Migrations and Unidirectional Movements of Dragonflies in Northeastern North America

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Figure 1. Some locations of reports of dragonfly movements and migration and major species involved. This is not complete and designed only to show that dragonfly movements and migrations in the northeast are widespread and involve different species.

1 *Aeshna interrupta lineata*, Brandon, Manitoba, (Catling & Kostiuk 2008)
2 *Anax junius*, Cape May, New Jersey, (Russell et al. 1998)
5 *Anax junius*, Wheatley, Ontario, (Nisbet 1960)
6 *Celithemis eponina*, Huyck's Bay, Ontario, (here)
7 *Epiaeschna heros*, Long Island, New York, (Walter 1996a)
8 *Epiaeschna heros*, Cape Cod, Massachusetts, (Sones 1995)
9 *Epiaeschna heros*, Fairbury, Illinois, (Mundt 1882)
10 *Epitheca cynosura*, Walpole island, Ontario, (Catling 2005)
11 *Sympetrum vicinum*, Metcalfe, Ontario, (Catling & Brownell 1997)
12 *Tramea lacerata*, Cranberry Marsh, Ontario, (Barker 2000)
Migrations and Unidirectional Movements of Dragonflies in Northeastern North America

Front cover: A skyscape with migrating dragonflies including Black Saddlebags (*Tramea lacerata*) and Twelve-spotted Skimmers (*Libellula pulchella*).

Back cover: A resting dragonfly’s view of the lighthouse at Cape May, New Jersey. The flowers are Swamp Rose-mallows which sometimes grow in the thousands around Cape May ponds. The location has been an important one for migration of birds, Monarch butterflies and dragonflies for many decades (Allen & Peterson 1936). Public domain photo.

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Dedication

Dragonflies are one of the most highly valued groups of animals in the natural world. They are loved, admired, appreciated, and respected. They are often featured in artwork. They are protected by people who understand their value in controlling pest insects and in providing food for fish and waterfowl. More than once while carrying out research studies of dragonflies with nets, we have been approached by a local resident who has said: “I hope that you are not disturbing my dragonflies … they are all there is between me and the mosquitoes.” Despite their obvious value as part of the balance of nature, we have not done nearly enough to protect them or even to understand them. This guide is dedicated to all the lovers of dragonflies who will use them to focus attention on the natural world.

Figure 2. Replica of the dragonfly Tiffany (stained leaded glass) lamp hand-made by Louis Comfort Tiffany in New York City is 60 cm diameter x 20 cm high and includes 400 pieces of glass. Tiffany shades were popular between 1890 and 1910. Hannes Grobe, 12 June 2007. CC-BY-SA-2.5.
Abstract

This guide addresses questions concerning dragonfly migration and movement in northeastern North America such as: (1) which dragonflies migrate? (2) when? (3) how can they be identified? (4) how many? (5) in what direction? and (6) under what conditions? It includes illustrations and information for: (1) 8 species of dragonflies known to be migratory including: Anax junius, Epi aeschna heros Libellula pulchella, Libellula semifasciata, Pantala flavescens, Pantala hymenaea, Tramea carolina, Tramea lacerata; (2) Other species for which unidirectional movements have been observed including: Aeshna constricta, Aeshna eremita, Aeshna interrupta lineata, Celithemis elisa, Pachydiplax longipennis, Sympetrum corruptum, Sympetrum rubicundulum, Sympetrum vicinum; and (3) Two species for which more information is needed including: Aeshna sitchensis, and Sympetrum danae. Information is provided for six excluded species. The term “migration” is used in the strict sense to refer to a regular and predictable mass movement of most members of a population in a particular direction from an emergence area to a reproductive area, followed by a return trip to the emergence area. The term “unidirectional movement” can be used for observations that do not quite fit the strict definition of migration. Sudden appearance of a species in the absence of a local adult population of that species is circumstantial evidence of migration. Migrations and other movements may occur to (1) to avoid mortality due to dry season or cold periods, (2) in response to a dense population, or (3) in response to parasites. Autumn migrations often follow the passage of a cold front (as in bird migration), and spring migrations have been associated with drought and long periods of winds from the south. The number of dragonfly individuals in a migration varies from less than a hundred to millions. Direction is partly governed by topography and coastlines but re-orientation may occur in the presence of obstacles such as large bodies of open water. There are approx. 200 species of dragonflies in northeastern North America and 17 are reported to migrate or undertake unidirectional flights. Dragonflies make good environmental monitors because they inhabit both aquatic and terrestrial habitats, but monitoring migrations is particularly useful because they represent large areas. Migration may be of much greater ecological significance than is currently imagined and much remains to be understood.

Acknowledgements

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Why the guide?

Like many other books, this one started with a file of information used mostly to answer questions. That grew into a short guide to help people wanting to identify species, and that just kept growing. Soon we had accumulated substantial information and a useful list of references. Now we are pleased to make that available.

Professional entomologists (those studying dragonflies are called Odonatists) have stressed the need for more information to answer many questions about migration (e.g., May 2013). Among the questions are: (1) which dragonflies migrate? (2) when? (3) how can they be identified? (4) how many? (4) in what direction? and (5) under what conditions?

This guide is designed to answer some of these questions, and to provide a basic introduction to dragonfly migration in northeastern North America as well as a means of identification. Although first planned to cover the Great Lakes region, it was later expanded to the northeast generally. We intend to replace it in the future with a more complete third edition.

Studying dragonfly migration

“… anyone interested … can make a real contribution if trained to distinguish a few species of dragonflies on the wing and to keep careful records of their observations.” … May 2013, p. 2

Methods
The names and order used here is that of the Paulson & Dunkle checklist (2012 edition). For each species, the size and identification characters (in dark red print) are followed by notes on observations and ecology. Locations, dates and photographers are provided for illustrations in Appendix 2 and in illustration captions.

Other sources
There is a very useful online dragonfly identification guide (Paulson et al. 2012) on The Migratory Dragonfly Partnership website. There is also a very interesting powerpoint presentation entitled “Dragonfly migration in North America”.
http://www.migratorydragonflypartnership.org/index/identificationGuides
The Hawk Migration Association of North America has assisted in gathering data on dragonfly migration. On their website [http://www.hmana.org/migratory-dragonfly-partnership/] are:

(1) 2014 Migratory Dragonfly Partnership Results
(2) 2013 Migratory Dragonfly Partnership Results
(4) Migratory Dragonfly Data Collection Protocol
(5) Migratory Dragonfly Partnership Datasheet

What is migration?

Migration has been defined as “spatial displacement that typically entails part or all of a population leaving the habitat where emergence took place and moving to a new habitat in which reproduction ensues” (Corbet 1999, p. 394). This could apply to dispersal which is characteristic of many dragonflies. Migration in the strict sense involves a return to the place of origin by the same or a subsequent generation. In the case of the migrations of Green Darner (Anax junius), it takes at least two generations to complete the round trip. Sometimes reproduction in the new habitat is not observed and sometimes a part of the complete round trip is not observed. A particular species may not migrate every year and only a part of a population may migrate. A primary feature of a migration is unidirectional flight. In this way a migration is readily distinguished from a feeding swarm but dragonflies may feed and congregate while migrating. Both congregations and appearance prior to emergence of local populations are additional evidence of migration. The term “migration” is used in the strict sense to refer to a regular and predictable mass movement in a particular direction from an emergence area to a reproductive area, followed by a return trip to the emergence area. Some prefer to use the term “unidirectional movement” for observations that do not quite fit the strict definition of migration.

The difference between these terms is sometimes difficult to determine. For example does a migration really have to be predictable? how much of a population has to be involved? how important is it to observe a return flight? and so on. Taber (2002) noted that strong winds from the east preceded his observations of “fallout” of 4,500 dragonflies on man-made islands of the Chesapeake Bay Bridge. Some of
these were well-known migrants such as Green Darner representing 25% and Swamp Darner representing 10%. Others species present are not often implicated in migration, such as Eastern Pondhawk (25%), Harlequin Darner (10%) and Eastern Amberwing (5%). These may have been blown in from the Delmarva Peninsula to the east (or perhaps they were migrating and forced down by unfavourable weather). The 250,000 dragonflies all heading south on 13 Sept. 1992 at the pasture at Rocky Knob on the Blue Ridge Parkway, Virginia, (Kessler 2013) seems to be a case of migration in the strict sense, despite the fact the return flight was not observed and some of the species present were a small fraction of their populations, suggesting accidental involvement. These examples do illustrate the range of very interesting observations of dragonfly movements.

Major unidirectional movements that are not long distance, not followed by breeding, nor by an obvious return flight are surrounded by the same questions and mysteries as migrations. Unidirectional movements over short distances do not only involve dragonflies but other orders of insects and animals. “Bands” including thousands of flightless Mormon Crickets (Anabrus simplex) walking the same way across the prairie are co-ordinated by an unknown means. Similarly, plagues of locusts fly the same way but are not necessarily migrating according to the definition above. Salamander “migrations” in the Appalachian may not really be migrations.

Although it is not important to force certain definitions, it is useful to remember that a lot of variation may be included in either “migration” or “unidirectional movement”. The effort should be directed more to documenting and understanding dragonfly movements than to defining them. With more understanding, a classification system may be more easily developed.

How to detect movements

When a large swarm of a few million dragonflies passes by, detection is not difficult. Movements that involve smaller numbers of individuals are just as interesting (although not as spectacular). An important source of circumstantial evidence occurs when dragonflies appear suddenly in large numbers in a place where they did not breed, then just as suddenly vanish a short time afterward. This may happen before the species in question has emerged in the local area. There is a “core group” of generally accepted migrants in the northeast including those listed below (Russell et al. 1998):

*Anax junius* (Drury), COMMON GREEN DARNER  
*Epiaeschna heros* (Fabricius), SWAMP DARNER
*Libellula pulchella* Drury,  TWELVE-SPOTTED SKIMMER

*Libellula semifasciata* Burmeister,  PAINTED SKIMMER

*Pantala flavescens* (Fabricius),  WANDERING GLIDER

*Pantala hymenaea* (Say),  SPOT-WINGED GLIDER

*Tramea carolina* (Linnaeus),  CAROLINA SADDLEBAGS

*Tramea lacerata* Hagen,  BLACK SADDLEBAGS

Other species may be involved in regular unidirectional flights in northeastern North America (or elsewhere). These include cases of partial migration involving a part of a population or variable migration that may not be conspicuous every year, or just cases where information is inadequate:

*Aeshna constricta* Say,  LANCE-TIPPED DARNER

*Aeshna eremita* Scudder,  LAKE DARNER

*Aeshna interrupta* Walker *lineata* Walker,  VARIABLE DARNER

*Celithemis elisa* (Hagen),  CALICO PENNANT

*Celithemis eponina* (Drury),  HALLOWEEN PENNANT

*Pachydiplax longipennis* (Burmeister),  BLUE DASHER

*Sympetrum corruptum* (Hagen),  VARIEGATED MEADOWHAWK

*Sympetrum rubicundulum* (Say),  RUBY MEADOWHAWK

*Sympetrum vicinum* (Hagen),  AUTUMN MEADOWHAWK

For certain other species movements are less pronounced, but there is still some evidence:

*Aeshna sitchensis* Hagen,  ZIGZAG DARNER

*Sympetrum danae* (Sulzer),  BLACK MEADOWHAWK

Finally for some dragonflies, the evidence is poor, at least in northeastern North America. These species are discussed in Appendix 1.

**Origins and Influences**

Dragonfly migrations may be a consequence of many factors. For example, they may have developed: (1) to avoid dry season mortality or cold periods, (2) in response to a dense population, or (3) in response to a parasite such as the parasitic nematode *Prosthogonimus ovatus* which has been linked to migrations of *Libellula quadrimaculata* in Europe.
Monitoring Dragonflies

An autumn migration may follow the passage of a cold front (as in bird migration), i.e., a mild sunny day following a heat wave. Spring migrations on the east coast in 1995 were associated with drought in the southeast states and many days of warm winds from the south (Soltesz et al 1995, Sones 1995, Nikula and Sones 1995). What influences dragonflies to move in a particular direction is unclear, but in general all dragonflies in a migration proceed in the same direction and the route may be governed mainly by topography and coastlines. Dragonfly migrations are sufficiently regular and predictable at some places that interpretive signs (markers) have been placed, for example at Cape May, New Jersey http://www.hmdb.org(marker.asp?marker=43979

Migration numbers

There are approximately 5000 species of dragonflies worldwide but less than 100 migrate (Russell et al 1998). In northeastern North America (Canada and adjacent US – Figure 1) there are approx. 200 species and 17 indulge in migration and unidirectional flights. The most conspicuous migrants in eastern NA are the great autumnal swarms of Green Darners (Anax junius) often accompanied by Wandering Gliders (Pantala flavescens) and Black Saddlebags (Tramea lacerata). The numbers of dragonflies in a migration varies from less than a hundred to millions. All of the species that have unidirectional movements and migrations in northeastern North America are covered here, and that is about 10 % of our dragonfly fauna.

Animal migrations disappearing

Migration of animals is a poorly understood phenomena and it is disappearing (Wilcove and Wikelski 2008) due to climate change and a variety of other environmental stresses caused by humans. This is important because migrations may provide huge environmental services. If migratory dragonflies
produced in Canada sustained Swallow-tailed Kites (Catling 2003) in South Florida for a critical period, and at other times those same birds were significant predators of pest insects over crops, then we could see the importance. Migrating dragonflies may be significant in controlling human diseases spread by biting insects. Possibilities of this kind are endless because the living world is connected in complex ways. All that we do definitely know is that migrations are ecologically important over large areas and that includes the migrations of dragonflies.

**Some dragonflies are major migrants**

Although prevalent under certain circumstances, dragonflies are not nearly as well known for their migration in North America as Monarch Butterflies (*Danaus plexippus*), yet they migrate further (further than any other insect) and their migrations can be seen worldwide. The migration of the Wandering Glider (also known as the Globe Skimmer, *Pantala flavescens*) from India over the Indian Ocean to the Maldives Islands (500 miles from India) and then to the Seychelles Islands (2,000 miles from India) then to Mozambique and on to Uganda in Africa (5,500 miles from India) is 11,000 miles roundtrip (Hobson et al. 2012, etc.). This compares to the 4,300 mile round trip of the Monarch Butterfly from southern Canada to the highlands of Mexico, which was once thought to be the longest insect migration. Wandering Gliders move so far across the planet that those from different continents are genetically indistinguishable (Troast, 2016). We have seen documentation for dragonfly migrations in various parts of Africa, South America, Asia, the valleys of the Alps in southern Europe, much of the rest of Europe including Scandinavia, Iceland and the Pacific Coast of the U.S.

**New tools**

The exciting new tools available for tracking migrations extend from the use of stable isotopes to track natal origins over longer distances (Hobson et al. 2012) to citizen science in determination of causal factors operating over shorter distances. See also Harrison et al. (2011).

**Migratory adaptation**

Migratory species have larger (longer and wider) and smoother wings, a larger anal lobe that has developed through an expansion of the discoidal region, and longer and denser thoracic pilosity (Suarez-Tovar and Sarmiento 2016). These differences might favour gliding as an energy-saving displacement strategy.
**Aeshna** spp., Blue Darners

Not all of the northeastern Darners (Aeshnidae) migrate, but a few of the `Blue Darner` group have been accepted as migrants (e.g. *Aeshna constricta* and *Aeshna eremita*, Russell et al. 1998). A huge unidirectional movement of *A. interrupta lineata* is well documented for Manitoba (Catling & Kostiuk 2008). Even the species of northern regions indulge in long distance movements. The boreal *Aeshna sitchensis* was recorded at Point Petre and Prince Edward Point on the S shore of Prince Edward Co., NE Lake Ontario in mid-September in 2009 (D. Bree, Ontario Odes list serve, 17 Sept. 2009). This would have required a long distance flight mostly in a southerly direction, from Manitoulin Island or north of Algonquin Park. *Aeshna constricta* does occur with fall migrants in small numbers on the NE shore of Lake Ontario at Prince Edward Point, Sandbanks and Presqu`île. *Aeshna verticalis* is also found with *Anax junius* on the north shore of Lake Ontario, and may be underrepresented in observations at a distance because it has a green thorax and a bluish abdomen (as in *A. junius*). Many species of Darners form feeding swarms, often of more than one species, that are present at a locality on one day and gone the next. These are often not associated with either other migrants or migration routes.

*Aeshna constricta* and *A. eremita* are shown in detail. The other species are listed (below). The colour illustrations produced by Walker (1912, reproduced here (with only *A. septentrionalis*, similar to *A. sitchensis*, missing) may be helpful in identification along with reference to the following notes and to other texts).

*Aeshna canadensis* Walker, CANADA DARNER  
*Aeshna clepsydra* Say, MOTTLED DARNER  
*Aeshna constricta* Say, LANCE-TIPPED DARNER  
*Aeshna eremita* Scudder, LAKE DARNER  
*Aeshna interrupta* Walker *interrupta*, VARIABLE DARNER  
*Aeshna interrupta* Walker *lineata* Walker, VARIABLE DARNER  
*Aeshna juncea* (Linnaeus) *americana* Bartenef, SEDGE DARNER  
*Aeshna septentrionalis* Burmeister, AZURE DARNER  
*Aeshna sitchensis* Hagen, ZIGZAG DARNER  
*Aeshna subarctica* Walker, SUBARCTIC DARNER  
*Aeshna tuberculifera* Walker, BLACK-TIPPED DARNER  
*Aeshna umbrosa* Walker *umbrosa*, SHADOW DARNER  
*Aeshna verticalis* Hagen, GREEN-STRIPED DARNER

**An overview of Aeshna:** *Aeshna clypsedra* has the first lateral stripe extended forward at the top instead of backward, and has large pale spots between the lateral stripes so that the thorax is extensively pale in lateral view. *Aeshna interrupta*
interrupta has the first lateral thoracic stripe distinctively broken into two spots. Aeshna subarctica has the first lateral thoracic stripe uniquely bent forward in its upper half. The western species californica, palmata and multicolor, all have a straight first thoracic stripe.

Four eastern species have a straight first thoracic stripe (interrupta, juncea, tuberculifera and umbrosa). These may be divided into two groups. (1) Only A. interrupta and A. juncea have a prominent black line across the face. In interrupta lineata the lateral thoracic stripes are thinner. Females of A. juncea also have the basal plate of the ovipositor distinctly bilobed whereas its posterior edge is more or less straight in A. interrupta lineata. (2) Aeshna tuberculifera and A. umbrosa are both without prominent face lines (may be present but faint or not prominent in A. tuberculifera). Males of the former have more or less pointed cerci whereas those of A. umbrosa are broadened at the tip (spatulate) in lateral view and have an ante-apical inferior spine. Female A. tuberculifera differ in being notably constricted at abdominal segment 3 (Dunkle 2000, p. 46) and have stylets that reach beyond the base of abdominal segment 10 those of A. umbrosa reaching to half the length of that segment. Although A. umbrosa is sometimes said to have the first thoracic stripe shape like a walking stick, the females may often lack the handel of the stick.

Six eastern species have a more or less sinuate (zig-zag) first thoracic stripe (A. canadensis, A. constricta, A. eremita, A. septentrionalis, A. sitchensis, and A. verticalis). These are readily divided into two groups. (1) A. eremita, A. septentrionalis, and A. sitchensis, have a heavy black line across the face. Aeshna sitchensis and A. septentrionalis, are species of the northern boreal forest and treeline which have a narrow first stripe and the line of contact of the eyes is relatively short, and no longer than the occiput. In A. septentrionalis the frontal stripe on top of the head is not extended forward on each side of the T-spot but in A. sitchrensis it is. Aeshna eremita has a relatively broad first stripe (more than 1 mm wide) and the line of contact of the eyes is longer than the occiput. (2) Of the remaining species, without a black line across the face, A. constricta is distinctive in the male having spatulate cerci and the female has the largest ovipositor with the styli extending to the base of the appendages and s9 is longer than s8. Both A. canadensis and A. verticalis males have pointed cerci and the females have smaller ovipositors. Although the anterior lateral thoracic stripe of males of A. verticalis is usually entirely green, some males of A. canadensis also have green first lateral thoracic stripe. In A. verticalis, the upper horizontal offshoot of the first thoracic stripe is as broad as the upper vertical part of the stripe and the stripe is strongly angled on both back and front edges. In A. canadensis the upper horizontal offshoot is half as wide as the upper vertical part of the stripe and the back of the stripe is relatively straight. This is sometimes difficult to evaluate but is said to
apply to both sexes. There is a large difference between these two species in the hamules on the underside of second and third abdominal segments of the male. In *A. canadensis* the hamular processes are directed forward and the processes are expanded below their convergent tips. In *A. verticalis* the processes are short and directed inward to meet and are also of even width.

*Aeshna eremita* Scudder, **LAKE DARNER**

Figure 3. Lake Darner, male. Beaver Meadow Conservation Area, 43.95794, -77.17778, Prince Edward Co., Ontario, 6 Sept. 2015. Photo P.M. Catling.
Figure 4. Lance-tipped Darner, male. Stream on Simpson Rd., 43.85089, -77.13199, Prince Edward County, Ontario, 9 Aug. 2015. Photo P.M. Catling.
Figure 5. Lateral views of northeastern Darners reproduced from Walker (1912), with only *A. septentrionalis* (similar to *A. sitchensis*), missing.
Anax junius (Drury), COMMON GREEN DARNER

Large, 68-78 mm. The greenish thorax is characteristic of this large species. Males have a mostly bluish abdomen and in females the abdomen is pale bluish, purplish, or pinkish. The Comet Darner (Anax longipes Hagen) has a red or brown abdomen.

Mature adults move north in spring and a new summer generation participates in huge southbound flights in the late summer and autumn. Part of the northeastern population overwinters as larvae and may be more or less resident. Migrants breed in the south and an apparently new generation moves north early in spring (April in Great Lakes region).
By attaching tiny radio transmitters to Green Darners in southern New Jersey, it was found that the migratory patterns and decision rules were like those of migrating songbirds (Wikelski 2006). They migrated during the day after two nights of lower temperatures (decrease of 2-6°C) and covered approx. 60 km/day in approx. 6 days. When the ocean at the tip of Cape May Point was encountered, the flight direction was re-oriented to the north to go around Delaware Bay or cross it at a narrow point. Re-orientation of this kind explains directional exceptions during a predominantly southward flight.

Figure 7. Common Green Darner, female. Point Petre, 43.84436, -77.15554, Prince Edward County, Ontario, 10 Sept. 2016. Photo P.M. Catling

Trottier (1966, 1971) reported that both resident and migrant populations existed. He found that a population near Montreal was comprised entirely of migrants. They arrived in early spring, mated, oviposited in May and June, then emerged and migrated in August and September. A southern Ontario occurrence included both a migratory and an overwintering resident population with larval development proceeding at different rates. Adults of the latter oviposited in July and August and nymphs emerged in June and July of the following year.

This is the best known migrating dragonfly in the northeast with autumnal concentrations of many thousands sometimes observed. A high number of 1.2 million individuals of this species were seen at Chicago. They move up to 140 km/day and change direction temporarily to avoid bodies of water 25 km wide.
Figure 8. Swamp Darner, male. Consecon Creek bridge at hwy 62, 44.03238, -77.28603, Prince Edward Co., Ontario, 31 July 2016. Photo P.M. Catling.
**Very large, 82-94 mm.** This is the largest dragonfly in the northeast. The two wide straight lines on the sides of the thorax and the ringed abdomen with two or three rings per segment are distinctive.

This species is at the northern limit of its range in the northeast so there may not always be conspicuous numbers in either spring or fall migration. It sometimes flies high above trees or in shady swamps. It is fast and agile on the wing and generally not frequently encountered. It may be a spring and fall migrant as well as overwintering in the larval stage. It breeds successfully in southern Canada (Hutchinson & Ménard 2007) where emergence likely occurred in early summer since water was gone in mid-August. In autumn concentrations that are presumed to be migratory are reported from the Atlantic coast of the US (e.g Russell et al. 1998 for Cape May) as well as inland to the south (Illinois – see Walker 1958, p. 47).

Figure 9. Swamp Darner, female. Consecon Creek, 44.0302, -77.2851, Prince Edward Co., Ontario, 4 June 2016. Photo B. Kostiuk & P.M. Catling.
On 15 August 2009 Bill Lamond (with Kevin McLaughlin and Alan Wormington) witnessed a large movement of Swamp Darners at Point Pelee National Park, Essex Co., Ontario. They counted 420 during a one hour period, between 1:30 and 2:30 PM, as the dragonflies flew south off of the tip of the point. There were also about 40 Twelve-spotted Skimmers, 2 Wandering Gliders and one Black Saddlebags flying off the tip. Only two Green Darners were seen. They estimated thousands of Swamp Darners in the park on 15 August 2009 based on various observations (B. Lamond, Ont Odo Listserve, 15/08/2009). A southwesterward migration of more than 2000 moved southwest at Race Point Beach near the tip of Cape Cod on 6 June 1995 (Sones 1995). “Huge numbers” of Swamp Darter were reported at Cape May on July 24 2013 (MDP 2013).

Figure 10. Face of male Swamp Darter. Consecon Creek bridge at hwy 62, 44.03238, -77.28603, Prince Edward Co., Ontario, 31 July 2016. Photo P.M. Catling.
Epitheca cynosura (Say), **COMMON BASKETTAIL**

Medium, 39-44 mm. Since this is only a spring or early summer dragonfly it cannot be confused with other species with dark spots at the base of the wing that fly in fall (i.e. *Epitheca princeps* and *Tramea lacerata*). In the more northern parts of the Great Lakes region of Ontario (Muskoka, Ottawa Valley), this species is distinctive in the extensive brown area at the base of the wing but further south on the Lake Erie shore there is often almost no dark spot. Sometimes a degree variability occurs in in regions between where the dark spot is often intermediate in size but may also be larger or smaller. The more southern males are distinctive in having the superior terminal appendage without tubercles or spines (and those from further north have the distinctive dark spot at the base of the wing). This species only flies in the spring but unidirectional flights involving hundreds of individuals are sometimes seen in from mid- May to early June (Catling 2005). Although Kormondy (1959) and Walker and Corbet (1975) described four kinds of flight in this species, they had not observed unidirectional flight which probably takes place over relatively short distances, and apparaently within 10 m of the ground.

Figure 11. Male Common Baskettail with basal dark area of intermediate size on hindwing. Beaver Meadow Conservation Area, 43.9545, -77.1727, Prince Edward County, Ontario, 29 May 2016. Photo P.M. Catling.
Figure 12. Common Baskettail male (above), female below. Bog S of Chaffey’s Lock, 44.4971, -76.4146, Frontenac County, Ontario, 23 May 2015. Photo P.M. Catling.
Figure 13. Calico Pennant male (above), female (below). E. of Middleville, 45.14798, -76.31435, Lanark County, Ontario, 15 June 2016.

**Medium, 29-34 mm.** Although accepted as a migrant by Russell et al. (1998), Walter (1996a,b) considered his western Long Island records due to dispersal. Black wing tips and large basal spot on hindwing differ from Halloween Pennant.
Figure 14. Halloween Pennant male (above), female (below). N side of Army Reserve Rd. between Lighthall and Charwell Rds., 43.8778, -77.10213, Prince Edward County, Ontario. 12 July 2015. Photo P.M. Catling
Medium 36-42 mm. The lack of prominently darkened wing tips separates this from the Calico Pennant and the Banded Pennant (latter mostly south of Great Lakes). The more or less orange colour of the wings and sometimes fluttering flight has led to the idea that it may receive some protection as a result of resembling the distasteful Monarch Butterfly. Although males are said to be similar to females in wing colour, in parts of the Great Lakes at least, females tend to be a much duller reddish-orange and sometimes even straw-colored.

This species is known to have unidirectional flights of post-teneral individuals. These flights may be small but have been quite noticeable. For example between 11:45 and 12:45 AM on a mild sunny, 26°C day (on 15 July 2016), following a 32°C day and a 19°C night, 17 individuals crossed a road 0.5 – 2 m above the ground flying SW into a 15-20 kph wind from that direction at a location in central Prince Edward County north of Wellington on Lake Ontario. This apparently small flight was accompanied by two Anax junius and one Tramea lacerata flying in the same direction.

However, on another occasion (30 July 2015) most were flying NNE into a wind from that direction at a nearby location. This suggested the possibility of their flight direction being determined by wind direction. However, large concentration of up to 500 in 3 acres have been found at natural concentration points such as shorelines and tips of peninsulas that would result from southwesterly movement. At the same time only a few or several are seen over water during these movements. Instead they occur primarily in extensive open meadows and agricultural fields. Some moving both SW and NE were in tandem although mostly not near water.

Examination of road kill perpendicular to a southwesterly flight path in eastern Lake Ontario has revealed two hundred dead individuals evenly distributed along half a km of roadway (and no other dragonflies). It is possible that many hundreds were killed along this stretch of road but many may be quickly removed by birds and some blown far off the road so that what is seen is only a portion of that killed, and those killed were only a small portion of those crossing.

Paulson (2011) refers to seeing many tandem pairs in cross-country flight up to 60 ft above the ground in The Everglades. They cope so well with windy conditions that accumulation due to being blown by wind seems unlikely.

A large number of Celithemis sp. in a small area does not necessarily signify a migration, if there is even a small wetland nearby. For example over 5,000 C. elisa emerged from a 35 x 40 m pond in New York State over a five day period (5-9 June 2006, Gregoire & Gregoire 2008).
Erythrodiplax berenice Drury, **SEASIDE DRAGONLET**

**Small, 31-35 mm.** This species occurs N on the east coast to southern Nova Scotia where it may be disjunct (absent from the Bay of Fundy and from at least the north coast of Maine). It is confined to coastal saltmarsh and appears to be ecologically replaced by the similar Black Meadowhawk northward in Baie de Chaleur (Catling 2009, Catling et al. 2006) but may overlap on south coastal Nova Scotia and part of coastal Maine. Two separate occurrences on the St. Lawrence River may be a result of transport by ship from further south since remnants of true saltmarsh are absent in the lower and middle St. Lawrence despite earlier inundation by the Champlain Sea. There are inland occurrences of Seaside Dragonlet in southwestern U.S.

Figure 15. Seaside Dragonlet, old male. Hampton Beach Salt Marsh, 42.9240, -70.0825, New Hampshire, 13 Sept. 2016. Photo P.M. Catling.

The younger Seaside Dragonlet has thinner pale marks on the side of the thorax compared to two dominant and broad pale markings in the Black
Meadowhawk. The female dragonlet also differs in having a projecting subgenital plate. Males of both species turn black with age, but the dragonlet has longer stigmas (longer than the width of the face (excluding the eyes) but they are shorter in the meadowhawk). The obscure remnant markings of the thorax may also be helpful in males.

This species was considered to be migratory in eastern North America by Russell et al (1998).

Figure 16. Seaside Dragonlet, female. Photo by M. Ostrwski, Assateague Island, Worcester Co., Maryland on 5 June 2010. CC BY-SA 2.0.

Figure 17. Seaside Dragonlet habitat in Hampton Saltmarsh. Photo P.M. Catling.
Figure 18. Twelve-spotted Skimmer male (above), female (below). Male, Millenium Trail at bridge near hwy 33, 43.9655, -77.2850, Prince Edward County, Ontario, 27 June 2016. Female, Beaver Meadow Conservation Area, 43.9578, -77.1778, Prince Edward County, Ontario, 7 June 2015. Photo P.M. Catling.
Large, 52-57mm. Both males and females have 12 black spots on the wings. In males only, there are 8 white spots between the black spots. Females and younger males without white spots may be confused with females of *Platthemis lydia* (Drury), the Common Whitetail, which has entirely different males with black banded wings. The females of *P. lydia* have triangular instead of rectangular pale markings on the sides of the thorax characteristic of Twelve-spotted Skimmer. See also Prince Baskettail under rejected species.

Twelve-spotted Skimmers are seen in small numbers in late Aug. and early Sept. migrations of Green Darners on the Atlantic coast (Russell et al. 1998). A high of 990 were seen on western Long Island on 10 Aug. 1996 (Walter 1996a,b). They have also been reported from boats in Delaware Bay (Soltesz et al. 1995).

Figure 19. Twelve-spotted Skimmer female. The diagonal pale lines on the thorax and the rectangular markings on the abdomen are characteristic of this species. Beaver Meadow Conservation Area, 43.9578, -77.1778, Prince Edward County, Ontario, 7 June 2015. Photo P.M. Catling
Libellula semifasciata Burmeister, **PAINTED SKIMMER**

Figure 20. Painted Skimmer, male. Charwell Pt. Rd. Fen, 43.8793, -77.0893, Prince Edward County, Ontario, 1 June 2015. Photo P.M. Catling.

**Medium 45-48 mm.** Walter (1996a,b) noted that it occurred on western Long Island in New York in low numbers but “its flight was direct and unquestionably that of a migrant”. It is reported to migrate relatively early (35 on 29 July). In May it has been numerous in the New York city area appearing on Manhattan streets. A southwestward migration of this species was documented at Race Point Beach near the tip of Cape Cod on 6 June 1995 (Sones, 1995). During the same year hundreds were observed in southern New Jersey from mid- to late April at a time prior to anticipated local emergence (Soltesz et al. 1995).
Libellula vibrans Fabricius, GREAT BLUE SKIMMER

Large, 56-63 mm. The bright blue body and white face of males is distinctive. Females pale with top of the legs (femora) distinctively pale-based. Both sexes have darkened wing tips.

In 1995 there was a sudden influx on 20 and 21 May, much earlier than they had been recorded previously and in sites where they had not been seen the previous year. Soltesz et al. (1995) speculated that a northward movement of Great Blue Skimmers may occur every year with varying intensity due to the length of the period of southerly winds. Movements of this species have been reported in spring and early summer.

Figure 21. Great Blue Skimmer. Rhododendrites, July 2014. CC-BY-SA-4.0.
*Pachydiplax longipennis* (Burmeister), **BLUE DASHER**
Figure 22 (previous page). Blue Dasher, male above, female below. Male, S side of Picton below Delhi Park, 44.00604, -77.13847, Prince Edward County, Ontario, 18 June 2016. Female, Picton Harbour, 44.00991, -77.13512, Prince Edward County, Ontario, 13 July 2016. Photo P.M. Catling.

Figure 23. Blue Dasher, female. Female may develop a pale bluish abdomen as seen in mature males, or retain a brownish abdomen with pale spots. Bryant Rd. Quarry Pond, 44.0614, -77.5396, Prince Edward County, Ontario, 12 July 2016. Photo P.M. Catling.

**Small – medium, 28-45 mm.** The black tipped blue abdomen is distinctive in mature males which may have either brownish or green eyes. The pattern of pale stripes on the side of the thorax is helpful in identification of both sexes. Wings often with dark streaks at the base and tinted with brown. With age the males may develop extensive brown areas beyond the middle of the wings. The similar Eastern Pondhawk lacks colour at the wing base and stripes on the thorax. Blue Dashers are said to be large in the spring and small in the autumn (Paulson 2011, p. 492). This was accepted as a migrant by Russell et al. (1998). It was seen moving consistently to the south on western Long Island by Walter (1996a, b) where the high of 207 on 1 Aug. 1998 seemed low. Walter speculated that it may be only a partial migrant. Eight were observed on a boat 12 km from the shore on Delaware Bay on 6 June 1992 and adults were abundant in places where emergence had not yet occurred and tenerals not yet seen (Soltesz et al. 1995).
Pantala flavescens (Fabricius), **WANDERING GLIDER**

Figure 24. Wandering Glider, male. Picton, 44.0089, -77.1408, Prince Edward County, Ontario, 7 Sept. 2015. Photo P.M. Catling.

**Medium, 47-50 mm.** The yellow to orange-brown colour of this species is distinctive. It glides and hovers with a swift, agile flight. Wandering Gliders have a global distribution and wandering is so extensive that a recent genetic study suggested that globally there is only a single panmictic population (Troast et al. 2016, see also p. 6 under ‘Some dragonflies are major migrants’). Although the large migrating groups of Green Darners in autumn often have only a few Wandering Gliders or Spot-winged Gliders, there are some reports of large groups of these two. Wandering Gliders were 80% and Spot-winged Gliders 10% of hundreds of dragonflies seen moving northwest at South Beach, Morris Island, Cape Cod, Mass., on 30 July 1995. On the same day, a hundred were also seen on Cuttyhunk Island, large numbers were at Cape Ann near Rockport, and thousands were moving north past Cape May (Nikula and Sones 1995). During migration they may congregate along roads and in parking lots.
Pantala hymenaea (Say), **SPOT-WINGED GLIDER**

**Medium 45-50 mm.** The dark spot at the middle base of the hindwing is distinctive for this species. It has two pale diagonal streaks on the thorax as do some other migratory species, but not the Wandering Glider. The brown, instead of orange-yellow or reddish, body also helps to distinguish it from the Wandering Glider in flight. Older individuals may lose the contrasting abdomen pattern.

Spectacular spring and fall flights are seen on the Atlantic coast, but it is less common than the Wandering Glider northward. Remarkably it has been reported from the north shore of Lake Superior and even southern James Bay.

Figure 25. Spot-winged Glider male. Point Petre, 43.84436, -77.15554, Prince Edward County, Ontario, 27 Aug. 2016. Photo P.M. Catling.
Sympetrum corruptum (Hagen), VARIEGATED MEADOWHAWK

Figure 26. Variegated Meadowhawk, male. Photo by S. Berardi, California, 9 Oct. 2010. CC BY-SA 2.0.

**Medium 39-44 mm.** The contrasting red (or yellow-brown), white and black on the abdomen is distinctive for this species. It is larger than the other meadowhawks and has two pale lines on the side of the thorax (the latter character shared with a few other species treated here). The legs are black and yellow striped and the stigma is darker in the middle than at each end.

This species migrates in large numbers in late summer in the western mountains and along the Pacific coast. Individuals seen in the east may be vagrants from the west, but it is known to breed in high phosphorous habitats in eastern Ontario (sewage lagoons with western birds such as Wilson`s Phalarope, Bracken and Lewis 2003). Newly emerged Variegated Meadowhawks were reported at the St. Lazarre Sand pits Quebec in late July (MDP 2013). They arrive in Wisconsin on warm winds from the south in mid-April (Legler et al. 1998).
Sympetrum danae (Sulzer), **BLACK MEADOWHAWK**

Figure 27. Black Meadowhawk, male. Oliphant Beach Fen, 44.74089, -81.27911, Bruce County, Ontario, 23 July 2016. Photo P.M. Catling.

**Small, 30-33 mm.** The mature black males, but without a white face as in species of *Leucorrhinia*, are distinctive. Females and younger males may be confused with other species of *Sympetrum* but differ in their darker colour and very pronounced and complex yellow pattern on the sides of the thorax including bright yellow stripes. In older males and females this yellow pattern becomes dark brown or dark greenish-brown but is still often visible (until it darkens further, especially in
males). Note also paired long triangles on top of the abdomen and brown on front of thorax in younger individuals. The pale markings on the side of the abdomen are thicker than in the Seaside Dragonlet.

In various parts of Europe, *S. danae* migrates inland, along coasts, over the sea and arrives on coastal islands (reviewed by Corbet 1999, p. 420-421 and see also Walker and Corbet 1975 reference to migration off the Irish coast).

Although this species has not been implicated in migrations in Canada, it is found far south of summer breeding areas in the late autumn. On 9 October 2003, one was found in Point Pelee National Park at the western end of Lake Erie. Several were present in a swamp near Ottawa in early October of 1996 having survived three frosts. Some endured later frosts with the last seen there on 27 October 1996. In addition several were encountered on the Toronto waterfront in early October 1996. It was not reported at these locations before or after and it may, or may not, be an inconspicuous late autumn migrant. Its occurrences in southern Ontario where we have seen tenerals or otherwise suspect breeding include places with disjunct boreal flora and fauna including the cool fens on the west side of the Bruce Peninsula, higher areas and extensive cold bogs.

Similar to the situation in Ontario, King (2016) indicates that in Minnesota “recent observations indicate it may occasionally migrate south late in the year”.

Figure 28. Black Meadowhawk, Elfin Skimmer, and Saffron-winged Meadowhawk habitat at Oliphant Beach Fen, 44.74089, -81.27911, Bruce County, Ontario, 23 July 2016. Photo P.M. Catling.
*Sympetrum rubicundulum* (Say), **RUBY MEADOWHAWK**

Figure 29. Ruby Meadowhawk, male. The right hamule of the illustrated specimen is shown in lateral (above) and ventral (below) views. Fry Rd., 44.063, -77.1659, Prince Edward County, Ontario, 13 July 2015. Photo P.M. Catling.

**Small, 33-34 mm.** Males of this group are bright red, females tan-orange, both with black triangles along the side of the abdomen. Males in particular have a tan face and this is a very helpful identification feature, but some populations of *S. obtrusum* (“normally” with a white or ivory face) and *S. internum* (“normally” with a red face) have a face that is yellowish or dirty white. These have been called “dirty-faced” or Jane’s Meadowhawks (*S. janae*) by some experts, but have generally not been recognized as distinct (e.g. Donnelly 1998). Although some authors believe that “face colour is of no value”, it may be of value in some regions where hybridization does not occur.

The group is often referred to as a “complex” and hybridization between taxa may be frequent. With intermediate colouration and difficult morphology, identification can be a challenge. One guide warns of frustration and suggests that
the reader “grab a cold beer, sit down, and wait for the feeling to go away”. A few experts have claimed that field identification is not possible and use characteristics of the male hamules (Donnelly 2013, Figure 30). The difficulties with intergradation and hybridization may be regional, - for example the east coast but not all of the Great Lakes region.

**Some details:** Within northeastern North American *Sympetrum*, two species have two rows of cells between the radial intercalary vein (IR3) and the radial supplement or planate vein (Rspl, - Walker and Corbet 1975, p. 6). These are *S. corruptum* and *S. madidum*. The remainder have only one row. Of these five are without a prominent ventral tooth on the superior appendage of the male and the vulvar lamina of the female is only slightly emarginate (*S. costiferum, S. danae, S. occidentale, S. semicinctum, and S. vicinum*). Of the remaining four species that do have a ventral tooth or a deeply bifid vulvar lamina, *S. ambiguum* has the tibiae yellow externally and the upper part of the face bluish or greenish. This leaves three rather similar species with tibiae black externally and face coloured variously (including *S. rubicundulum*).

The three taxa may be more or less separated by the key below but they intergrade to a degree and additional taxonomic clarification of this group is required. Various theses initiated to resolve the problems have failed (Michalski 1991).

**1a.** In male apex of hamules bifid for 1/3 of length in lateral view; apex of dorsal branch of hamulus rounded or somewhat pointed; face of adult male yellowish-red; vulvar lamina of female inflated and fused along midline for much of its length, the tips not divergent … *S. rubicundulum*

**1b.** In male apex of hamules bifid for less than 1/4 of length in lateral view; apex of dorsal branch of hamulus square and sometimes bifid; face of adult male reddish or whitish; vulvar lamina of female not inflated and not fused along midline for more than a third of its length, the tips divergent or not … 2

**2a.** In male apex of hamules bifid for 1/4 of length in lateral view; face of adult male reddish; apices of vulvar lamina of female somewhat divergent … *S. internum*

**2b.** In male apex of hamules bifid for 1/5 of length in lateral view; face of adult male whitish; apices of vulvar lamina of female not divergent … *S. obtrusum*
Ruby Meadowhawks frequently perch on the tips of dead branches. They breed in temporary, marshy, and fishless pools in swampy areas and may be the earliest Meadowhawks to emerge (early July). This species was accepted as a migrant by Russell et al. (1998). Despite the identification difficulties, it should at least be separable from other Meadowhawks demonstrating migratory behaviour.

Figure 30. Hamules (sternal region of male abdominal segment 2) in ventral and lateral view (redrawn from Donnelly 2013), and vulvar lamina (female ventral segment 9) in ventral view (redrawn from Walker and Corbet 1975).

*Sympetrum vicinum* (Hagen), **AUTUMN MEADOWHAWK**
Figure 31. Autum Meadowhawk male (above) and female (below). Charwell Rd. ponds, 43.07851, -77.09167, Prince Edward County, Ontario, 22 Aug. 2015. Photo P.M. Catling.
Small, 31-35 mm. The yellow (or pale) legs distinguish this from similar northeastern species. Although adults may have some red on the face, the lack of the prominent and well delineated black triangles on the sides of the thorax is helpful in separating this from the Cherry-faced Meadowhawk (*Sympetrum internum* Montgomery).

Figure 32. Immature Autumn Meadowhawks are pale yellow (female shown here). Weatherhead Rd. Marsh, 44.1041, -77.3955, Prince Edward County, Ontario, 12 July 2016. Photo P.M. Catling.

In the fall, this species appears suddenly by the hundreds far from water and disappears just as quickly (e.g. King 2013). Unidirectional flight involving mostly pairs (in tandem) is far more widespread than the few published observations suggest (e.g. Catling & Brownell 1997) but it may not be over long distances. Sixty pairs passed an observation point in eastern Ontario flying southwest on 1 Oct. 1996. It was estimated that 10,000 pairs moved southwest through a 20 mile wide corridor in eastern Ontario in the first part of October that year. Since pairs are involved, reproduction may be an objective, but tandem flight may also improve buoyancy. May (2013) questioned whether the unidirectional flights of this species were “seasonal refuge flights”.

**Key to northeastern Species of *Tramea***
The only species of *Tramea* that are seen fairly often seen as migrants in the northeast are the Carolina and Black Saddlebags, but other species are reported and may become more abundant. These latter two are the largest, around 50 mm long, whereas the Red and Striped are smaller, 40-50 mm long. The Red Saddlebags is more common in Wisconsin and on the west side of the northeast as defined here than the Carolina Saddlebags. It is reported in swarms away from water with Black Saddlebags and Wandering Gliders (Paulson 2011), this raising some question about whether or not it migrates. Apart from the narrow saddle, the abdomen is pale brown or reddish-brown but black at the tip. See also discussion of Striped Saddlebags under “Excluded Species”.

1a. Hindwing saddle (basal wing patch) 3 times as long as wide … *Tramea calverti*
1b. Hindwing saddle (basal wing patch) 2 times as long as wide … 2

2a. Wing patches and body black … *Tramea lacerata*
2b. Wing patches and body red or reddish-brown … 3

3a. Wing patches smaller; face red, no metallic-violet on forehead; black spots only on top of S8,S9; clear window on inside of wing patch circular and as wide as abdomen … *Tramea onusta*
3b. Wing patches larger; face not red, metallic-violet on forehead; black spots on top of S8,S9 mostly extending to bottom of segment; clear window on inside of wing patch less obvious and triangular … *Tramea carolina*
Large, 41-49 mm. Much less common than the Black Saddlebags in northeastern fall migrations. Older males are distinctive in its mostly bright red to reddish-brown abdomen and reddish-brown basal hindwing venation. S8 and 9 are mostly black. In younger individuals and females the red colouration may be brown or yellow-brown, and they are less easily distinguished from Black Saddlebags. It may be undercounted due to being mistaken for the Black Saddlebags. Probably mostly a vagrant in southern Canada, but more than a dozen “red saddlebags” seen at the tip of Long Point on Lake Erie on 23 May 2013. The presence of red individuals in spring and of only yellow-brown individuals in fall has led to the notion that it does not breed in the Kitchener region of southern Ontario (Ont Odo Listserve 03/09/2014). At least 3 Carolina Saddlebags were part of a congregation of 2500 Black Saddlebags and 1800 Green Darners at Pelee on 17/09/2011 (Ont Odo Listserve, 19/09/2011). On 29 July 1997 at Fort Tilden on western Long Island, New York, 24 migrants reported (Walter 1996a).

Figure 33. Carolina Saddlebags, male in front, female behind. Photo by F. Flannery, Richmond, North Carolina. CC BY-SA 2.0.

Tramea lacerata Hagen, BLACK SADDLEBAGS
Large, 51-55 mm. The extensive black bases of the hindwings are characteristic of this mostly black species. Females are paler and may have more yellow on the abdomen.

In southern Ontario this species appears to have colonized areas north of its northern limit of approx. 20 years ago (e.g. Bracken & Lewis 2002). The result of this is its presence in migratory concentrations, north of where it was previously seen in the fall such as the northeast shore of Lake Ontario. This species was more common than Green Darner at the Cranberry Marsh hawk migration monitoring site in western Lake Ontario in 1999 (Barker 2000) where a high of 410 were seen on 15 Sept. and 1246 were seen overall. It was second to Green Darner (21%) of
dragonflies recorded at Hawk Watch monitoring stations (HMANA 2014). Although Black Saddlebags and Green Darners often migrate together in the fall as with the 250,000 at Rocky Knob, Virginia, on 13 Sept. 1992 (Kessler 2013), in some places the peak of Black Saddlebags may be a little earlier.

References


Ontario Odes list serve, https://groups.google.com/forum/#!forum/Ont-Odes


Taber, B. 2002. Spring dragonfly (Odonata) and butterfly (Lepidoptera) fallout at the Chesapeake Bay Bridge-tunnel. Bannisteria 19: 26-27.
Appendix 1: Excluded species

The species listed below have not been observed in definite southward migration and/or may be dispersed north occasionally on prolonged winds from the south (Russell et al. 1998, pers. obs.).

*Epitheca (Epicordulia) princeps*, PRINCE BASKETTAIL

Figure 35. Prince Baskettail female. Benway Rd. at hwy 1, 44.0076, -77.4355, Prince Edward County, Ontario, 19 June 2016. Photo P.M. Catling.

**Large, 59-75 mm.** Up to 20 individuals of this species have been found in mid-September in glades of wooded areas in northeastern Lake Ontario but a definite migration is not clear. It is still advisable to draw attention to this species since (as
well as the female whitetail, *Plathemis lydia*), it can be confused with the migratory Twelve-spotted Skimmer (p. 32) which differs in having diagonal pale lines on sides of the thorax and a shorter and thicker abdomen. There is both regional and local variation in the size and number of dark spots on the wings. Individuals lacking the central wing spot may look like the migratory Black Saddlebags (*Tramea lacerata*), but the hind wings of the latter are much wider basally and dark spot extends across the whole basal area of the hind wing.

*Erythemis simplicicollis* Say, **EASTERN PONDHAWK**

![Eastern Pondhawk](image)

Figure 36. Eastern Pondhawk male (above), female (below). Male, Ben Gill Quarry Pond, 44.038302, -77.289317, Prince Edward County, Ontario, 11 June 2016. Female, MacCauley Mtn. Pond, 44.0046, -77.1258, Prince Edward County, Ontario, 1 Aug. 2015. Photo P.M. Catling.
Medium, 38-44 mm. The large numbers on Chesapeake Bridge (Taber 2002) and unidirectional flight at Rocky Knob (Kessler 2013) are noteworthy, but more information is required for this species. It is a widespread and often abundant dragonfly of ponds and marshes.

Young males and females are mostly green. Older males develop a pruinose blue abdomen and later the thorax also turns pruinose blue. A blue mature male Eastern Pondhawk might be confused with a Blue Dasher but the latter has a whitish face and pale stripes on the thorax. The thorax of the Eastern Pondhawk is completely blue (or green or both) and the face is green. At the stage when the abdomen is blue but the thorax green, Eastern Pondhawks may be confused with Green Darners, but the latter are much larger and have a darker blue or pink abdomen with a pattern of black markings. Female Eastern Pondhawks have a distinctive downward projecting subgenital plate at tip of abdomen.

Libellula axilena Westwood, Bar-Winged Skimmer

Figure 37. Bar-winged Skimmer. Vicki De Loach, 2 June 2013. CC BY-NC-ND 2.0

Large, 41-46 mm. On the edge of its range in the northeast. The early sightings (numbers not available) for L. axilena in 1995 in New Jersey (Soltesz et al. 1995) may suggest that it was a “spring migration year” for this and other species.

The immature males and females are brown and yellow. Mature males are blue. Mature males differ from Great Blue and Slaty Skimmers by the more prominent wing markings. Females and immature males have a prominent dark line that widens below on the thorax below the hind wing, unlike Slaty Skimmer. The femora is entirely black unlike Great Blue Skimmer.
*Libellula quadrimaculata* Linnaeus, **FOUR-SPOTTED SKIMMER**
Large, 42-46 mm. This species differs from the Painted Skimmer in being without terminal wing bands. Both Pennants and the Twelve-spotted Skimmer have more prominent spots. Older individuals become dark and greyish.

Although migrations of this species have not been reported in eastern North America (or elsewhere in North America), it is a well-known migrant in Europe. An estimated 100,000 per hour were noted flying west on the Skaw Peninsula of Denmark on 16 May 2000 (Hansen 2001, see also Burton 1996). Larger migrations are said to occur at 10 year intervals and to be stimulated by trematode worm parasitism. The European mass movements usually occur in late May. Other information on European migrations is provided by Corbet (1999, p. 418 and elsewhere). Smaller scale movements may occur in North America, but have not attracted attention.
Sympetrum costiferum (Hagen), **SAFFRON-WINGED MEADOWHAWK**
Medium, 31-37 mm. It wanders and breeds in the same habitats as the Wandering Glider but is uncommon and evidence for unidirectional movements is lacking.

*Tramea calverti* Muttkowski, **STRIPED SADDLEBAGS**
Large, 45-49 mm. The periodic northward movements of this species may be attributed to unusual weather conditions (Soltesz 1992). In 2010 this species first appeared in Sept. and Oct. Various reports suggest that it may be expanding its normal range northward.

Appendix 2, Figures and their sources.

**Figure 1. Some locations of reports** of dragonfly movements and migration in the northeast. P.M. Catling.

**Figure 2.** Replica of the dragonfly Tiffany lamp hand-made with stained leaded glass by Louis Comfort Tiffany in New York City is 60 cm diameter x 20 cm high and includes 400 pieces of glass. Tiffany shades were popular between 1890 and 1910 but the first art demonstrating the charismatic nature of dragonflies was much earlier. Hannes Grobe, 12 June 2007. CC-BY-SA-2.5.

**Figure 3. Lake Darner**, male. Beaver Meadow Conservation Area, 43.95794, -77.17778, Prince Edward Co., Ontario, 6 Sept. 2015. Photo P.M. Catling.

**Figure 4. Lance-tipped Darner**, male. Stream on Simpson Rd., 43.85089, -77.13199, Prince Edward County, Ontario, 9 Aug. 2015. Photo P.M. Catling

**Figure 5.** Lateral views of northeastern Darners reproduced from Walker (1912), with only *A. septentrionalis* (similar to *A. sitchensis*), missing.

**Figure 6. Common Green Darner**, male. Macauley Mtn. Pond, 44.0046, -77.1258, Prince Edward County, Ontario, 1 Aug. 2015. Photo P.M. Catling.

**Figure 7. Common Green Darner**, female. Point Petre, 43.84436, -77.15554, Prince Edward County, Ontario, 10 Sept. 2016. Photo P.M. Catling

**Figure 8. Swamp Darner**, male. Consecon Creek bridge at hwy 62, 44.03238, -77.28603, Prince Edward Co., Ontario, 31 July 2016. Photo P.M. Catling.

**Figure 9. Swamp Darner**, female. Consecon Creek, 44.0302, -77.2851, Prince Edward Co., Ontario, 4 June 2016. Photo B. Kostiuk & P.M. Catling.
Figure 10. Face of male Swamp Darner. Consecon Creek bridge at hwy 62, 44.03238, -77.28603, Prince Edward Co., Ontario, 31 July 2016. Photo P.M. Catling.

Figure 11. Male Common Baskettail with basal dark area on hindwing of intermediate size. Beaver Meadow Conservation Area, 43.9545, -77.1727, Prince Edward County, Ontario, 29 May 2016. Photo P.M. Catling.

Figure 12. Common Baskettail male (above), female below. Bog S of Chaffey’s Lock, 44.4971, -76.4146, Frontenac County, Ontario, 23 May 2015. Photo P.M. Catling.

Figure 13. Calico Pennant male (above), female (below). E. of Middleville, 45.14798, -76.31435, Lanark County, Ontario, 15 June 2016. Photo P.M. Catling.

Figure 14. Halloween Pennant male (above), female (below). N side of Army Reserve Rd. between Lighthall and Charwell Rds., 43.8778, -77.10213, Prince Edward County, Ontario. 12 July 2015. Photo P.M. Catling.

Figure 15. Seaside Dragonlet, old male. Hampton Beach Salt Marsh, 42.9240, -70.8205, New Hampshire, 13 Sept. 2016. Photo P.M. Catling.

Figure 16. Seaside Dragonlet, female. Photo by M. Ostrwski, Assateague Island, Worcester Co., Maryland on 5 June 2010. CC BY-SA 2.0.

Figure 17. Seaside Dragonlet habitat in Hampton Saltmarsh. Photo P.M. Catling.

Figure 18. Twelve-spotted Skimmer male (above), female (below). Male, Millenium Trail at bridge near hwy 33, 43.9655, -77.2850, Prince Edward County, Ontario 27 June 2016. Female, Beaver Meadow Conservation Area, 43.9578, -77.1778, Prince Edward County, Ontario, 7 June 2015. Photo P.M. Catling.

Figure 19. Twelve-spotted Skimmer female. The diagonal pale lines on the thorax and the rectangular markings on the abdomen are characteristic of this species. Beaver Meadow Conservation Area, 43.9578, -77.1778, Prince Edward County, Ontario, 7 June 2015. Photo P.M. Catling.

Figure 20. Painted Skimmer, male. Charwell Pt. Rd. Fen, 43.8793, -77.0893, Prince Edward County, Ontario, 1 June 2015. Photo P.M. Catling.

Figure 21. Great Blue Skimmer. Rhododendrites, July 2014. CC-BY-SA-4.0.

Figure 22. Blue Dasher, male above, female below. Male, S side of Picton below Delhi Park, 44.00604, -77.13847, Prince Edward County, Ontario, 18 June 2016. Female, Picton Harbour, 44.00991, -77.13512, Prince Edward County, Ontario, 13 July 2016. Photo P.M. Catling.

Figure 23. Blue Dasher, female. Female may develop a pale bluish abdomen as seen in mature males, or retain a brownish abdomen with pale spots. Bryant Rd. Quarry Pond, 44.00614, -77.5396, Prince Edward County, Ontario, 12 July 2016. Photo P.M. Catling.

Figure 24. Wandering Glider, male. Picton, 44.0089, -77.1408, Prince Edward County, Ontario, 7 Sept. 2015. Photo P.M. Catling.
Figure 25. **Spot-winged Glider** male. Point Petre, 43.84436, -77.15554, Prince Edward County, Ontario, 27 Aug. 2016. Photo P.M. Catling.

Figure 26. **Variegated Meadowhawk**, male. Photo by S. Berardi, California, 9 Oct. 2010. CC BY-SA 2.0.

Figure 27. **Black Meadowhawk**, male. Oliphant Beach Fen, 44.74089, -81.27911, Bruce County, Ontario, 23 July 2016. Photo P.M. Catling.

Figure 28. **Black Meadowhawk**, Elfin Skimmer, and Saffron-winged Meadowhawk habitat at Oliphant Beach Fen, 44.74089, -81.27911, Bruce County, Ontario, 23 July 2016. Photo P.M. Catling.

Figure 29. **Ruby Meadowhawk**, male. The right hamule of the illustrated specimen is shown in lateral (above) and ventral (below) views. Fry Rd., 44.063, -77.1659, Prince Edward County, Ontario, 13 July 2015. Photo P.M. Catling.

Figure 30. Hamules (sternal region of male abdominal segment 2) in ventral and lateral view (redrawn from Donnelly 2013), and vulvar lamina (female ventral segment 9) in ventral view (redrawn from Walker and Corbet 1975).

Figure 31. **Autum Meadowhawk** male (above) and female (below). Charwell Rd. ponds, 43.07851, -77.09167, Prince Edward County, Ontario, 22 Aug. 2015. Photo P.M. Catling.

Figure 32. Immature **Autum Meadowhawks** are pale yellow (female shown here). Weatherhead Rd. Marsh, 44.1041, -77.3955, Prince Edward County, Ontario, 12 July 2016. Photo P.M. Catling.

Figure 33. **Carolina Saddlebags**, male. Photo by V. DeLoach, Georgia. CC BY-NC-ND 2.0.

Figure 34. **Black Saddlebags**, male. Little Bluff Marsh, 43.93536, -76.9912, Prince Edward County, Ontario, 24 June 2016. Photo P.M. Catling.

Figure 35. **Prince Baskettail** female. Benway Rd. at hwy 1, 44.0076, -77.4355, Prince Edward County, Ontario, 19 June 2016. Photo P.M. Catling.

Figure 36. **Eastern Pondhawk** male (above), female (below). Male, Ben Gill Quarry Pond, 44.038302, -77.289317, Prince Edward County, Ontario, 11 June 2016. Female, MacCauley Mtn. Pond, 44.0046, -77.1258, Prince Edward County, Ontario, 1 Aug. 2015. Photo P.M. Catling.

Figure 37. **Bar-winged Skimmer**. Vicki De Loach, 2 June 2013. CC BY-NC-ND 2.0.

Figure 38. **Four –spotted Skimmer** male (above) and female (below). Charwell Point Rd., 43.8744, -77.0857, Prince Edward County, Ontario, 7 June 2015. Photo P.M. Catling.

Figure 39. **Four-spotted Skimmer**, older, dull male. Weatherhead Rd. Marsh, 44.1041, -77.3995, Prince Edward County, Ontario, 12 July 2016. Photo P.M. Catling.
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