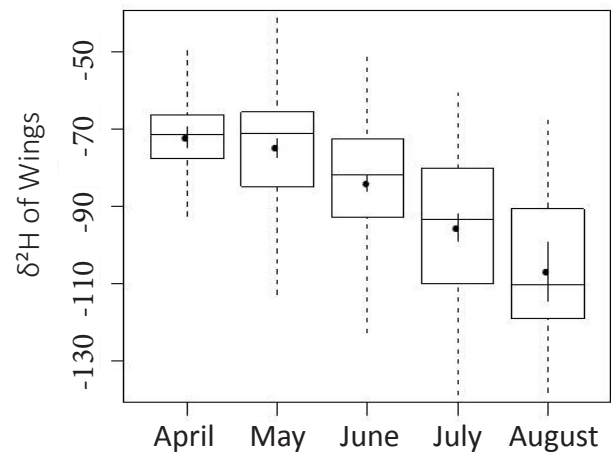
Analysis

VCE has completed analysis of the deuterium ratios in 1000 wings from adult Common Green Darner (*Anax junius*) and 300 Common Green Darner exuviae across eastern North America, to examine how this species migrates back north in the spring. Each wing sampled was also photographed so that the degree of wing wear (expected to be greater in dragonflies that are older and/or had flown long distances) could be determined for each specimen. When wings from adult *Anax* collected in Gulf states (Florida, Alabama, Louisiana, Texas) were examined by month, there was extensive variation in the deuterium signature. This implies that within each month there is a wide range of locations of origin, and that many adults are coming up from the south even in late summer. When wings from specimens collected in the far reaches of the northern part of *Anax* range were examined, the results looked more as expected, i.e. in April on average the specimens had come from far south (migrant populations), and by late summer specimens had originated in the far north (resident populations; see graph at right).

Analysis of the data is continuing. VCE staff is now collecting exuviae records to get a better idea of *Anax* development in the east. Mapping the dates of collected exuviae shows more of a directed movement up north, with wide scattering in the summer, more records only in the north in late summer, then exuviae records only in Florida by late October. They also looked at the first-of-the-season arrival dates of adults in a few different states and found that those date ranges were not as tight as seen so far with the exuviae reports. Additional critical data for *Anax junius* phenology throughout North America will be provided from volunteers via the addition of exuviae reporting to Pond Watch records in 2014.

VCE is also hoping to refine certain elements of the isotope analysis to get an idea of any inherent limitations that might be operating, for example, sampling the wing of a newly-emerged adult and the exuvia from which it just emerged, to see if and by how much these values differ.


Anax Adult wings from Northern Range



Wings examined from northern range of *Anax junius*. In April *A. junius* are originating from the south, while specimens sampled in the summer originated from the north.

MDP Steering Committee Annual Meeting

The annual MDP steering committee meeting took place in Portland, OR on 15–16 January 2013. Each annual meeting is a 2-day process during which project reports and updates are given, any associated challenges are identified and addressed, and action plans are created for the coming year. This is a valuable opportunity for formal and informal interactions among the group, as it is the only time each year that the steering committee meets face-to-face. This continues to be an extremely useful process for the group, and many of the accomplishments and resources detailed in this report occurred as the result of the annual meeting planning and discussions.



The Migratory Dragonfly Partnership uses research, citizen science, education, and outreach to understand North American dragonfly migration and promote conservation of the habitat on which they rely. Established in 2011, the Partnership is a collaboration among dragonfly experts, nongovernmental programs, academic institutions and federal agencies from the United States, Mexico, and Canada.

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*Working to Understand and Conserve
North American Dragonfly Migration*