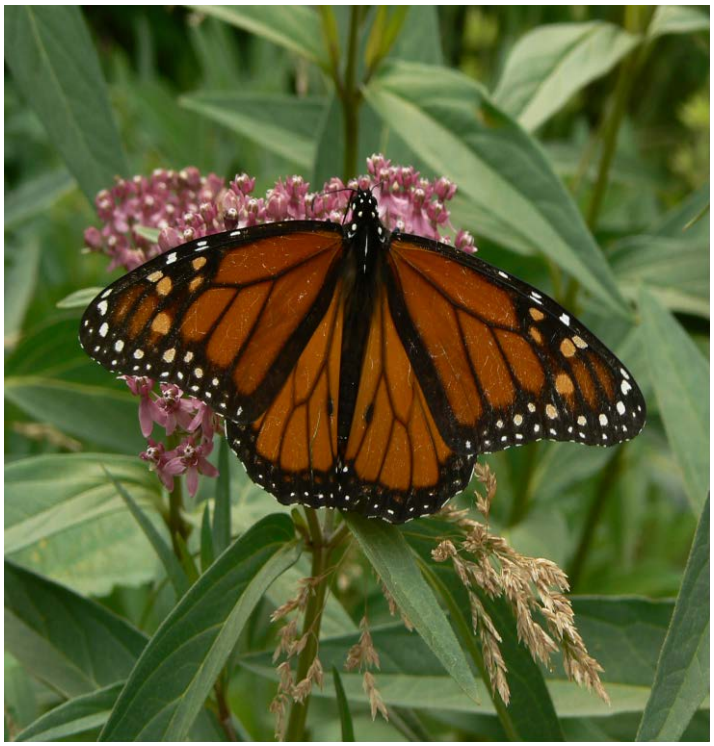
***Species at Risk Act***
Management Plan Series

# Management Plan for the Monarch (*Danaus plexippus*) in Canada

## Monarch



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**Cover illustration:** Monarch © Karine Bériault 2007

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[1] http://sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1

# PREFACE

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of management plans for listed Special Concern species and are required to report on progress within five years after the publication of the final document on the SAR Public Registry.

The Minister of Environment and Climate Change and Minister responsible for the Parks Canada Agency is the competent minister under SARA for the Monarch and has prepared this management plan, as per section 65 of SARA. To the extent possible, it has been prepared in cooperation with the provincial governments of British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Québec, New Brunswick, Nova Scotia and Prince Edward Island, as per section 66(1) of SARA.

Success in the conservation of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this plan and will not be achieved by Environment and Climate Change Canada, Parks Canada Agency, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this plan for the benefit of the Monarch and Canadian society as a whole.

Implementation of this plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

[2] http://registrelep-sararegistry.gc.ca/default.asp?lang=En&n=6B319869-1%20

# ACKNOWLEDGMENTS

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Numerous researchers and Monarch enthusiasts also contributed to the writing and development of this document. This management plan would not have come to fruition without the help and advice received from Donald Davis (Chair, Monarch Butterfly Fund), Jennifer Heron (British Columbia Provincial Government), Jean Lauriault (Canadian Museum of Nature), Michel Leboeuf, Yves Dubuc (researchers in Quebec), Maxim Larivée and Stéphane Le Tirant (Montréal Insectarium), Jocelyne Jacob (National Capital Commission), Ryan Drum (United States Fish and Wildlife Service), Ignacio J. March Mifsut (Ministry of Environment and Natural Resources - Mexico) and Scott Black (Xerces Society for Invertebrate Conservation).

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# EXECUTIVE SUMMARY

The Monarch is an insect for which the remarkable lifecycle and migration of certain populations has attracted the attention of people worldwide. In North America, the Monarch is a symbol of international cooperation, conservation and appreciation of nature. Although the Monarch lives in temperate regions during the summer, no life stage of the Monarch is able to survive temperate-zone winters and each autumn Monarch migrate south to overwintering sites, and then return to the southern portion of their breeding range the following spring to begin the cycle again.

In the Americas, the Monarch comprises five populations with different overwintering areas but without discrete genetic differentiation. They are the Eastern North American, Western North American, Southern Florida, Cuban and Central American populations. In Canada, the Monarch comprises two mostly disjunct populations: a large and widely distributed Eastern population and a smaller Western population. This management plan addresses both the Eastern and Western populations. It is estimated that between 10% and 15% of the North American breeding population of Monarch is found in Canada, although density varies from year to year.

The Monarch was listed as a species of Special Concern under Canada's *Species at Risk Act* (SARA) in 2003. This designation was based on the premise that, although this species has a population of millions to over one billion individuals, it is vulnerable in the most sensitive stage of its annual cycle, during its overwintering. The overwintering areas occupied by Monarch are very restricted and threats to these sites, combined with threats to breeding habitat and along migratory routes, are sufficient to suggest that the species could become threatened in the near future. The Eastern and Western Monarch populations have declined dramatically over the past 15 to 20 years.

Limiting factors for Monarch include their restricted overwintering grounds, the impact of parasitoids and parasites, unstable spring conditions in the Gulf of Mexico coastal states where the first breeding event occurs following their overwintering in Mexico (Eastern population), and predation on their overwintering grounds.

The primary threats facing Monarch include the degradation and loss of overwintering habitat in Mexico and along the Californian coast, the widespread use of pesticides and herbicides throughout their breeding grounds, climate change, severe weather events, succession and conversion of breeding and nectaring habitat, and for the Eastern population, the impacts of Bark Beetles on overwintering habitat.

As agreed to with the United States and Mexico, the long-term goal is to ensure the conservation of the Monarch butterfly migratory phenomenon. In the near-term, and to substantially lower the risk of extinction of the Eastern Monarch population, the three countries will work towards a target of six hectares of occupied overwintering habitat in Mexico by 2020. The available information is not sufficient to set a quantitative population target for the Western migratory Monarch population. The three countries have agreed to work towards identifying a target for the Western migratory Monarch population.

Broad strategies and conservation measures have been identified to help achieve the management objectives for the Monarch.

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# 1. COSEWIC* SPECIES ASSESSMENT INFORMATION

**Date of Assessment:** April 2010

**Common Name (population):** Monarch

**Scientific Name:** *Danaus plexippus*

**COSEWIC Status:** Special Concern

**Reason for Designation:** This species has a population of millions to over one billion individuals. The most sensitive stage of its annual cycle is overwintering. There are two main overwintering areas: the Oyamel Fir Forests of Central Mexico, where 90% of the population overwinters, and the coastal regions of California. The overall area of these sites is relatively small, and threats, especially from logging in the Oyamel Fir Forests are sufficient to suggest that the species could become Threatened in the near future.

**Canadian Occurrence:** BC, AB, SK, MB, ON, QC, NB, PE, NS

**COSEWIC Status History:** Designated Special Concern in April 1997. Status re-examined and confirmed in November 2001 and in April 2010.

*Committee on the Status of Endangered Wildlife in Canada

# 2. SPECIES STATUS INFORMATION

Globally, the rank assigned to the Monarch is G4 (apparently secure) (NatureServe, 2016); see Table 1 for a list and description of the various jurisdictional conservation ranks. It is estimated that between 10% and 15% of the North American breeding population of the Monarch is found in Canada, but density varies from year to year (Oberhauser, pers. comm., 2012). In Canada, the Monarch was listed as Special Concern under the federal *Species at Risk Act* in 2003. It is also listed as Special Concern under Ontario's *Endangered Species Act, 2007* and New Brunswick's *Species at Risk Act, 2012*. At the time of publication, the United States Fish and Wildlife Service was conducting a status review of the Monarch under the *Endangered Species Act*, following a petition by conservation organizations and species experts to list the species as Threatened.

**Table 1. List and description of various conservation status ranks for the Monarch (NatureServe, 2016; ACCDC, 2013a).**

| Species/Population | G-Rank* | N-Rank | S-Rank |
|---|---|---|---|
| Monarch | G4 | Canada: N5B<br><br>USA: N5B, N2N3 | British Columbia (S3B); Alberta (S3**); Saskatchewan (S3B); Manitoba (S5B); Ontario (S2N, S4B); Quebec (S5B); New Brunswick (S3B); Nova Scotia (S2B); Prince Edward Island (S1B); Newfoundland Island (S2B) and Labrador (SNR) |
| Monarch – Mexican overwintering population (Eastern migratory population) | G4T1 | Canada: NNR<br><br>USA: NNRB | Alberta (SNRB), Manitoba (SNRB), Saskatchewan (SNRB), Ontario (SNRB), Quebec (SNRB), New Brunswick (SNRB), Nova Scotia (SNRB), Prince Edward Island (SNRB) |
| Monarch – Californian overwintering population (Western migratory population) | G4T2T3 | *Canada: ranking not presented<br><br>USA: NNR | *Ranking not presented by NatureServe; however British Columbia would be included in the Western migratory population |

** The conservation status of a species is designated by a number from 1 to 5, preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global, N = National, and S = Subnational). The numbers have the following meaning: 1 = critically imperiled, 2 = imperiled, 3 = vulnerable, 4 = apparently secure, 5 = secure. B = Breeding. NR = Not Ranked. T = Infraspecific taxon (subspecies, varieties and other designations below the level of species).*

*** Although the S-Rank for Alberta listed in NatureServe is S3, this is a breeding population, as in other jurisdictions.*

# 3. SPECIES INFORMATION

## 3.1 Species Description

The Monarch is a member of the Order Lepidoptera (butterflies and moths) and the family *Nymphalidae*, sub-family *Danainae*, and is sometimes referred to as the Milkweed butterfly (COSEWIC, 2010). The Monarch, like all butterflies, has a life cycle composed of four stages: egg, larvae (or caterpillar), pupa (or chrysalis), and adult.

The Monarch egg is a pale, yellow-cream colour, somewhat oval in shape and has a flat base with a bluntly pointed apex (tip) (CEC, 2008; COSEWIC, 2010). In the wild, female butterflies lay between 300 and 400 eggs, but can lay between 500 and 700 eggs in captivity (Oberhauser, 1997).

The Monarch larvae is recognizable by its distinctive white, yellow and black bands and a pair of black filaments at its head and tail (see Figure 1) (Carmichael and Vance, 2004). Monarch larvae feed only on milkweeds *(Asclepias* spp.*)* and related genera (Marshall, 2006). Monarch larvae undergo five instars (intervals between molts) over a period of 9 to 13 days.

**Figure 1**. Monarch larvae.

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The pupa is green and gold, and is found attached to a substrate, usually away from the host plant, but rarely on a milkweed plant

(Figure 2). This is the least-studied stage of the Monarch, due to the difficulty in locating pupa in the wild (Oberhauser, 2004). Monarch pupa are cryptically coloured, as opposed to the bright warning colouration exhibited by adults. On the final day as a pupa, the orange black and white pattern of the adult wings becomes visible through the pupa covering (CEC, 2008).

© Figment Films; photo credit: John Mitchell

**Figure 2.** Maturation of a Monarch pupa (chrysalis) towards emergence.

The adult Monarch is a relatively large butterfly, with a wing span of between 9 and 11cm. Its bright orange wings have black veins, and black edges that contain white spots along the margin. The underside of the wings is a dull orange colour, so that when the wings are folded in rest, the butterfly appears camouflaged as it clusters or rests singly in trees or other substrates (CEC, 2008). Colour and size variations have been observed in adults. Males and females can be distinguished by a black spot (scent gland) found only on the hind wings of males (Carmichael and Vance, 2004). In central Canada and eastern United States where their ranges overlap, adults are sometimes confused with the North American Viceroy butterfly (*Limenitis archippus*), which is similar to the Monarch but is smaller and is distinguished by a black line crossing the hind wing (Carmichael and Vance, 2003; CEC, 2008).

## 3.2 Populations and Distribution

The Monarch is indigenous to the Americas (North, Central and South) but has been introduced to many other countries and islands where populations persist, including: Portugal, Spain, Australia, New Zealand, Hawaii and other Pacific Islands such as the Philippines (Shappert, 2004).

There are two recognized subspecies of Monarch (*Danaus plexippus*) (Smith et al., 2005). *D. p. plexippus* is the subspecies that is found in North America and forms the Eastern and Western migratory populations of Monarch that are observed in Canada. Monarch from the West Indies, Central America and South America north of the Amazon drainage are the subspecies *D. p. megalippe.* Other subspecies that have been proposed include: *D. p. leucogyne, D. p. nigrippus, D. p. portoricensis* and *D. p. tobagi*, (Lamas, 2004). Research is ongoing to determine the actual number of Monarch subspecies.

## Populations not occurring in Canada

In southern Florida, small Monarch butterfly resident populations are known to exist (Altizer et al., 2000). Some resident populations have also been reported in Texas, but are likely temporary and are periodically lost due to freezing temperatures (Brower, pers. comm. *in* COSEWIC, 2010).

In Cuba, there are also Monarch butterfly resident populations in which individuals vary in wing length and shape, and noticeably differ in behaviour from those in the Eastern population (Dockx et al., 2004). A relatively small number of Monarch from the Eastern population do travel to Cuba and other Caribbean islands and may hybridize with resident Monarch, but are not believed to return to the USA in the spring, as Monarch that overwinter in Mexico do (Dockx, 2004 and Dockx, 2012).

In Central America, the Monarch occurs from southern Mexico to Panama (COSEWIC, 2010). Unlike the more northern populations, the Central American population is relatively sedentary and is reproductively active throughout the year (Haber, 1993).

## Populations occurring in Canada

In Canada, two mostly disjunct migratory populations of the Monarch occur: the Eastern population and the Western population. The approximate distribution of the Monarch in Canada is shown in Figure 5. Most of the individuals found in British Columbia overwinter in California, and most of the individuals from east of the Rocky Mountains in Canada overwinter in Central Mexico. Nonetheless, recent findings indicate that there is mixing of the two populations and that the Western population may be reinforced by individuals from the Eastern population (Lyons et al., 2012).

### *Eastern population*

The Eastern population's annual breeding range extends from the Gulf of Mexico coastal states (Texas, Louisiana, Mississippi, Alabama, Georgia, and Florida) northwards to southern Canada (Alberta to New Brunswick and Nova Scotia), and from the Great Plains States and Prairie Provinces eastwards to the Atlantic Coast and the Maritime Provinces (COSEWIC, 2010).

The breeding habitat of the Eastern population has changed significantly over the last 150 years (Brower, 1995). The prairies of central North America are thought to have been the main breeding area for the Eastern population prior to the 1880s. In the latter half of the 19$^{th}$ century, as the prairies were cultivated and the eastern forests were cleared for agriculture, a rapid eastward and northern spread in Common Milkweed (*Asclepias syriaca*) may have led to a major shift eastward for Monarch breeding habitat (Brower, 1995). The historically cleared deciduous forest corresponds with the main current breeding range of the Eastern population (Urquhart, 1960). During the middle and latter part of the 20$^{th}$ century, it became increasingly challenging to maintain small farms, and the consequent increase in abandoned farmland in the east created a substantial amount of suitable habitat for breeding and nectaring butterflies (COSEWIC, 2010). In certain areas, Monarch breeding habitat may be more abundant today than previously, particularly as milkweed is commonly sold in nurseries and as butterfly gardens have increased in popularity (R. Parrott, pers. comm. *in* COSEWIC, 2010).

Southern Ontario and southern Quebec represent the most extensive breeding area in Canada, where abandoned farmland and other open areas, such as ditches, meadows and hedgerows, serve as prime habitat for the widespread Common Milkweed (COSEWIC, 2010). In the Prairie Provinces, the breeding distribution of the Monarch is concentrated in the south where Showy Milkweed (*Asclepia speciosa*) occurs. Monarch abundance decreases northwards and westwards from Manitoba to Alberta. As the Monarch feeds solely on milkweeds during its larval stage in Canada, individuals observed north and east of the range limit of milkweeds (*Asclepias* spp.) are considered vagrants (non-breeding individuals) (COSEWIC, 2010). Vagrant butterflies have been observed in Newfoundland and the Northwest Territories, as well as in northern areas of other provinces.

Although the Monarch is uncommon to rare in Alberta and Prince Edward Island, in some years, adults and larvae have been found in these two provinces (Layberry et al., 1998; Bird et al., 1995; Davis, pers. comm. *in* COSEWIC, 2010; Pohl et al., 2011). For example, in the summer of 2012, Monarch were observed ovipositing and feeding on Showy Milkweed and Swamp Milkweed (*Asclepias incarnata*) in Vegreville, Alberta and their entire life cycle was documented with the adults observed emerging from their pupa in early July and August (Hughes, 2012). Evidence shows that in some years the Monarch breeds on Prince Edward Island on patches of the native Swamp Milkweed and on the introduced Common Milkweed. In New Brunswick and Nova Scotia, the Monarch breeds in scattered locations due to the limited distribution of milkweed. Due to a lack of milkweed in Newfoundland, the Monarch does not breed in this province.

During their fall migration, the Monarch has been observed roosting on trees along the northern shores of Lake Ontario and Lake Erie. Roosts can be predictably found in areas such as Presqu'ile Provincial Park, Prince Edward Point National Wildlife Area, Long Point Provincial Park, Long Point National Wildlife Area, Rondeau Provincial Park and Point Pelee National Park (COSEWIC, 2010). The departure of hundreds of thousands of Monarch from Point Pelee National Park in any given year has been observed numerous times (Wormington, 1994, 1997, 2008; COSEWIC, 2010).

### *Western population*

The Western population's annual breeding range extends from the southwestern United States (Arizona and New Mexico) northwards to southern British Columbia and from the Rocky Mountains westwards to the Pacific Coast (COSEWIC, 2010). In British Columbia the Monarch is generally restricted to the dry Southern Interior, where it is frequently observed. The Monarch is also infrequently observed at other locations in British Columbia, such as the Lower Fraser Valley, on Vancouver Island, and in the Rocky Mountain Trench (Guppy and Shepard, 2001). Showy Milkweed, which is the only milkweed native to British Columbia, occurs in the dry areas of the Southern Interior and serves as the Monarch's larval food plant (Guppy and Shepard, 2001). Although Milkweed is still abundant in the Southern Interior, its distribution and abundance could be negatively impacted by land clearing or range weed control programs (Guppy and Shepard, 2001). Observations from the Lower Mainland and coastal regions of British Columbia are likely of wayward migrants, as host plant availability and wet weather are not considered favourable for Monarch.

## Population Size

Since the discovery of Monarch overwintering sites in Mexico in 1975 by Canadian entomologists Fred and Norah Urquhart after a 38 year search (Urquhart, 1976), monitoring and reporting of Monarch butterfly sightings and migrations have been underway throughout North America and Mexico. Monarch populations are monitored in many locations to determine the numbers passing through migratory sites, and areas occupied at the overwintering sites. Certain monitoring programs also assess the timing or location of spring and fall migratory movement. These programs indicate that despite the wide distribution of Monarch for the majority of its life cycle, individuals tend to concentrate in certain areas at given times during migration and also use highly restricted overwintering sites (COSEWIC, 2010).

The number of Monarch in both the Eastern and Western populations fluctuate annually in response to climatic conditions during the breeding season and severe weather events that can influence breeding success and population growth. However, since the late 1990s both the Eastern and Western Monarch populations, as measured at their overwintering sites, have declined significantly (Rendón-Salinas and Tavera-Alonso, 2014; Monroe et al., 2016).

### *Eastern population*

Monitoring the areas occupied by overwintering Monarch in the Oyamel Fir (*Abies religiosa*) forests of central Mexico provides a yearly estimate for the Eastern Monarch population because Monarch from the Eastern population overwinter in this region. Reliable information on colony sizes and locations are available beginning from the 1994-1995 overwintering period. Prior to this, information was not collected in a comparable manner (Brower et al., 2012). Estimates of the average total area occupied by Monarch colonies at overwintering sites in Mexico between 2004 and 2016 (*Mean=3.36 ha*) reveal a substantial population decline in comparison to the average between 1994 and 2016 (*Mean=5.91 ha*) (Taylor, 2016). Although the population has increased over the last two years from an all-time low of 0.67 ha in 2013-14 to 4.01 ha in 2015-16, this level is still below the long-term average of 5.91 ha and much lower than levels observed prior to 2004 (Figure 3) (Taylor, 2016; World Wildlife Fund, 2016).

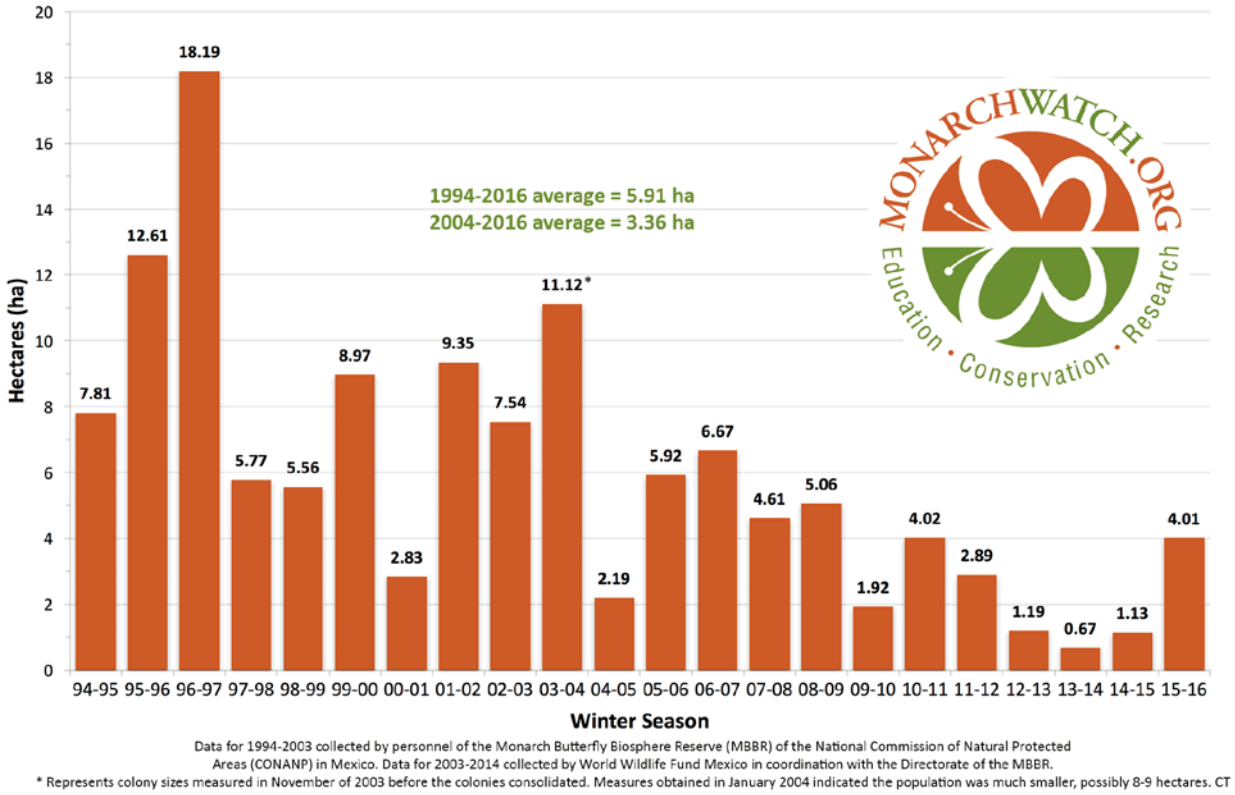


**Figure 3.** Total area occupied by Monarch colonies at overwintering sites in Mexico from 1994/95 to 2015/16.

Recent analysis of data from summer breeding (Ries et al., 2015) and fall migration (Badgett and Davis, 2015) monitoring programs did not identify declines in Monarch abundance over the past 20 years. However, monitoring of migrating Monarch at Long Point, Ontario over the same time period did document population declines (Crewe and McCracken, 2015). Pleasants et al. (2016) refuted the conclusion that summer breeding numbers had not declined, noting errors in the interpretation of monitoring program information and exclusion of important considerations.

### *Western population*

Organized monitoring of Monarch overwintering sites in California began in 1997, at which point there was an average of 12,233 Monarch per site (total count over 1.2 million). Since that time Monarch have declined considerably and in 2015 there were only 1,557 Monarchs per site (total count 292,674), representing a 76% decline from the maximum observed in 1997 and a 35% decline from the 19-year average (Figure 4) (data from Monroe et al., 2016). Monitoring since 2010 has also included six sites from Arizona. In the early years of the count, several overwintering sites in Baja California, Mexico were also included, but counts were discontinued there after 2004; the status of these sites is currently unknown.

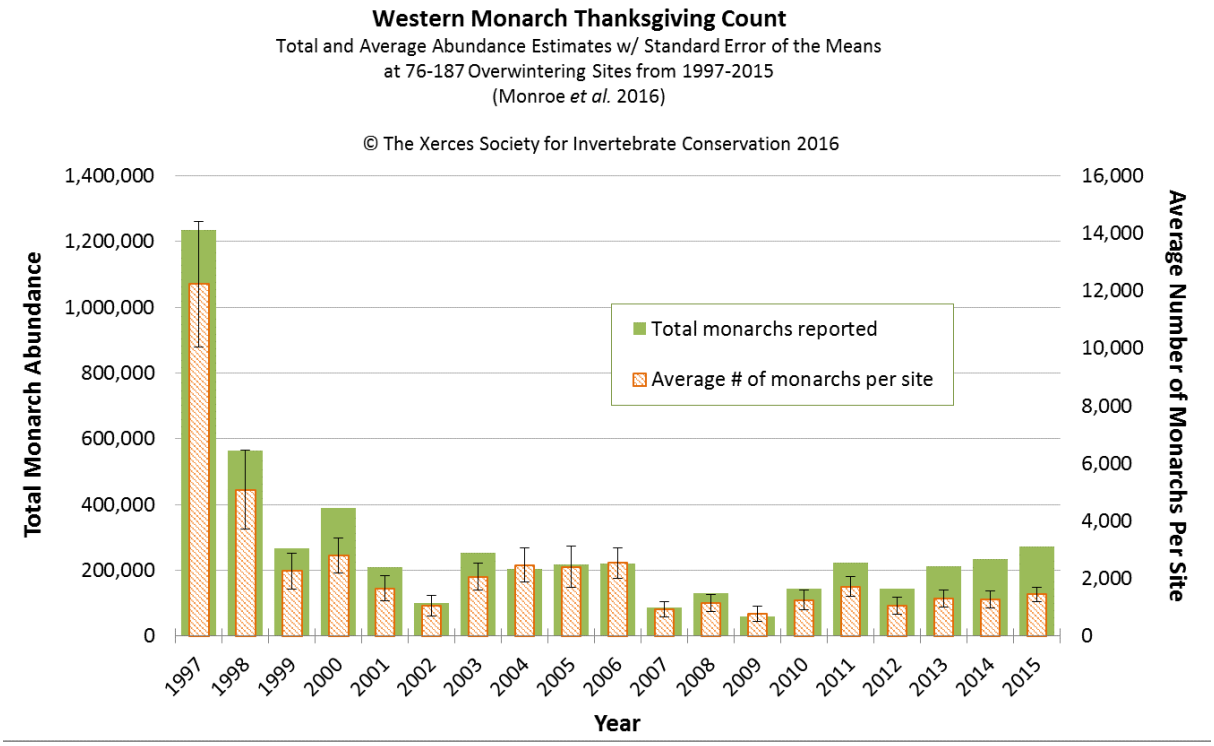


**Figure 4.** Estimated Monarch abundance at overwintering sites in California.

## 3.3 Life Cycle

Both the Eastern and Western Monarch populations are migratory and have complex life cycles. Although they live in temperate[3] regions during the summer, unlike other temperate insects, no life stage of the Monarch can survive temperate-zone winters. Every autumn, Monarch from the Eastern and Western populations migrate south to overwintering sites, and then return to the southern portion of their breeding range the following spring to begin the cycle again (see Figure 5). Although some butterflies and moths travel long distances, they generally go in one direction, whereas the Monarch is the only butterfly to make such a long, two-way migration (MonarchLab, 2013), with individuals from the Eastern population flying up to 3600 km to reach their winter destination (Brower, 1996a). Monarch can reduce their energy expenditure during the fall migration to the overwintering grounds by soaring, gliding and riding columns of rising warm air to reach altitudes where strong prevailing winds speed their flight (Gibo and Pallet, 1979; Gibo, 1981).

### *Eastern Population*

In March or early April, Monarch that have overwintered in Mexico mate and begin their northward migration. This is the first generation of adults that starts re-colonising the Monarch breeding range in North America. Both males and females leave overwintering sites, with females laying their eggs on the resurgent milkweed in northern Mexico and the Gulf of Mexico

[3] that part of the earth which lies between either tropic and the corresponding polar circle; having a climate that is warm in the summer, cold in the winter, and moderate in the spring and fall.

coastal states (Brower, 1996a). Most Monarch will die following this initial breeding event; however, there have been reports of individuals making the entire return journey to Ontario. Such individuals have been recorded at Point Pelee in late April and early May but were in poor physical condition (Wormington, pers. comm. *in* COSEWIC, 2010). Within the same season, adults of the new generation continue the migration to the northern edges of their breeding range. Along the way, they produce subsequent generations, and typically reach southern Canada near the end of May and the first week of June (Wormington, 2008). Miller et al. (2012) estimated that 10% of individuals reaching the northern breeding grounds originated directly from Mexico but that the majority (90%) were Monarchs from the first breeding event in the southern U.S.

In southern Canada, the Eastern population of Monarch produces two to three generations each year between June and September (Holmes et al., 1991). The eggs hatch in three to eight days (Schappert, 2004) and the larvae feed on the leaves, flowers and fruits of milkweed plants for nine to fifteen days under normal summer temperatures (Oberhauser, 2004). Development from egg to adult butterfly averages 30 days but can range between 20 and 45 days depending on factors such as temperature, day length, and availability of the food plant (COSEWIC, 2010).

Summer generation adults live about 30 days. The late summer generation adults emerge in a state called reproductive diapause, in which reproductive organs are in an undeveloped immature state. These adults migrate to their overwintering sites in central Mexico. These individuals live seven to nine months without breeding or laying eggs until the following spring. The long southward migration of the Eastern population toward central Mexico typically starts in early August, although Monarch have been seen in Canada heading south in early November (Wormington, pers. comm. *in* COSEWIC, 2010).

The migration routes of the Eastern population of Monarch either concentrate in a “central flyway”, which involves migration through Kansas, Oklahoma and Texas en route to Mexico, or an “eastern flyway” that involves migration along the Atlantic seaboard and then along the Gulf Coast (see Figure 5). The Monarch that follow the central route seem to be more successful in reaching the overwintering grounds in Mexico, whereas the more eastern route may reinforce the southern Florida and Cuban populations (Brindza et al., 2008; Howard and Davis, 2009; COSEWIC, 2010). Based on isotopic analysis, Wessenaar and Hobson (1998) demonstrated that 50% of the Monarch at Mexican overwintering sites originated from the midwestern United States, with proportionately fewer Monarch originating from the northerly and southerly extremes of the breeding range.

### *Western population*

The Western population undergoes a similar but shorter migration from the overwintering sites along the coast of California and in Baja, California in Mexico to the breeding range, which includes areas in Arizona, New Mexico and the southern interior of British Columbia as well as the Pacific coastal states in the United States (see Figure 5). Similar to the Eastern population, spring and summer adults of the Western population live for about one month, and those that overwinter and migrate live between seven and nine months (CEC, 2008).

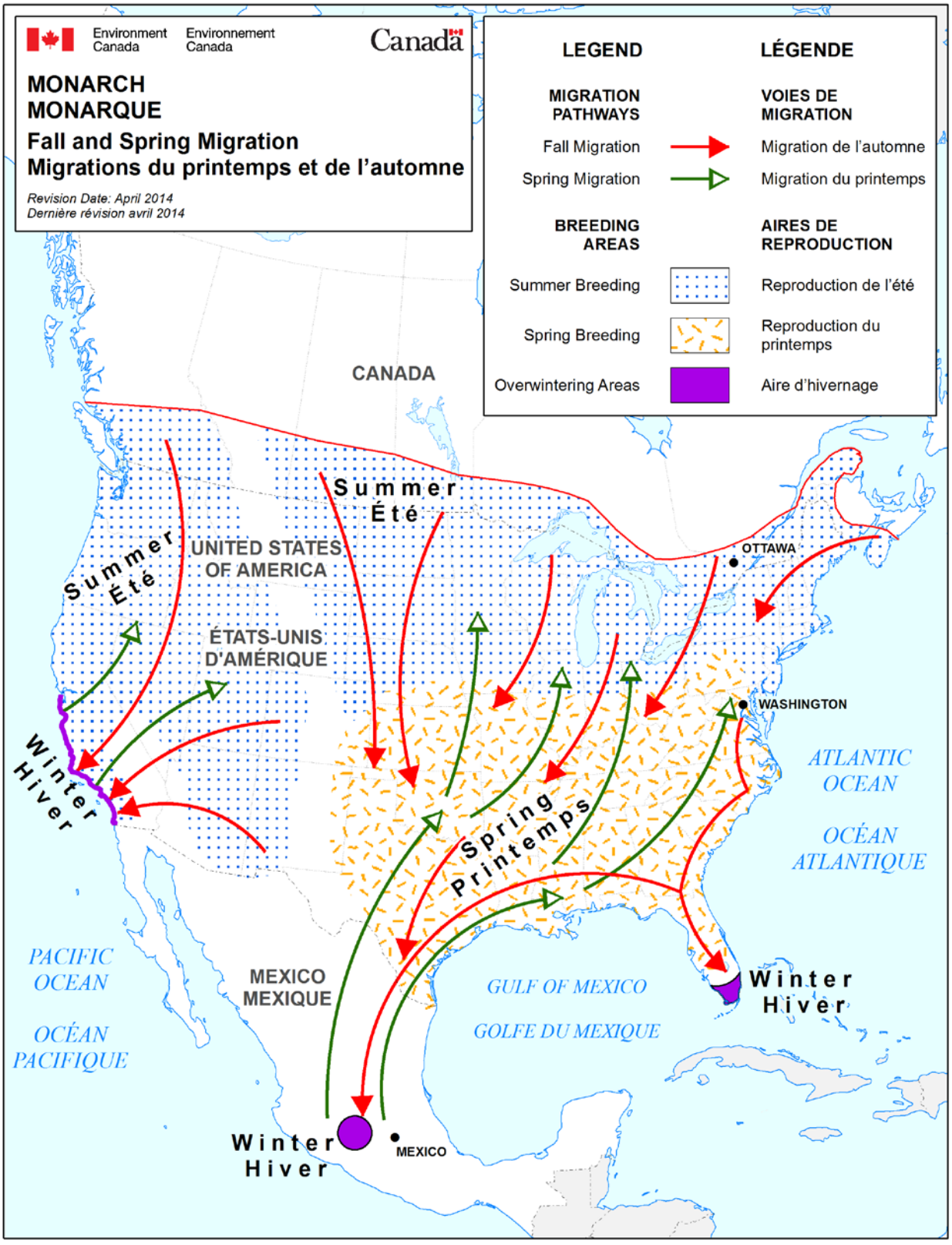


**Figure 5.** Map showing the spring and fall migration pattern of Monarch butterflies and approximate spring and summer breeding distribution (Adapted from Monarch Watch, 2010).

## 3.4 Needs of the Monarch

### 3.4.1 Habitat and biological needs

The Monarch requires the following four types of habitat for persistence: breeding, nectaring, staging and overwintering (COSEWIC, 2010).

#### Breeding habitat

As Monarch larvae feed solely on the leaves, flowers and fruits of the milkweed, a member of the dogbane family (*Apocynaceae*), their breeding habitat is dependent on the presence of these plants. In Canada, Monarch larvae feed solely on milkweeds in the genus *Asclepias*, but in the United States larvae are known to feed on the Honeyvine Milkweed (*Cynanchum laeve*) (Yeargan and Allard, 2005).

There are 14 species of milkweed in Canada. The most prevalent milkweeds upon which the Monarch feeds are the Common Milkweed, Swamp Milkweed, Butterfly Milkweed (*Asclepias tuberosa*) and Showy Milkweed. Milkweeds grow in a variety of environments, including farmlands, open wetlands, dry sandy areas, short grass and tall grass prairie, agricultural areas, river banks, irrigation ditches, arid valleys, south-facing hillsides, and along roadsides and in roadside ditches. Milkweeds are also often planted in gardens. In the wild, the vast majority of Monarch found at overwintering sites in Mexico (85%) are known to have developed on Common Milkweed and Showy Milkweed (Seiber et al., 1986; Malcolm, 1987).

#### Nectaring habitat

Nectaring habitat occurs throughout the breeding range of the Monarch in various environments ranging from native grasslands to home gardens and road medians. Adult butterflies feed on a variety of wildflowers (COSEWIC, 2010). These nectar sources are vital to Monarch survival, but are particularly important during the fall migration when sugars from the nectar are converted to fat, which provides Monarchs with energy for successful overwintering (COSEWIC, 2010). Goldenrods (*Solidago* spp.), asters (*Aster* spp.), and related genera such as *Symphytrichum* spp., *Doellingeria* spp., *Virgulus* spp., and *Oclemena* spp., as well as milkweeds (*Asclepias* spp.), are most frequently used as nectar sources (COSEWIC, 2010). During migration, Monarchs will also stop and feed on a number of flowering crop plants (e.g., alfalfa) and other nectar producing plants such as dandelions and flowering annuals in home and community gardens (D. Davis, pers. comm.)

#### Staging habitat

Staging areas are important during migrations to allow the Monarch to feed and deposit fat reserves and to rest at night before resuming their flight (Davis et al., 2012). Fat reserves provide the energy necessary for migration and are also essential for overwintering survival. Within staging areas, Monarchs appear to be flexible in terms of roost site selection, with sites often observed in pines, conifers, maples, oaks, pecans and willows (Davis et al., 2012).

The Great Lakes pose a significant geographic obstacle to the Monarch during its migration. In the fall, large clusters (or aggregations) of Monarch converge along the shores of Lake Erie and Lake Ontario, as they rest and feed before embarking on the flight across the water. This makes Southern Ontario a primary management area for the Monarch in Canada. In Ontario, Monarch have been observed in late summer or early fall in large numbers in areas such as Prince Edward Point National Wildlife Area, Presqu'ile Provincial Park, Tommy Thompson Park (Toronto), Long Point National Wildlife Area and nearby areas, Rondeau Provincial Park, and Point Pelee National Park. There are also reports of Monarchs staging in areas of southwest Nova Scotia before crossing the Bay of Fundy (M. Elderkin, pers. comm.)

## Overwintering habitat

Overwintering sites, which are essential for Monarch survival, are only known to occur in very restricted areas, with unique habitat characteristics, in Mexico and the United States.

### *Eastern population*

Overwintering sites for the Eastern population of Monarch are located in the Oyamel Fir forests of central Mexico (Urquhart, 1976; Slayback et al., 2007). Millions of adult Monarch aggregate on Oyamel Fir trees and pine-oak pine trees in 11 sanctuaries that follow the Transverse Neovolcanic Belt along the border between the states of Michoacán and the State of Mexico (Rendón-Salinas and Tavera-Alonso, 2013; Brower, 1996[a]). Oyamel Fir forests are specialized high altitude ecosystems that occur only between elevations of 2,400 and 3,600 metres. These high altitude forests provide a unique microhabitat which allows Monarch to lower their metabolic rate and reduce their activity between mid-November and mid-March (Brower, 1996[a]). The Oyamel Fir trees provide cover and protect the Monarch from freezing, severe rain, snow, desiccation, and windstorms (Brower et al., 2002).

Approximately thirty overwintering Monarch colonies are known to exist and are spread over an area roughly 6400 $km^2$ in size (WWF Mexico, 2013); however, suitable forested areas within the appropriate elevation cover only approximately 562 $km^2$ (Slayback et al., 2007). Within this 562 $km^2$ area, Monarch may be found on the same stands of trees as their predecessors were found, two to four generations removed, or may settle in the same general area and elevation but up to 1.5 km away (Slayback et al., 2007).

### *Western Population*

The overwintering habitat of the Western population occurs from Ensenada in Baja California, Mexico to Rockport, California, and rarely extends inland more than 1 or 2 km from the coast (Sakai pers comm. *in* COSEWIC, 2010). Approximately 400 overwintering sites have been recorded (Schappert, 2004) and the vast majority of them are associated with stands of non-native Australian eucalyptus trees (MonarchWatch, 2005; COSEWIC, 2010). Eucalyptus were introduced to California in the 1850s (Lane, 1993), and were widely planted for landscaping, as windbreaks, and for use as fuel (COSEWIC, 2010). This dispersal also coincided with the deforestation of coastal stands of native tree species, such as Monterey Pine (*Pinus radiata*) and Monterey Cypress (*Cupressus macrocarpa*). The native pine and cypress are also used by the Monarch as overwintering habitat, but to a lesser degree today as they have become less abundant (Lane, 1993).

### 3.4.2 Limiting factors

#### Restricted overwintering grounds

The availability of suitable overwintering sites is a potentially limiting factor for the Monarch. Due to the specialized microclimatic conditions needed for the Monarch to overwinter successfully and the restricted areas within which these are found, suitable overwintering sites are few in number, particularly for the Eastern population (approximately 30 sites in Mexico).

#### Spring conditions for migration

Spring conditions in the Gulf of Mexico coastal states (Texas, Louisiana, Mississippi, Alabama, Georgia and Florida) are a significant limiting factor for the Eastern population of Monarch. This is where Monarchs that have overwintered in Mexico reproduce and create the next generation that will migrate to more northerly breeding grounds. Stable spring conditions without major wind storms, drought or excessive rains, allow for optimal milkweed emergence and arriving butterflies can successfully reproduce there, and their descendants can continue the migration northward (D. Davis, pers. comm. *in* COSEWIC, 2010). Spring and summer weather that is either too hot, or too cold, has been shown to lower breeding season survivorship and fecundity and alter larval growth rates (Brower et al., 2012). For more information on the impact of weather conditions on Monarch populations, see the 'Climate change' and "Severe weather events' discussion in Section 4.2.

#### Parasitoids and parasites

Both the Eastern and Western populations of Monarch are host to a number of parasitoids. A large suite of invertebrates prey upon on Monarch eggs and larvae, which can cause a mortality rate exceeding 90% over the course of the butterfly's development (Oberhauser, 2004, 2012). Parasitoids lay their eggs on larvae, and emerge from the carcasses of their prey at different stages in the Monarch life cycle: larvae, pupa, and adults. These parasitoids include a number of fly and wasp species, such as tachinid flies (Tachinidae) which are widespread (Oberhauser et al., 2007, 2012).

The Monarch is also host to parasites, viruses, protozoans and bacteria. Of these, the protozoan *Ophryocystis elektroscirrha* has been well studied, and has been found to reduce the survival of Monarch larvae and reduce adult butterfly mass and lifespan at high levels of infection (Altizer and Oberhauser, 1999). The prevalence of *O. elektroscirrha* is highly variable among Monarch populations, but appears to vary inversely with host migration distances (McLaughlin & Myers, 1970). The Western population which undergoes a shorter migration tend to be heavily infected (approximately 30% of butterflies), whereas the longest-distance migrants of the Eastern population experience infection to a lesser degree (less than 8% of butterflies).

## Predation at overwintering sites

Predation of Monarch at overwintering sites in Mexico by Black-headed Grosbeak (*Pheucticus melanocephalus*) and Black-backed Oriole (*Icterus galbula abeillei*) has been observed to cause up to 10% mortality of one Monarch overwintering colony (Arellano et al., 1993). Predation at smaller colonies, which have a proportionally greater circumference, may reach as high as 44% because birds typically feed around the perimeter of the colony (Calvert et al., 1979). Predation at overwintering sites in California by Chestnut-backed Chickadees (*Parus rufescens*), European Starlings (*Sturnus vulgaris* L.) and Scrub Jays (*Aphelocoma coerulescens*) has also been observed (Sakai, 1994). The Black-eared Mouse (*Peromyscus melanotis*) is a known predator of overwintering Monarchs and may kill substantial numbers at overwintering colonies (Brower et al., 1985; Glendinning et al., 1998).

# 4. THREATS

## 4.1 Threat Assessment

The Monarch faces a wide range of direct and indirect threats throughout its range (see Table 2).

**Table 2. Threat assessment table for the Monarch.**

| Threat | Level of Concern[1] | Extent | Occurrence | Frequency | Severity[2] | Causal Certainty[3] |
|---|---|---|---|---|---|---|
| **Habitat Degradation or Loss** | | | | | | |
| **Overwintering habitat** | | | | | | |
| Forest loss and degradation | High | Mexico | Current | Continuous | High | High |
| Housing development | Medium | California | Current | One time | Medium | High |
| Eucalyptus stand removals | Medium | California | Current | One time | Medium | High |
| Bark beetle outbreak | Low | Mexico | Current | Unknown | Medium | Medium |
| **Breeding and nectaring habitat** | | | | | | |
| Widespread use of herbicides | High | Breeding range | Current | Seasonal | High | High-Medium |
| Widespread use of pesticides | Medium | Breeding range | Current | Seasonal | Medium | Medium |
| Succession and/or conversion of breeding and nectaring habitat | Medium-Low | Breeding range | Current | Continuous | Unknown | Medium |
| **Changes in ecological dynamics or natural processes** | | | | | | |
| Climate change | High-Medium | Breeding and wintering range | Current | Recurrent | High-Medium | Medium |
| Severe weather events | High-Medium | Breeding and wintering range | Current | Recurrent | High-Medium | Medium |

[1] *Level of Concern: signifies that managing the threat is of (high, medium or low) concern for the conservation of the species, consistent with the management objectives. This criterion considers the assessment of all the information in the table.*

[2] *Severity: reflects the population-level effect (High: very large population-level effect; Medium; Low; Unknown).*

[3] *Causal certainty: reflects the degree of evidence that is known for the threat (High: available evidence strongly links the threat to stresses on population viability; Medium: there is a correlation between the threat and population viability e.g. expert opinion; Low: the threat is assumed or plausible).*

## 4.2 Description of Threats

### Forest loss and degradation (overwintering habitat)

The Monarch was listed under the federal *Species at Risk Act* as a species of Special Concern in Canada, largely due to human-caused pressures on the Oyamel Fir forests in central Mexico. Used as overwintering habitat for the Eastern population of Monarch, these forests have been degraded by intensive commercial logging (legal and illegal), uncontrolled wood harvesting for domestic use, charcoal production, and periodic agricultural fires that spread into adjacent forests (Snook, 1993; Brower and Missrie, 1998, Brower et al., 2002). Degradation of overwintering forest habitat in the Oyamel Fir forests is one of the primary threats to the Eastern population of Monarch (Brower, 1996b; Brower et al., 2002, Brower et al., 2012).

The conversion of forest habitat to agriculture and pasture land has also resulted in the loss of Monarch overwintering habitat at the Oyamel Fir forests. For overwintering sites to retain the appropriate microclimate, a certain minimum size and quality of forest patches must occur. Forest loss and degradation has resulted in the creation of openings, and has decreased forest density, exposing overwintering butterflies to winter storms, cold temperatures and wet conditions which can result in increased and sometimes substantial mortality (COSEWIC, 2010).

To quantify the rate of forest degradation and fragmentation, aerial photographs of a 420.2 $km^2$ area of the Oyamel Fir forests taken in 1971, 1984, and 1999 were analyzed (Brower et al., 2002). Between 1971 and 1999, the number of conserved forest patches (forest with >80% cover) increased from 13 to 60, but their mean size decreased from 21.14 $km^2$ to 2.54 $km^2$. Based on a yearly decline of 2.41% between 1984 and 1999, less than 100 $km^2$ of high quality forest was projected to remain within 20 years and less than 45 $km^2$ in 50 years (Brower et al., 2002). Declines in forest cover in areas used by the Monarch have been documented, even in the core areas of reserves that were declared protected by presidential decree in 1986 (Sierra Chincua, Sierra Campanario, and Cerro Chivati Huacal) (Williams and Brower, 2007; NASA, 2008).

Monitoring of forest cover in the Monarch Butterfly Biosphere Reserve, which consists of 136 $km^2$ of core zones (all extractive activities prohibited) and 427 $km^2$ of buffer zones (sustainable extractive activities permitted) between 2001 and 2012 revealed that 12.5 $km^2$ were deforested and 9.3 $km^2$ were degraded within core zones (Vidal et al., 2014). However, it was noted that Mexican authorities have effectively enforced efforts to protect the Monarch Reserve, particularly from 2007 to 2012. Enforcement, together with efforts to create alternative income generation and employment stopped large-scale illegal logging in 2012, but small scale logging is a growing concern (Vidal et al., 2014).

### Widespread use of herbicides

#### *Eastern population*

With the increasing popularity of crops such as corn (maize), soy and glyphosate-tolerant crops, the spraying of pesticides and herbicides has increased in areas where milkweed plants occur (Brower, 2001). Pleasants (2015) estimated that there has been a 64% decline in milkweed on the American Midwest landscape and an 88% decline in Monarch production in the Midwest

between 1999 and 2010, which is coincident with an increase in the use of glyphosate herbicide, in conjunction with increased planting of glyphosate-tolerant corn and soybeans. This finding is significant because there is growing evidence that the "Corn Belt" region of the Unites States Midwest is the most important area in terms of Monarch productivity for the Eastern population during the breeding season (Flockhart et al., 2013) and this finding is also consistent with a study by Flockhart et al. (2014) which found that recent declines in Monarch abundance are driven by a reduction in milkweed in the United States. In Canada, as of 2005, approximately 95% of the area planted with canola and 60% of the area planted with soybeans was done with glyphosate resistant varieties (Beckie et al., 2006). Further demonstrating the importance of agricultural habitats to Monarch, a study of Monarch egg density on milkweeds found that egg density was, on average, 3.89 times higher in agricultural fields than non-agricultural habitats (Pleasants and Oberhauser, 2013). It has also been estimated, using models, that large-scale elimination of milkweeds in agricultural and surrounding landscapes can increase host plant search time by Monarch females, resulting in reduced fecundity (Zalucki and Lammers, 2010). Spray drift may also negatively impact nectaring plants surrounding agricultural fields (Blackburn and Boutin, 2003 and Gove et al., 2007).

### *Western population*

In British Columbia, pesticide use against insect pests and herbicide use for the control of invasive weeds on croplands or rangelands may have significant impacts on non-target species and their food plants within application areas (Zevit and Guppy, 2011). In the Okanagan Valley, vineyards and fruit orchards are prevalent and increasing in extent. In both agricultural systems, there is widespread application of pesticides; however, the effects of pesticides on Monarch breeding habitat remain unknown (COSEWIC, 2010). It has been suggested that the planting of genetically engineered cotton and corresponding use of glyphosate in the southern United States and California has contributed to the decline of the Western population of Monarch (Centre for Biological Diversity et al., 2014).

## Widespread use of pesticides

While a broad range of pesticides could pose a risk to Monarchs, specific concern has been raised over the impacts of neonicotinoid insecticides on Monarchs and other pollinators. Neonicotinoids are a class of persistent, systemic insecticides that are extremely toxic to arthropods and whose use in North America has increased greatly in recent years (Goulson, 2013; Hopwood et al., 2013; Monarch Joint Venture, 2013; Douglas and Tooker, 2015; van der Sluijs et al., 2015). Research on the impact of neonicotinoids on Monarch, including sublethal effects in an ecosystem setting, is needed. Pacenka and Lundgren (2015) suggested that clothianidin could act as a stressor to Monarch populations, but also noted that further study was required to determine whether this neonicotinoid was contributing to Monarch declines.

Reduced survivorship and growth rates of Monarch larvae that feed on milkweeds which have been dusted with the pollen of *Bt*[4] corn has been reported (Hansen Jesse and Obrycki, 2000; Losey et al., 1999). Other research, however, has found that *Bt* corn anthers and pollen did not have a significant impact on egg deposition or larval survival (Jesse and Obrycki, 2003);

[4] *Bt* corn is a variety of corn that has been genetically modified to produce a protein which is toxic to Leptidoptera larvae, in particular, the European corn borer.

similarly, a risk assessment indicated that the impacts of *Bt* corn pollen on Monarch populations would be negligible (Sears et al., 2001). Otto and Lang (2010), in their synthesis of laboratory and field studies on the effects of *Bt* on non-target Lepidoptera, stated that a general conclusion on the level of risk for butterflies and moths could not be drawn based on the available information, although the papers reviewed did indicate a potential hazard for Lepidoptera.

## Climate change

Modeling of future climate scenarios suggests that global climate change will have a significant and negative effect on the Monarch overwintering sites in Mexico (Oberhauser and Townsend, 2003; Sáenz-Romero et al., 2012). The precise effect that climate change will have on the Oyamel Fir forests is unknown, but modelling suggests that the currently known overwintering sites are likely to become significantly less suitable for the Monarch over the next 50 years due to increased cool-weather precipitation which could result in increased mortality (Oberhauser and Townsend, 2003). Based on climatic models, Sáenz-Romero and Lindig-Cisneros (2012) predicted that the climate suitable for Sacred (Oyamel) Firs will ascend in altitude with climate change, resulting in no suitable habitat within the Monarch Butterfly Biosphere Reserve by 2090. The impacts of pests and disease are expected to increase over the same time period due to increased temperature and drought stress brought on by climate change (Ramirez et al., 2015)

Although climate change data and trends that allow for future projections of overwintering habitat suitability are not available, climate change is also likely to have an impact on the overwintering habitat of the Western population of the Monarch (CEC, 2008). With a hotter and drier climate, the risk of catastrophic wildfires (similar to those that swept through southern California in October of 2007) will increase and threaten ecosystems (Fimrite, 2007). Though the link between climate change and wildfires is debated, years of hotter and drier weather and the increase in invasive plant species (Bell et al., 2009) could conceivably sustain larger and longer fires such as those that have naturally occurred historically in the region. This has the potential to affect the coastal forests of California, and damage Monarch overwintering sites.

There is growing evidence that climate change may also impact migratory species through shifts in phenology and mistimed migration (Robinson et al., 2009). For example, Parmesan (2007) found that butterflies exhibited a stronger response to climate shifts than herbs did, which may result in increased asynchrony (i.e., mismatched timing) in insect-plant interactions. It should be noted, however, that the relationship between climatic variables and Monarch population dynamics are complex and will require additional study to allow for predictions on the effects of changing climate regimes (Zipkin et al., 2012).

## Severe weather events

Variable and severe weather such as cold and wet summers or drought can reduce Monarch success during its northward migration and reduce reproduction and growth rates in its breeding range (COSEWIC, 2010; Brower et al., 2012). Monitoring at Monarch overwintering sites in the Oyamel Fir Forests of Mexico showed that a storm in 1999-2000 caused the overwintering Monarch colony to occupy the smallest area recorded between 1993 and 2000 (COSEWIC, 2010). Between 2001 and 2003, the Eastern population seemed to recover as the total area occupied by the overwintering colony increased, but it then declined again dramatically in the winter of 2004-2005. This decline was likely due to an accumulation of factors including winter

storms, a wet and cold summer season in Canada and the United States in 2004, and continued degradation of overwintering habitat (Brower et al., 2005). In March 2016 a severe winter storm occurred in Mexico, killing an estimated 7.4% of the overwintering Eastern migratory population (Dirección de la Reserva de la Biosfera Mariposa Monarca and WWF-Mexico, 2016).

### Housing development (overwintering habitat)

Overwintering habitat for the Western population of Monarch rarely extends inland by more than 1-2 km from the coast. Of the 400 known overwintering sites in California, the majority are threatened by coastal real estate development (Brower, 1995). From 1990 to 1998, over 12% of the overwintering habitat available to the Monarch in California was lost to such development (Meade, 1999; Frey and Schaffner, 2004). Malcolm (1993) reported 21 overwintering sites in California completely lost to land development or conversion, and an additional 7 sites badly disturbed. For example, a famous overwintering site at Pacific Grove was destroyed when a motel was built among the trees used by Monarch, to accommodate visitors (Lane, 1993).

### Eucalyptus stand removals (overwintering habitat)

Eucalyptus trees are used by overwintering Monarch of the Western population as host sites to replace native host trees, such as the Monterey Pine and the Monterey Cypress which have been depleted. The native trees are still used by the Monarch to overwinter, but to a lesser degree as they are far less abundant (Lane, 1993). Eucalyptus trees offer various advantages over the native species, as they are evergreen and create excellent windbreaks. Further, their leaf and branch structure is ideal for clustering, which helps the butterflies to conserve warmth through cold winter nights (Slack, 2004). In California, Eucalyptus trees are being actively eradicated because they are extremely damaging ecologically for many native species, and are a fire hazard. This further threatens Monarch overwintering habitat availability.

### Succession and/or conversion of breeding and nectaring habitat

Abandoned farmlands that currently provide suitable breeding and nectaring habitat for the Eastern population of Monarch are at risk of being lost, as they either regenerate into forest or are developed and converted for residential or industrial development. Monarch habitat may also be lost or degraded if lands are put into intensive agricultural production, for example, as it becomes economically viable to grow certain crops (e.g., corn as a source of biofuel) (COSEWIC, 2010). Alternatively, less intensive farming practices that incorporate habitat features can provide breeding and nectaring habitat for Monarch.

### Bark Beetle outbreak (overwintering habitat)

Bark beetles (*Scolytus* spp.) represent a threat to Monarch because when present in sufficient numbers they are capable of killing Oyamel Fir trees, particularly when they are stressed during drought conditions (Monarch Butterfly Fund, 2009); such an outbreak occurred in 2009. It has been proposed that infestations by *S. mundus* may increase in the future due to environmental stress caused by climate change (Manzo-Delgado et al., 2014). During a forest health assessment in 2010, Steed and Willhite (2011) observed the following bark beetle species: *S. mundus*, *Psuedohylesinus variegatus* and *Pityopthorus* spp. in Oyamel Firs and *Dendroctonus mexicanus* in pine species. The long-term impacts of bark beetle on Monarch overwintering habitat are poorly understood (CEC, 2008) and should be studied further.

## Additional threats

A number of other threats to Monarch have been identified and these are discussed briefly below.

Common Milkweed, which is an important host plant for Monarch reproduction, is considered to be a noxious weed in the Weed Control Acts of Manitoba (Province of Manitoba, 2010), Quebec (Schappert, 1996) and Nova Scotia (NS Dep. Of Agri., 2007); in Manitoba, Showy Milkweed is also listed. In most provinces where a Weed Control Act exists, there is no active program to target, eliminate or eradicate milkweeds; rather, the main thrust is to respond on a "complaint" basis to control a particular issue of concern (White, 1996). A control program is in place to eradicate Common Milkweed in the province of Nova Scotia, due to a likely increase in its numbers, as a result of the recent shift in agricultural practices to low-tillage management (White, 1996). In May 2014 the Ontario government removed Milkweed species from the Schedule of Noxious Weeds under the *Weed Control Act* and added Dog-strangling Vine (*Vincetoxicum rossicum*) and Black Dog-strangling Vine (*Vincetoxicum nigrum*).

Roadside habitat may be of increasing importance for Monarch given the reduction in available breeding habitat in other areas (e.g., agricultural fields) (Flockhart et al., 2014). Accordingly, the removal of milkweed and nectar-producing, flowering vegetation along roadsides is a potential threat to Monarch. Mowing, cutting, and spraying of herbicides on roadside vegetation are common practices to help increase road safety by improving visibility and deterring wildlife, in order to minimize the chance of vehicle collisions with wildlife crossing roads.

In certain areas the Monarch is vulnerable to mortality from vehicle collisions, particularly throughout its summer range (Damus, 2007). Since Common Milkweed grows in abundance along road sides, the threat of collision is higher in these areas. The potential for collisions with wind turbines has been identified as a possible threat to Monarch (COSEWIC, 2010), particularly during migrations, although very little evidence on the extent or severity of butterfly collision mortality with wind turbines currently exists (Damus, 2007). In Ontario, Monarch have been observed in large clusters in roosts on the north shores of Lake Erie and Lake Ontario, where wind turbines have been built, or where they are planned or proposed. In Western Canada, wind energy sites located in migratory pathways of the Monarch are being explored for their potential impacts on the Western population (Zevit and Guppy, 2011).

The introduction of invasive species may pose a threat to Monarch. For example, Dog-strangling Vine, a member of the milkweed family introduced to North America in the mid 1800s, may be used unsuccessfully for reproduction. Although Monarch exhibit a strong preference towards Common Milkweed, female butterflies will lay eggs on the leaves of Dog-strangling Vine, but upon hatching the larvae cannot survive (Mattila and Otis, 2003; DiTommaso and Losey, 2003; Casagrande and Dacey, 2007). Casagrande and Dacey (2007) found that in Rhode Island, Monarch were more likely to use *Vincetoxicum* spp. for egg-laying than in previous studies in New York and Ontario, but similarly found that larvae did not survive on these hosts. Dog-strangling Vine may also represent a threat to Monarch by displacing its native host plant, Common Milkweed (DiTommaso and Losey, 2003).

The release of butterflies (e.g., at weddings and other events) has been identified as a threat to Monarch and other butterflies because it may result in: the transmission of disease and parasites;

impacts on migratory patterns; harmful genetic mixing; poaching of butterflies at overwintering sites to support commercial markets; and impacts on studies of butterfly distribution and migration. For this reason, commercial breeding and release of Monarchs is now discouraged by some experts and conservation groups (Xerces Society for Invertebrate Conservation, 2010; Altizer et al., 2014; North American Butterfly Association, 2014).

# 5. MANAGEMENT OBJECTIVES

Canada has worked cooperatively with the United States and Mexico to establish the following management goal and near-term population target, which will serve as the management objectives for this management plan.

**Goal:**

The long-term goal is to ensure the conservation of the Monarch butterfly migratory phenomenon.

**Near-term population targets:**

As a first step, and to substantially lower the risk of extinction of the Eastern Monarch population, the three countries will work towards a target of six hectares of occupied overwintering habitat in Mexico by 2020.

The available information is not sufficient to set a quantitative population target for the Western Monarch population. The three countries have agreed to work towards identifying a target for the Western Monarch population.

**Context:**

The Eastern and Western populations of Monarch have experienced major declines over the past 15-20 years and continue to face significant threats throughout their migratory ranges. Therefore, immediate and significant action will be required to prevent the loss of these migratory populations. The near-term population target identified above is based on the best available science and will be reviewed based on the outcome of further research and monitoring. While it is recognized that the science around Monarch recovery is emerging and is incomplete in some areas, this target provides an initial basis for measuring progress and stimulating action. Finally, it is acknowledged that achieving the goal and near-term target will require extensive effort from a range of partners, and that even with this support, achieving the target is subject to phenomenon such as extreme weather events and climate change. Monarch populations are also subject to significant between-year variation, so this will need to be taken into account when assessing progress.

Although Canada is home to a relatively small portion of the breeding habitat for the Eastern and Western migratory populations, it can play a role in conservation of the species by providing breeding, nectaring and staging habitat throughout the Canadian Monarch range and by mitigating threats to Monarch in Canada. Given that migratory Monarch populations are largely dependent on a wide range of habitats outside Canada, both in the United States and in Mexico, support for international initiatives will also be essential for the conservation of Monarch.

# 6. BROAD STRATEGIES AND CONSERVATION MEASURES

## 6.1 Actions Already Completed or Currently Underway

### Habitat conservation

In 1986, the Mexican government, through a Presidential Decree, created a protected area which included Monarch overwintering habitat. In 2000, this protected area was expanded from 161 to 562 $km^2$ to include a buffer zone. In October 2006, the protected area was officially designated as a United Nations Educational, Scientific and Cultural Organization (UNESCO) Biosphere Reserve known as the Monarch Butterfly Biosphere Reserve. Subsequently, in July 2008, the Monarch Butterfly Biosphere Reserve in Mexico was added to the list of UNESCO World Heritage Sites. Mexico is also undertaking a joint strategy for sustainable forest use and conservation between its forestry, biodiversity, parks, environmental protection and natural resources agencies.

In 1995, the governments of Canada and Mexico officially recognized the uniqueness of the Monarch butterfly and its migratory cycle in their *Declaration for the Creation of an International Network of Monarch Butterfly Reserves*. In Mexico, five sanctuaries in the Monarch Butterfly Biosphere Reserve (MBBR) and three protected areas in Canada (Long Point National Wildlife Area, Point Pelee National Park, and Prince Edward Point National Wildlife Area) were nominated under this declaration.

The Commission for Environmental Cooperation (CEC) Council followed up on this bi-national initiative in 1996, passing a resolution to develop a North American Monarch Butterfly Conservation Program to: support increased research, monitoring, mapping, and management of Monarch habitats; establish additional protected areas; increase public education and outreach; and to promote partnership development. The CEC has since funded various projects, including one in 1997 to support communities in the MBBR in Mexico in their efforts to develop strategies for sustainable forest management, and another in 2000 to enhance the delivery of sustainable tourism through the development of a North American eco-tour guide network. With the support of the World Wildlife Fund and other environmental non-government organizations, private donors and government agencies, work is ongoing through the Monarch Butterfly Conservation Fund to offer long-term economic incentives to local communities that are committed to preserving forest in the MBBR core zone.

Between 1995 and 2005, the U.S. Fish and Wildlife Service (USFWS), in cooperation with Mexican agencies and non-governmental organizations (NGOs), invested over $650,000 in projects to: protect and restore overwintering habitat of the Monarch through participatory training in natural resource management and reforestation; promote conservation through public outreach and environmental education for schoolchildren; and, facilitate communication between researchers in the Canada, United States and Mexico. In 2015, the USFWS partnered with the National Wildlife Federation (NWF) and National Fish and Wildlife Foundation (NFWF) to deliver millions in funding to support Monarch habitat creation and enhancement, and the U.S. Department of Agriculture announced an investment of $4 million to help agricultural

producers provide food and habitat for Monarch in the American Midwest and southern Great Plains in 2016.

The Monarch Butterfly Model Forest, or *Bosque Modelo Mariposa Monarca* (BMMM), was established in 1997 as part of the International Network of Model Forests for the protection and conservation of Monarch overwintering habitat in Mexico. Canada assisted technically in the development of a strategic plan for ecotourism, community development, and natural resource management, and funding for the program was provided through the Canadian International Development Agency (CIDA). The Manitoba Model Forest (MBMF) also partnered with the BMMM, resulting in a variety of education and restoration projects. In 2008, the BMMM project site area was incorporated as part of the Monarch Butterfly Biosphere Reserve (Manitoba Model Forest Inc., 2010).

In 2005, Mexico, the United States, and Canada initiated a process to establish a Trilateral Monarch Butterfly "Sister Protected Areas" (SPA) Network. The SPA Network is a partnership of wildlife refuges and national parks in the United States and Canada, and natural protected areas in Mexico, working together on Monarch conservation projects.

In 2006, the following Protected Areas were identified as the first to become part of the Monarch Butterfly SPA Network.

Under the Mexican Comisión Nacional de Áreas Naturales Protegidas (CONANP):

- Reserva de la biosfera de la Mariposa Monarca (Michoacán)
- Parque Nacional Iztaccihuatl Popocatepetl Zoquiapan (Estado de México, Puebla et Morelos)
- Parque Nacional Cumbres de Monterrey (Nuevo León)
- Área de Protección de Flora y Fauna Maderas del Carmen (Coahuila)

Under the United States Fish and Wildlife Service (USFWS):

- Balcones Canyonlands National Wildlife Refuge (Texas)
- St. Marks National Wildlife Refuge (Florida)
- Flint Hills, Quivira, and Marais des Cygnes National Wildlife Refuges (Kansas)
- Neal Smith National Wildlife Refuge (Iowa)

Under the United States National Parks System (NPS):

- Cuyahoga Valley National Park (Ohio)

Under the Canadian Wildlife Service (CWS):

- Long Point National Wildlife Area (Ontario)
- Prince Edward Point National Wildlife Area (Ontario)

Under Parks Canada Agency (PCA):

- Point Pelee National Park (Ontario)

## Monarch management

In 1996, Canada, Mexico and the United States established the Trilateral Committee for Wildlife and Ecosystem Conservation (Trilateral Committee). The committee's mandate is to facilitate the development of partnerships among associated and interested groups, and to enhance the cooperation and coordination among wildlife agencies in programs and projects for the conservation and management of species and ecosystems of mutual interest (Trilateral Committee, 2007). In 2007, the Trilateral Committee endorsed the development of the *North American Monarch Conservation Plan* (NAMCP) by the Commission for Environmental Cooperation. Completed in 2008, the NAMCP outlines key tri-national collaborative conservation objectives and outcomes to ensure that 1) sufficient overwintering habitat is available in the United States and Mexico for the populations to persist; and 2) sufficient breeding and migrating habitat is available in Canada, Mexico and the Unites States to maintain their current contribution to the overall North American population. A key objective of the NAMCP is to monitor Monarch population distribution, abundance and habitat quality (CEC, 2008). Accordingly, a tri-national multi-stakeholder group of experts recommended the development and dissemination of a Monarch monitoring program, and in 2009, CEC published *The Monarch Butterfly Monitoring in North America: Overview of Initiatives and Protocols* as a tri-lateral resource (CEC, 2009).

At the February 2014 North American Leaders' Summit in Mexico a joint statement was made committing the United States, Mexico and Canada to "…*establish a working group to ensure the conservation of the Monarch butterfly, a species that symbolizes our association*." Since that announcement, each country has made progress on Monarch conservation domestically and a Trinational Monarch Science Partnership has also been established. This science partnership will establish science priorities and develop a trinational monitoring strategy for Monarch.

## Management initiatives in Canada

In Canada, various provinces have taken initiatives to manage and conserve Monarch butterfly populations and their habitat. In Atlantic Canada, the Maritimes Butterfly Atlas was initiated in 2010 to provide comprehensive and systematic surveys to improve understanding of the numbers, distribution, and status of butterflies throughout the Maritimes (ACCDC, 2013b). The government of Ontario has produced a species at risk fact sheet on Monarch. Habitat for roosting and breeding Monarchs is being actively maintained on High Bluff Island at Presqu'ile Provincial Park, a noted Monarch migration hotspot and breeding location.

## Monitoring and research

Over the years, collaborative efforts between researchers, volunteers, teachers, and students to collect and analyze Monarch data resulted in numerous citizen science projects that allowed a significant improvement in the understanding of Monarch ecology.

One of the most renowned initiatives is the Monarch tagging program (Insect Migration Studies) initiated by Dr. Fred Urquhart in the 1930s to determine where the Canadian butterflies spend their winter months. In 1952, Dr. Urquhart made a first appeal for volunteers to assist with Monarch tagging, and over the next 40 or so years thousands of people participated. Recovery of numerous tagged butterflies led to the discovery of Monarch migration routes and their

overwintering sites in Mexico. The tagging efforts continue today, with the participation of Monarch Watch, Monarch Alert in California, and other organizations. Results from the Monarch Watch program are meticulously recorded on its public website Monarch Watch (www.monarchwatch.org).

Another resource available to support Monarch conservation is eButterfly (www.e-butterfly.org). This user-friendly website allows butterfly watchers across North America to record, archive and share their butterfly observations, providing researchers with a comprehensive picture of the abundance and distribution of butterflies.

In Canada, programs are in place to observe and monitor the butterflies as they aggregate in fall staging areas along the shores of the Great Lakes, such as in Presqu'ile Provincial Park, Long Point National Wildlife Area, Point Pelee National Park, and Rondeau Provincial Park (Crewe et al., 2007).

In addition to tagging and monitoring, research on Monarch behaviour and physiology (migration, flight tactics and navigation, habitat selection, etc.) along with analyses of threats to Monarch and its habitat (mortality, predation, climate change, etc.) have been undertaken. See Appendix B for some examples.

## Outreach and public engagement

As a flagship species, Monarch can help raise awareness of environmental issues such as habitat loss, environmental degradation and declines in pollinators. A variety of outreach and public engagement initiatives focusing on the Monarch occur throughout Canada. The following table summarizes several key initiatives currently underway (Table 3).

**Table 3. Key outreach and public engagement programs and projects.**

| Outreach Program/Project | Initiatives | Location |
|---|---|---|
| **Monarch Watch** | • Tagging and observation program to monitor Monarch movements and identify their migration corridors and rest areas.<br>• Program involves over 2,000 schools, nature centres and other organizations, and estimates over 100,000 participants in tagging activities each fall.<br>• Monarch Waystation Program which helps create, protect and conserve Monarch habitats. | Canada & USA |
| **Journey North** | • Internet-based environmental educational program that helps to track online Monarch butterfly migrations each fall and spring as butterflies journey to and from Mexico. | Canada, USA and Mexico |
| **Monarchs Without Borders** | • International research and conservation program run by the Montreal Insectarium, to rear, tag, and release Monarch butterflies. | Montreal Insectarium, Quebec |
| **Monarch Teacher Network of Canada** | • Network of teachers and others using Monarch butterflies to teach biology, conservation and the importance of environmental stewardship. | Canada |

A variety of local community activities and events are also ongoing to help educate the public on Monarch biology and its needs throughout the breeding season (see Table 4 for examples). As a result of these programs, the popularity of planting and conserving milkweeds and other nectar producing garden plants in home and school gardens, nature centers, and parks has increased over recent years.

**Table 4. Examples of local outreach and public engagement activities.**

| Outreach Activity | Initiatives | Location |
|---|---|---|
| **"Butterfly Days" and "Monarch Days"** | ● Butterfly conservatories and museums reach out to the community by offering interactive lessons to promote the conservation of Canada's biodiversity. | Canada |
| **Monarch Butterfly Club** | ● Printing and sale of butterfly kits to encourage the creation of chemical-free Monarch butterfly habitat, including milkweed and nectar sources. | Nova Scotia |
| **"Monarchs and Migrants Weekend"** | ● Annual celebration of all things that migrate, involving interactive events including nature walks and Monarch tagging displays to promote awareness. | Presqu'ile Provincial Park, Ontario |
| **"Monarch Butterfly Migration Festival"** | ● Annual festival engaging the community through guided butterfly hikes, tagging demonstrations, Adopt-a-Monarch Program, etc. | Rondeau Provincial Park, Ontario |
| **"Monarchs" live exhibit** | ● Annual exhibit where visitors are invited to get a close up look at the Monarch life cycle (including live caterpillars and Monarch roosts) and learn about conservation efforts through interpretive programs, displays, a factsheet, videos, social media, etc. | Point Pelee National Park |

A list of outreach and public engagement organizations, groups, and associations involved in Monarch research and education can be found in Appendix B.

## 6.2 Broad Strategies

Both the Eastern and Western populations of Monarch are impacted by numerous and significant threats. These threats occur throughout their entire range and affect breeding, nectaring and overwintering habitat. Managing such diverse, complex and significant threats will require the commitment of various levels of government, stakeholders, conservation organizations and the public. To achieve the management plan objectives, the following broad strategies are recommended:

- Support international cooperation for management of the Monarch and its habitat throughout the entirety of its two migratory pathways.
- Promote coordination between the various levels of government to develop and implement policy and programs that manage threats and conserve and enhance the quality and quantity of Monarch breeding and nectaring habitat in Canada.
- Conserve current Monarch staging habitat in Canada, and promote the enhancement of staging areas that are essential to successful migrations.

- Conduct research and monitoring in Canada and support international initiatives to address knowledge gaps in Monarch ecology.
- Continue to promote and support citizen engagement in the conservation and monitoring of Monarch and its habitat.

## 6.3 Conservation Measures

The following table outlines the conservation measures recommended to achieve the management plan objectives, and a given timeline for their implementation. Conservation measures are organized by the five broad strategies: international cooperation; conservation and management of breeding and nectaring habitat; conservation and management of staging habitat; research and monitoring; and outreach and public engagement.

**Table 5. Conservation measures and implementation schedule.**

| Conservation Measures | Priority[5] | Threats or concerns addressed | Timeline |
|---|---|---|---|
| **1.0 International Cooperation** | | | |
| 1.1 Support and encourage cooperation among international partners to manage the Monarch and its habitat throughout the entirety of its range. | High | All threats | Ongoing |
| 1.2 Support and participate in international Monarch conservation, research and monitoring initiatives (e.g., the 2008 North American Monarch Conservation Plan (NAMCP), Commission for Environmental Cooperation (CEC) projects and the Trinational Monarch Science Partnership). | High | All threats | Ongoing |
| **2.0 Conservation and Management of Breeding and Nectaring Habitat** | | | |
| 2.1 Promote coordination between the various levels of government to support the development and communication of policy, programs and guidelines that manage threats and conserve and enhance Monarch breeding and nectaring habitat, particularly in areas subject to habitat conversion, loss and degradation. | High | All threats | 2016 – 2020 and beyond |

[5] *"Priority" reflects the degree to which the measure contributes directly to the conservation of the species or is an essential precursor to a measure that contributes to the conservation of the species. High priority measures are considered those most likely to have an immediate and/or direct influence on attaining the management objective for species. Medium priority measures may have a less immediate or less direct influence on reaching the management objective, but are still important for management of the population. Low priority recovery measures will likely have an indirect or gradual influence on reaching the management objective, but are considered important contributions to the knowledge base and/or public involvement and acceptance of the species.*

| Conservation Measures | Priority[5] | Threats or concerns addressed | Timeline |
|---|---|---|---|
| 2.2 Develop and implement guidelines and/or best management practices that mitigate threats and create, conserve and enhance Monarch breeding and nectaring habitat. Guidelines and best management practices should be regionally and sector (e.g., agriculture, transportation, utility) specific to address timing requirements, invasive species present, species of Milkweed native to that region, and the nature of activities. | High | Widespread use of pesticides and herbicides<br>Succession and/or conversion of breeding and nectaring habitat<br>Removal of nectar producing/flowering vegetation along roadsides | 2016 – 2020 |
| 2.3 Support programs that prevent or mitigate the conversion of native grasslands, in addition to increasing this habitat type through restoration, compensation and enhancement activities. Apply integrated land management to minimize loss of native vegetation. | High - Medium | Succession and/or conversion of breeding and nectaring habitat | 2016 – 2020 |
| 2.4 Seek government engagement to have Monarch conservation needs incorporated into multi-species conservation initiatives and inventory and monitoring projects. | Medium - Low | Succession and/or conversion of breeding and nectaring habitat<br>Widespread use of pesticides and herbicides<br>Removal of nectar producing/flowering vegetation along roadsides | 2016 – 2020 and beyond |
| 2.5 Encourage the removal of native milkweed species from provincial Weed Control Acts. | Low | Control of milkweed | 2016 – 2020 |
| **3.0 Conservation and Management of Staging Habitat** | | | |
| 3.1 Support and extend current conservation efforts in federal and provincial protected areas and in other known staging sites in Canada through the promotion of Monarch conservation and/or stewardship programs. | High | Nectaring habitat succession and/or conversion<br>Ensuring there is sufficient staging habitat | 2016 – 2020 and beyond |
| 3.2 Promote the enhancement of habitat quality (i.e., nectaring habitat) at staging sites to help Monarch develop the reserves necessary to cross large obstacles such as the Great Lakes in southern Ontario. | High - Medium | Nectaring habitat succession and/or conversion<br>Ensuring there is sufficient staging habitat<br>Invasive species | 2016 – 2020 and beyond |

| Conservation Measures | Priority[5] | Threats or concerns addressed | Timeline |
|---|---|---|---|
| **4.0 Research and Monitoring** | | | |
| 4.1 Support research and monitoring projects that improve our understanding of milkweed distribution and abundance to allow for targeted conservation efforts. | High | Breeding and nectaring habitat succession and/or conversion<br>Widespread use of pesticides and herbicides<br>Invasive species | 2016 – 2020 and beyond |
| 4.2 Investigate the impact of pesticides and herbicides on Monarch (including herbicide-resistant crops and neonicotinoids). | High | Widespread use of pesticides and herbicides<br>Knowledge gaps | 2016 – 2020 and beyond |
| 4.3 Support the continuation and encourage the development of Monarch tagging and monitoring programs, to monitor and assess Monarch population sizes, migration pathways, and effects of habitat loss and degradation. In Canada, monitoring at known staging areas should be conducted. Strategic coordination of monitoring programs should be a priority.<br><br>Tagging should be conducted to determine whether butterflies emerging in the fall in Alberta, Saskatchewan and Manitoba migrate to the overwintering grounds in Mexico. Similarly, tagging should be conducted in southern British Columbia to document migratory patterns. | High - Medium | Knowledge gaps | 2016 – 2020 and beyond |
| 4.4 Continue to study the effects of climate change, severe weather events and Bark Beetle on Monarch habitat quality and availability and Monarch productivity. | Medium | Climate change and severe weather events<br>Bark beetle outbreak | 2016 – 2020 and beyond |
| 4.5 Assess the potential impacts of wind turbines on Monarch habitat, migration and survivorship. | Low | Collisions with vehicles and wind turbines<br>Knowledge gaps | 2016 – 2020 and beyond |
| 4.6 Assess the impacts of Monarch releases (e.g., at weddings and other events) on Monarch populations. | Low | Releases of Monarch butterflies<br>Knowledge gaps | 2016 – 2020 and beyond |

| Conservation Measures | Priority[5] | Threats or concerns addressed | Timeline |
|---|---|---|---|
| **5.0 Outreach and Public Engagement** | | | |
| 5.1 Support the development and implementation of education, outreach and public engagement activities to promote awareness of the Monarch and of threats to the species and its habitat. Outreach and engagement activities should be conducted broadly and should include the agricultural community and Indigenous communities. | High | All threats | Ongoing |
| 5.2 Promote engagement in the monitoring and conservation of the Monarch and its habitat by encouraging participation in citizen science Monarch monitoring and tagging programs, both by community members and in classrooms. Particular focus should be on areas of western Canada where migration patterns are not well established. | Medium | To address knowledge gaps | Ongoing |
| 5.3 Encourage the creation of butterfly gardens using milkweed species native to the area and the re-naturalization of degraded/unsuitable habitat. | Medium | Breeding and nectaring habitat succession and/or conversion | Ongoing |

# 7. MEASURING PROGRESS

Every five years, success in the implementation of the management plan and progress towards achieving the management plan objectives will be measured against the following performance indicators:

- The Monarch butterfly migratory phenomenon has been conserved.
- A minimum of six hectares of overwintering habitat in Mexico is occupied by Monarch each overwintering period by 2020.

# 8. REFERENCES

ACCDC (Atlantic Canada Conservation Data Centre). 2013a. Species Ranks. Web site: http://www.accdc.com/Products/ranking.html [accessed September 2013]

ACCDC (Atlantic Canada Conservation Data Centre). 2013b. Maritimes Butterfly Atlas. Web site: http://accdc.com/butterflyatlas/About.html [accessed August 2013]

Altizer, S., L. Brower, E. Howard, and K. Oberhauser. 2014. Concerns about mass-rearing and selling of Monarchs. Web site: http://www.learner.org/jnorth/tm/monarch/conservation_action_release.html [accessed January 19, 2014]

Altizer, S.M. and K.S. Oberhauser. 1999. Effects of the Protozoan Parasite *Ophryocystis elektroscirrha* on the Fitness of Monarch Butterflies (*Danaus plexippus*). *Journal of Invertebrate Pathology* 74(1): 76-83.

Altizer, S.M., K.S. Oberhauser and L.P. Brower. 2000. Associations Between Host Migration and the Prevalence of a Protozoan Parasite in Natural Populations of Adult Monarch Butterflies. *Ecological Entomology* 25: 125-139.

Arellano, G., J.I. Glendinning, J.B. Anderson, and L.P. Brower. 1993. Interspecific comparisons of the foraging dynamics of black-backed orioles and black-headed grosbeaks on overwintering Monarch butterflies in Mexico. pp. 315-322. *In* Malcom, S. B. and M. P. Zalucki (eds.), Biology and conservation of the Monarch butterfly. Publications of the Natural History Museum of Los Angeles County, Los Angeles, California. Science series no. 38.

Bell, C. E., J.M. Ditomaso, and M.T. Brooks. 2009. Invasive Plants and Wildfires in Southern California. University of California, Division of Agriculture and Natural Resources. Publication 8397. Web site: http://anrcatalog.ucdavis.edu/Details.aspx?itemNo=8397 [accessed April 2014].

Bird, C.D., G.J. Hilchie, N.G.Kondla, E.M. Pike, and F.A.H. Sperling. 1995. Alberta Butterflies. Provincial Museum of Alberta, Edmonton, AB. 347 pp.

Blackburn, L. G., and C. Boutin. 2003. Subtle effects of herbicide use in the context of genetically modified crops: A case study with glyphosate (Roundup®). *Ecotoxicology* 12: 271-285.

Bradley, C.A. and S. Altizer. 2005. Parasites Hinder Monarch Butterfly Flight: Implications for Disease Spread in Migratory Hosts. *Ecology Letters* 8(3): 290-300.

Brindza, L.P., L.P. Brower, A.K. Davis, and T. van Hook. 2008. Comparative success of Monarch Butterfly migration to overwintering sites in Mexico from inland and coastal sites in Virginia. *Journal of the Lepidopterists Society* 62:189-200.

Brower, L.P. 1995. Understanding and misunderstanding the migration of the monarch butterfly (*Nymphalidae*) in North America: 1857-1995. *Journal of the Lepidopterists Society* 49: 304-385.

Brower, L.P. 1996a. Monarch Butterfly Orientation: Missing Pieces of a Magnificent Puzzle. *Journal of Experimental Biology* 199: 93-103.

Brower, L.P. 1996b. Forest thinning increases monarch butterfly mortality by altering the microclimate of the overwintering sites in Mexico. Decline and Conservation of Butterflies in Japan III: 33-44. Proceedings International Symposium on Butterfly Conservation Osaka, Japan. Yadoriga Special Issue. Reprinted June 30, 1996.

Brower, L.P. 2001. Canary in the Cornfield: the Monarch and the *Bt* Corn Controversy. *Lepidoptera News* 4: 8-15.

Brower, L.P., J. Van Zandt Brower, and J.M. Corvino. 1967. Plant Poisons in a Terrestrial Food Chain. *Proceedings of the National Academy of Sciences of the United States of America* 57(4): 893-898.

Brower, L.P., B.E. Horner, M.A. Marty, C.M. Mofir, and B. Villa R. 1985. Mice (*Perocmyscus maniculatus*, *P. spicilegus*, *Microtus mexicanus*) as predators of overwintering monarch butterflies (*Danaus plexippus*) in Mexico. *Biotropica* 17(2): 89-99.

Brower, L.P., G. Castilleja, A. Peralta, J. Lopez-Garcia, L. Bojorquez-Tapia, S. Diaz, D. Melgarejo and M. Missrie. 2002. Quantitative Changes in Forest Quality in a Principal Overwintering Area of the Monarch Butterfly in Mexico, 1971-1999. *Conservation Biology* 16(2): 346-359.

Brower, L.P., A. Alonso, L, Fink, B. Frost, S. Malcom, K. Oberhauser, I. Ramirez, D. Slayback, O. Taylor, S. Weiss, and M. Zalucki. 2005. Reduced numbers of monarch butterflies overwintering in Mexico during the 2004-2005 season: evidence, possible causes and recommendations. Web site: www.monarchwatch.org/update/2005/0221_Sci_Adv_Rpt_11.pdf [accessed September 20, 2013].

Brower, L.P., O. Taylor, E. Williams, D. Slayback, R. Zubieta, and M. Isabel. 2012. Decline of monarch butterflies overwintering in Mexico: is the migratory phenomenon at risk? *Insect Conservation and Diversity* 5: 95-100.

Brower, L. P., and W. H. Calvert. 1985. Foraging dynamics of bird predators on overwintering monarch butterflies in Mexico. *Evolution* 39:852-868.

Brower, L.P. and S. Malcolm. 1991. Animal Migrations: Endangered Phenomena. *American Zoologist* 31(1): 265-276

Brower, L.P. and M. Missrie. 1998. Fires in the Monarch Butterfly Sanctuaries in Mexico. *Que Pasa* 3: 9-11.

Calvert, W.H., L.E. Hedrick, and L.P. Brower. 1979. Mortality of the Monarch Butterfly (*Danaus plexippus* L.): Avian Predation at Five Overwintering Sites in Mexico. *Science* 204: 847-851.

Canadian Food and Inspection Agency (CFIA). 2004. Web site: http://www.inspection.gc.ca/english/sci/biotech/enviro/monarce.shtml [accessed August 2008].

Carmichael, I. and A. Vance. 2003. Photo Field Guide to the Butterflies of Southern Ontario. *St. Thomas Field Naturalist Club,* St. Thomas, Ontario. 76pp.

Carmichael, I. and A. Vance. 2004. Photo Field Guide to Some Caterpillars of Southern Ontario. *St. Thomas Field Naturalist Club,* St. Thomas, Ontario. 72pp.

Casagrande, R.A. and J.E. Dacey. 2007. Monarch Butterfly Oviposition on Swallow-Worts (*Vincetoxicum* spp.). *Environmental Entomology* 36(3): 631-636.

Center for Biological Diversity, Center for Food Safety, The Xerces Society, and L. Brower. 2014. Petition to Protect the Monarch Butterfly (*Danaus plexippus plexippus*) Under the *Endangered Species Act*. Report submitted to the United States Secretary of the Interior, Washington D.C., 26 August 2014. 159 pp. Web site: http://www.biologicaldiversity.org/news/press_releases/2014/monarch-butterfly-08-26-2014.html [accessed January 20, 2015]

Commission for Environmental Cooperation (CEC). 2008. North American Monarch Conservation Plan. Quebec, Canada. 159pp.

Commission for Environmental Cooperation (CEC). 2009. The Monarch Butterfly Monitoring in North America: Overview of Initiatives and Protocols. 55pp.

Committee for the Status of Wildlife in Canada (COSEWIC), 2010. COSEWIC Assessment and Status Report on the Monarch, *Danaus plexippus*, in Canada. 42pp.

Crewe, T.L., J.D. McCracken, and D. Lepage. 2007. Population Trend Analyses of Monarch Butterflies Using Daily Counts During Fall Migration at Long Point, Ontario, Canada (1995-2006). Produced for the United States Fish and Wildlife Service. Bird Studies Canada, Port Rowan, ON, Canada.

Crolla, J.P. and J.D. Lafontaine. 1996. COSEWIC Status Report on the Monarch Butterfly. 23 pp.

Damus, M. 2007. Wind Plant Consequences to Butterflies – How Much Do We Know? *In* Tall Structures and Birds/Bats Information Group Volume 4, Issue 1.

Davis, A.K., N.P. Nibbelink and E. Howard. 2012. Identifying Large- and Small-Scale Habitat Characteristics of Monarch Butterfly Migratory Roost Sites with Citizen Science Observations. *International Journal of Zoology*. Volume 2012, Article ID 149026, 9p.

Dirección de la Reserva de la Biosfera Mariposa Monarca and WWF-Mexico. 2016. Briefing on the Snowing Event of March 2016 at overwintering colonies in Mexico. 3p.

DiTommaso, A. and J.E. Losey. 2003. Oviposition preference and larval performance of monarch butterflies (*Danaus plexippus*) on two invasive swallow-wort species. *Entomologia Experimentalis et Applicata* 108: 205-209.

Dockx, C, L. P. Brower, L. I. Wassenaar, and K. A. Hobson. 2004. Do North American Monarch Butterflies travel to Cuba? Stable Isotope and Chemical Tracer Techniques. *In* Ecological Applications volume 14, Issue 4.

Dockx, C. 2012. Differences in phenotypic traits and migratory strategies between eastern North American monarch butterflies, *Danaus plexippus* (L.). *Biological Journal of the Linnean Society* 106: 717-736.

Douglas, M.R., and J.F. Tooker. 2015. Large-Scale Deployment of Seed Treatments Has Driven Rapid Increase in Use of Neonicotinoid Insecticides and Preemptive Pest Management in U.S. Field Crops. *Environmental Science and Technology*. doi.10.1021/es5061g.

Fimrite, Peter. October 25, 2007. The Southern California Fires. Climate Change: Hotter World May Fan Flames. San Francisco Chronicle.

Fink, L.S. and L.P. Brower. 1981. Birds Can Overcome the Cardelonide Defense of Monarch Butterflies in Mexico. *Nature* 291: 67-70.

Flockhart, D.T., J. Pichancourt, D.R. Norris and T.G. Martin. 2015. Unravelling the annual cycle in a migratory animal: breeding-season habitat loss drives population declines of Monarch butterflies. *Journal of Animal Ecology* 84(1).

Flockhart, D.T., L.I. Wassenaar, T.G. Martin, K.A. Hobson, M.B. Wunder and D.R. Norris. 2013. Tracking multi-generational colonization of the breeding grounds by monarch butterflies in eastern North America. Proceedings of the Royal Society: *Biological Sciences* 280: 20131087. 8p.

Frey, D.F. and A. Schaffer. 2004. Spatial and temporal patterns of Monarch overwintering abundance in western North America. pp. 167-176. *In* Oberhauser, K.S. and M.J. Solensky (Eds), *The Monarch Butterfly: Biology and Conservation.* Cornell University Press, Ithaca, N.Y.

Garcia-Serrano, E., J.L. Reyes, and B.X. Alvarez. 2004. Locations and Areas Occupied by Monarch Butterflies Overwintering in Mexico from 1993 to 2002, pp. 129-133. *In* K. Oberhauser and M.J. Solensky (eds.), Monarch Butterfly Biology and Conservation. Cornell University Press, Ithaca, NY.

Gibo, David L. 1981. Altitudes attained by migrating monarch butterflies, *Danaus Plexippus* (Lepidoptera: Danaidae) as reported by glider pilots. *Canadian Journal of Zoology* 59(3): 571-572

Gibo, D.L. and M. J. Pallett. 1979. Soaring flight of monarch butterflies, *Danaus Plexippus* ( Lepidoptera: Danaidae), during the late summer migration in southern Ontario. *Canadian Journal of Zoology* 57: 1393-1401

Glendinning, J.I., A.A. Mejia, and L.P. Brower. 1988. Behavioral and ecological interactions of foraging mice (*Peromyscus melanotis*) with overwintering monarch butterflies (*Danaus plexippus*) in Mexico. *Oecologia* 75(2): 222-227.

Goulson, D. 2013. An overview of the environmental risks posed by neonicotinoid insecticides. *Journal of Applied Ecology* 50: 977-987.

Gove B., S. A. Power, G. P. Buckley, and J. Ghazoul. 2007. Effects of herbicide spray drive and fertilizer overspread on selected species of woodland ground flora: comparison between short –term and long-term impact assessments and field surveys: Herbicide and fertilizer impacts on woodland plants. *Journal of Applied Ecology* 44: 374-384.

Guppy, C. S. and J. H. Shepard. 2001. Butterflies of British Columbia: Including Western Alberta, Southern Yukon, the Alaskan Panhandle, Washington, Northern Oregon, Northern Idaho and Northwestern Montana. UBC Press, Vancouver, B.C. 414 pp.

Haber, W. A. 1993. Seasonal migration of Monarchs and other butterflies in Costa Rica. pp. 201-207. *In* Malcom, S. B. and M. P. Zalucki (eds.), Biology and conservation of the Monarch butterfly. Publications of the Natural History Museum of Los Angeles County, Los Angeles, California. Science series no.38.

Hansen Jesse, L and J.J. Obrycki. 2000. Field Deposition of Bt Transgenic Corn Pollen: Lethal Effects on the Monarch Butterfly. *Oecologia* 125: 241-248.

Holmes, A.M., Q.F. Hess, R.R. Tasker and A.J. Hanks. 1991. The Ontario Butterfly Atlas. Toronto Entomologists' Association, Toronto. 167 pp.

Hopwood, J., S.H. Black, M. Vaughn, and E. Lee-Mäder, 2013. Beyond the Birds and the Bees: Effects of Neonicotinoid Insecticides on Agriculturally Important Beneficial Invertebrates. The Xerces Society for Invertebrate Conservation. Web site: http://www.xerces.org/beyond-the-birds-and-the-bees/ [accessed: January 20, 2015]

Howard, E. and A.K. Davis. 2009. Fall migration flyways of Monarch butterflies in eastern North America revealed by citizen scientists. *Journal of Insect Conservation* 13: 279-286.

Hughes, R. B. 2012. The Monarch Migration of 2012 – A Vegreville Perspective. *Alberta Lepidopterists' Guild Newsletter – Fall 2012*. 21 pp.

Jesse, L.C.H, and J.J. Obrycki. 2003. Occurrence of *Danaus plexippus* L. (Lepidoptera: Danaidae) on milkweeds (*Asclepias syriaca*) in transgenic Bt corn agroecoystems. *Agriculture, Ecosystems and Environment* 97: 225-233.

Lamas, G. 2004. Atlas of Neotropical Lepidoptera. Checklist: Part 4A Hesperioidea – Papilionoidea. Scientific Publishers. 439 pp.

Lane, J. 1984. The Status of Monarch Butterfly Overwintering Sites in Alta California. *Atala* 9:17-20.

Lane, J. 1993. Overwintering Monarch Butterflies in California: Past and Present. pp. 335-344. *In* Malcom, S.B., and M.P. Zaluchi (Eds), Biology and Conservation of the Monarch Butterfly. The Natural History Museum of Los Angeles County, Los Angeles, California. Science series no. 38; pp. ix+419.

Layberry, R.A. , P.W. Hall, and J.D. Lafontaine. 1998. The Butterflies of Canada. University of Toronto Press. University of Toronto Press. Toronto, ON. 280 pp.

Losey, J.E., L.S. Rayor and M.E. Carter. 1999. Transgenic pollen harms monarch larvae. *Nature* 399: 214.

Lyons, J.I., A.A. Pierce, S.M. Barribeau, E.D. Sternberg, A.J. Mongue, and J.C. de Roode. 2012. Lack of genetic differentiation between monarch butterflies with divergent migration destinations. *Molecular Ecology* 21: 3433-3444.

Malcolm, S.B. 1987. Monarch butterfly migration in North America: Controversy and conservation. *Trends in Ecology and Evolution* 2(5): 135-138.

Malcolm, S.B. 1993. Conservation of Monarch Butterfly Migration in North America: An Endangered Phenomenon. pp. 357-361. *In* Malcom, S.B., and M.P. Zaluchi (Eds), Biology and Conservation of the Monarch Butterfly. The Natural History Museum of Los Angeles County, Los Angeles, California. Science series no. 38; pp. ix+419.

Manitoba Model Forest Inc. 2010. Monarch Butterfly Model Forest. http://www.manitobamodelforest.net/monarca_mariposa.html

Manzo-Delgado, L., J. López-García, and I. Alcántara-Ayala. 2014. Role of forest conservation in lessening land degradation in a temperate region: The Monarch Butterfly Biosphere Reserve, Mexico. *Journal of Environmental Management* 138: 55-66.

Marshall, Stephen A. 2006. Insects: Their Natural History and Diversity. Firefly Books Ltd., Richmond Hill, Ont. pp. 166-68, 185.

Mattila, H.R. and G.W. Otis. 2003. A Comparison of the Host Preference of Monarch Butterflies (*Danaus plexippus*) for Milkweed (*Asclepias syriaca*) Over Dog-strangler Vine (*Vincetoxinum rossicum*). *Entomologia Experimentalis et Applicata* 107(3): 193-199.

McLaughlin, R.E. and J. Myers 1970. *Ophryocystis elektroscirrha* sp. n. a neogregarine pathogen of the monarch butterfly *Danaus plexippus* (L.) and the Florida queen butterfly *Danaus gilippus berenice* Cramer. *Journal of Protozoology* 17: 300–305.

Meade, D. 1999. Monarch butterfly overwintering in Santa Barbara County, California. Report to Planning and Development Department of Santa Barbara County, California. Prepared by Althouse and Meade, Biological and Environmental Services. Paso Robles, California.

Monarch Butterfly Fund. 2009. Beetle Infestation: Beetle infestation impacting oyamel fir trees inside the Monarch Reserve. Article by Dr. Lincoln Brower. Web site: http://www.monarchbutterflyfund.org/node/246 [accessed January 8, 2015]

Monarch Watch. 2005. Reduced numbers of monarch butterflies overwintering in Mexico during the 2004-2005 season: evidence, possible causes and recommendations. Web site: www.**monarchwatch**.org/update/**2005**/0221_Sci_Adv_Rpt_11.pdf [accessed September 3, 2013].

Monarch Watch. 2010. Two-way Monarch Migration Map. Web site: http://monarchwatch.org/blog/2010/05/two-way-monarch-migration-map/ [accessed September 10, 2013].

MonarchLab. 2013. Monarch Migration. University of Minnesota. Web site: http://www.monarchlab.org/Lab/Research/Topics/Migration/Default.aspx [accessed September 10, 2013].

Monroe, M., D. Frey, and S. Stevens. 2015. Western Monarch Thanksgiving Count Data from 1997-2015. Web site: http://www.westernmonarchcount.org/data/ [accessed March 10, 2016].

NASA. 2008. Earth Observatory, Images. Web site: http://earthobservatory.nasa.gov/IOTD/view.php?id=8506. [accessed February 2013].

NatureServe. 2016. Online Encyclopedia of Life. Web site: http://www.natureserve.org/explorer/ [accessed March 3, 2016].

North American Butterfly Association. 2014. There's No Need to Release Butterflies -- They're Already Free. Web site: http://www.naba.org/releases.html [accessed April 22, 2014].

Nova Scotia Department of Agriculture and Fisheries. 2007. Nova Scotia Legislature. Web site: http://www.gov.ns.ca/legislature/legc/statutes/weedctrl.htm [accessed October 2007]

Oberhauser, K.S. 1997. Fecundity and egg mass of Monarch butterflies: effects of age, female size and mating history. *Functional Ecology* 11: 166-175.

Oberhauser, K.S. 2004. Overview of Monarch Breeding Biology *In* The Monarch Butterfly: Biology and Conservation. Oberhauser, K.S. and M.J. Solensky. (Eds). Cornell University Press, Ithaca, New York. pp. 3-8.

Oberhauser, K.S. 2012. Tachinid flies and monarch butterflies: Citizen Scientists document parasitism patterns over broad spatial and temporal scales. *American Entomologist* 58:19-22.

Oberhauser, K. and A. Townsend Peterson. 2003. Modeling current and future potential wintering distributions of eastern North American monarch butterflies. *In* Malcom, S. B. and M. P. Zalucki (eds.), Biology and conservation of the Monarch butterfly. Publications of the Natural History Museum of Los Angeles County, Los Angeles, California. Science series no. 38.

Oberhauser, K. S., I. Gebhard, C. Cameron and S. Oberhauser. 2007. Parasitism of monarch butterflies (*Danaus plexippus*) by *Lespesia archippivora* (Diptera: Tachinidae). *American Midland Naturalist* 157:312-328.

Pacenka, J.R., and J.G. Lundgren. 2015. Non-target effects of clothianidin on monarch butterflies. *The Science of Nature* 102: 19.

Parmesan, C. 2007. Influences of species, latitudes and methodologies on estimates of phenological response to global warming. *Global Change Biology* (13): 1860-1872.

Pleasants, J.M. 2015. Monarch butterflies and agriculture. Pp. 169-178 *In* K.S. Oberhauser, K.R. Nail, and S. Altizer (eds). Monarchs in a Changing World: Biology and Conservation of an Iconic Butterfly. Cornell University Press, Ithaca New York.

Pleasants, J.M., E.H. Williams, L.P. Brower, K.S. Oberhauser, and O.R. Taylor. 2016. Conclusion of No Decline in Summer Monarch Population Not Supported. Annals of the Entomological Society of America Advance Access [published February 4, 2016]. 3p.

Pleasants, J. M. and K. Oberhauser 2013. Milkweed loss in agricultural fields because of herbicide use: effect on the monarch butterfly population. *Insect Conservation and Diversity* 6: 135-144.

Pohl, G.R., G.G. Anweiler, B.C. Schmidt and N.G. Kondla. 2010: An annotated list of the Lepidoptera of Alberta, Canada. *ZooKeys* 38: 1–549.

Province of Manitoba. 2010. The Noxious Weeds Act. Manitoba Laws. Web site: http://web2.gov.mb.ca/laws/statutes/ccsm/n110e.php [accessed July 2014].

Ramirez, M.I., C. Saenz-Romero, G. Rehfeld, and L. Salas-Canela. 2015. Threats to the availability of overwintering hábitat in the Monarch Butterfly Biosphere Reserve. Pp. 157-168 *in* K.S. Oberhauser, K.R. Nail, and S. Altizer (eds.). Monarchs in a Changing World: Biology and Conservation of an Iconic Butterfly. Cornell University Press, Ithaca New York.

Rendón-Salinas, E. y G. Tavera-Alonso. 2013. Monitoreo de la superficie forestal ocupada por las colonias de hibernación de la mariposa Monarca en diciembre de 2012. Alianza WWF-Telcel / CONANP. 6 pp. Web site: http://www.wwf.org.mx/que_hacemos/mariposa_monarca/publicaciones/ [accessed March 14, 2016].

Rendón-Salinas, E., C.A. Valera-Bermejo, S. Rodríguez-Mejía, and Y.F. Martínez-Meza. 2010. Monitoreo de las colonias de hibernación de mariposa monarca: superficie forestal de ocupación en diciembre de 2009. *Report from World Wildlife Fund Mexico.*

Robinson, R. A., H. Q. P. Crick, J. A. Learmonth, I. M. D. Maclean, C. D. Thomas, F. Bairlein, M. C. Forchhammer, C. M. Francis, J. A. Gill, B. J. Godley, J. Harwood, G. C. Hays, B. Huntley, A. M. Hutson, G. J. Pierce, M. M. Rehfisch, D. W. Sims, M. B. Santos, T. H. Sparks, D. A. Stroud and M. E. Visser. 2009. Travelling through a warming world: climate change and migratory species. *Endangered Species Research* (7): 87-99.

Roeske, C.N., J.N. Seiber, L.P. Brower, and C.M. Moffit. 1976. Milkweed Cardenolides and their Comparative Processing by Monarch Butterflies (*Danaus plexippus* L.). *Recent Advances in Phytochemistry* 10: 93-167.

Sáenz-Romero, C. and R. Lindig-Cisneros. 2012. Will the Monarch Overwintering Sites Survive Climate Change? *American Butterflies* 20 (2): 14-17.

Sáenz-Romero, C., G.E. Rehfeldt, P. Duval and R.A. Lindig-Cisneros. 2012. *Abies religiosa* habitat prediction in climatic change scenarios and implications for monarch butterfly conservation in Mexico. *Forest Ecology and Management* 275: 98-106.

Sakai, W. 1994. Avian predation on the Monarch butterfly, *Danaus plexippus* (Nymphalidae: Danainae) at a Californian overwintering site. *Journal of the Lepidopterists' Society* 48(2): 148-156.

Schappert, Phil. 1996. Distribution, Status and Conservation of the Monarch Butterfly, *Danaus plexippus* (L.), in Canada. Report Submitted to the Commission for Environmental Cooperation, Québec, Canada.

Schappert, Phil. 2004. Monarch Butterflies: Saving the King of the New World. Key Porter Books, Toronto, Ontario. 128 pp.

Sears, M.K., R.L. Hellmich, D.E. Stanley-Horn, K.S. Oberhauser, J.M. Pleasants, H.R. Mattila, B.D. Siegfried and G.P. Dively. 2001. Impact of *Bt* Corn Pollen on Monarch Butterfly Populations: A Risk Assessment. *Agricultural Sciences* 98(21): 11937-11942.

Seiber, J.N., L.P. Brower, S.M. Lee, M.M. McChesney, H.T.A. Cheung, C.J. Nelson, and T.R. Watson. 1986. Cardenolide connection between overwintering monarch butterflies from Mexico and their larval food plant *Asclepias syriaca*. *Journal of Chemical Ecology* 12: 1157-1170.

Slack, G. 2004. Monarchs Hail The Eucalyptus. California Wild 57: 3. Web site: http://www.calacademy.org/calwild/2004summer/stories/habitats.html [accessed December 2007]

Slayback, D.A., L.P. Brower, M.I. Ramírez, and L.S. Fink. 2007a. Establishing the presence and absence of overwintering colonies of the Monarch butterfly in Mexico by the use of small aircraft. *American Entomologist* 53: 28-40.

Slayback, D.A. and L.P. Brower. 2007b. Further aerial surveys confirm the extreme localization of overwintering monarch butterfly colonies in Mexico. *American Entomologist* 53: 146-149.

Smith, D. A. S., G. Lushai, and J. A. Allen. 2005. A classification of *Danaus* butterflies (Lepidoptera: Nymphalidae) based upon data from morphology and DNA. Zoological *Journal of the Linnean Society* 144: 191-212.

Smithers, C. N. 1973. A note on the natural enemies of *Danaus plexippus* (L.) (Lepidoptera: Nymphalidae) in Australia. *Australian Entomological Magazine* 1:37-40

Snook, L.C. 1993. Conservation of the Monarch Butterfly Reserves in Mexico: Focus on the Forest. Pages 363-375 *in* Malcom, S. B. and M. P. Zalucki (Eds.), Biology and Conservation of the Monarch Butterfly. The Natural History Museum of Los Angeles County, Los Angeles, California. Science series no. 38; pp. ix+419.

Steed, B., and B. Willhite. 2011. Diagnosis and evaluation of insect and disease activity, and forest health in the Monarch Butterfly Biosphere Reserve. Report to CONANP. Web site: http://www.researchgate.net/publication/258051767_Diagnosis_and_evaluation_of_insect_and_disease_activity_and_forest_health_in_the_Monarch_Butterfly_Biosphere_Reserve_Diagnostico_y_evaluacin_de_ataques_de_plagas_enfermedades_y_salud_forestal_en_la_Reserva_de_la_Biosfera_Mariposa_Monarca [accessed January 19, 2015]

Taylor, C. 2016. Monarch Population Status. Monarchwatch.org. Web site: http://monarchwatch.org/blog/ [accessed March 2, 2016]

Trilateral Committee for Wildlife and Ecosystem Conservation and Management. 2007. Web site: http://www.trilat.org [accessed November 2012].

United States Department of Agriculture (USDA). 2004. Q&A: Bt Corn and Monarch Butterflies. Web site: http://www.ars.usda.gov/is/br/btcorn/index.html#bt8 [accessed August 2008]

Urquhart, F.A. 1960. The Monarch Butterfly. Toronto: University of Toronto Press. Pp. xxiv+361.

Urquhart, F.A. 1976. Found at Last: The Monarch's Winter Home. *National Geographic*. 150: 160-173.

van der Sluijs, J.P., V. Amaral-Rogers, L.P. Belzunces, M.F.I.J. Bijleveld van Lexmond, J-M. Bonmatin, M. Chagnon, C.A. Downs, L. Furlan, D.W. Gibbons, C. Giorio, V. Girolami, D. Goulson, D.P. Kreutzweiser, C. Krupke, M. Liess, E. Long, M. McField, P. Mineau, E.A.D. Mitchell, C.A. Morrissey, D.A. Noome, L. Pisa, J. Settele, N. Simon-Delso, J. D. Stark, A. Tapparo, H. Van Dyck, J. van Praagh, P. R. Whitehorn, M. Wiemers. 2015. Conclusions of the Worldwide Integrated Assessment on the risks of neonicotinoids and fipronil to biodiversity and ecosystem functioning. *Environmental Science and Pollution* 22(1): 148-154,

Ventana Wildlife Society. 2008. Monitoring Migrating Monarchs in Monterey County. Web site: http://www.ventanaws.org/conservation/monarchs.htm

Vidal, O., J. López-García, and E. Rendón-Salinas. 2014. Trends in deforestation and forest degradation after a decade of monitoring in the Monarch Butterfly Biosphere Reserve in Mexico. *Conservation Biology* 28(1): 177-186.

Wassenaar, L., and K.A. Hobson. 1998. Natal origins of migratory Monarch Butterflies at wintering colonies in Mexico: New isotopic evidence. *Proceedings of the National Academy of Sciences* 95:15436-15439.

Wells, S.M., R.M. Pyle, N.M. Collins. 1983. The IUCN Invertebrate Red Data Book. IUCN Conservation Monitoring Centre. Cambridge, U.K.

White, D.J. 1996. Status, Distribution, and Potential Impact from Noxious Weed Legislation. Report prepared for Canadian Wildlife Service, Ottawa.

White, D. S. 1989. Monarch butterfly (Lepidoptera: Danaidae) as prey for the dragonfly, *Hagenius brevistylus* (Odonata: Gomphidae). *Entomological news, and proceedings of the Entom* 100:129-32.

Williams, J., D. Stow and L. Brower. 2007. The influence of forest fragmentation on the location of overwintering monarch butterflies in central Mexico. *Journal of the Lepidopeterists' Society* 61(2): 90-104.

World Wildlife Fund. 2016. Aumenta la superficie ocupada por la mariposa monarca en los santuarios mexicanos. Web site : http://www.wwf.org.mx/?262370/Aumenta-superficie-ocupada-por-mariposa-monarca-en-santuarios-mexicanos [accessed March 3, 2016].

World Wildlife Fund. 2013. Monarch Butterfly Survey Indicates Lowest Numbers in 20 Years. Web site: http://www.worldwildlife.org/stories/monarch-butterfly-survey-indicates-lowest-numbers-in-20-years [accessed September 25, 2013].

Wormington, A. 1994. A mass migration of Monarchs at Point Pelee, Ontario, pp. 26-27 *in* Hanks, A. J. (ed.), *Butterflies of Ontario and summaries of Lepidoptera encountered in Ontario in 1993.* Toronto Entomologists Association Occasional Publications: 27-95.

Wormington, A. 1997. Another Mass Migration of Monarchs at Point Pelee, Ontario. Toronto Entomologists Association, Occasional Publication #29-97, p. 11.

Wormington, A. 2008. The Butterflies of Point Pelee National Park, Ontario. Unpublished Manuscript.

Xerces Society for Invertebrate Conservation. 2010. Policy statement on the release of butterflies. Web site: http://www.xerces.org/policy/ [accessed April 22, 2014].

Yeargan, K. V. and C.M. Allard. 2005. Comparison of Common Milkweed and Honeyvine Milkweed (*Asclepiadaceae*) as Host Plants for Monarch Larvae (*Lepidoptera: Nymphalidae*). *Journal of the Kansas Entomological Society* 78(3): 247-251.

Zalucki, M.P. and J.H. Lammers. 2010. Dispersal and egg short-fall in Monarch butterflies: what happens when the matrix is cleaned up? *Ecological Entomology* 35(1): 84-91.

Zalucki, M.P, A.R. Clarke, and S.B. Malcolm. 2002. Ecology and behavior of first instar larval Lepidoptera. *Annual Review of Entomology* 47: 361-393.

Zevit, P. and Guppy, C. 2011. BC's Coast Region: Species & Ecosystems of Conservation Concern. Web site: http://www.geog.ubc.ca/biodiversity/factsheets/pdf/Danaus_plexippus.pdf [accessed in July 2012].

Zipkin, E. F., L. Ries, R. Reeves, J. Regetz and K. Oberhauser. 2012. Tracking climate impacts on the migratory monarch butterfly. *Global Change Biology* 18: 3039 – 3049.

**Personal communications**

Elderkin, M. 2013. *Comments on draft Monarch Management Plan*. Species at Risk Biologist, Wildlife Division, NS Department of Natural Resources.

Oberhauser, K.S. 2012. Associate Professor, Department of Fisheries, Wildlife and Conservation Biology, University of Minnesota.

# APPENDIX A: EFFECTS ON THE ENVIRONMENT AND OTHER SPECIES

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[6]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[7] (FSDS) goals and targets.

Conservation planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that implementation of management plans may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the management plan itself, but are also summarized below in this statement.

The potential for the plan to inadvertently lead to adverse effects on the environment or other species was considered. Since the focus of recommended activities is primarily on non-intrusive measures such as working with international partners, population monitoring, conducting awareness activities, habitat conservation and enhancement, it is unlikely that the management plan will entail significant adverse effects. Maintenance of disturbed and early successional habitats to benefit Monarch would benefit species that utilize similar habitat but could also reduce habitat for species that require more advanced stages of succession.

[6] http://www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1
[7] www.ec.gc.ca/dd-sd/default.asp?lang=En&n=F93CD795-1

# APPENDIX B: ORGANIZATIONS AND PROGRAMS INVOLVED IN MONARCH OUTREACH, CONSERVATION AND RESEARCH

### *Citizen science*

eButterfly (www.e-butterfly.org / www.ipapillon.ca)
Monarch Watch (www.monarchwatch.org)
Monarch Larvae Monitoring Project (www.mlmp.org)
Monarch Lab: Monarchs in the Classroom (www.monarchlab.org)
Insectarium de Montréal (http://www2.ville.montreal.qc.ca/insectarium/)
Project Monarch Health (http://www.monarchparasites.org/)

### *Public engagement*

North American Butterfly Association (www.naba.org)
The Monarch Butterfly in North America
(http://www.fs.fed.us/wildflowers/pollinators/monarchbutterfly/)

### *Education*

Monarch Teacher Network – Canada (http://www.monarchteacher.ca/)
Journey North (www.learner.org/jnorth)
Insectarium de Montréal (http://www2.ville.montreal.qc.ca/insectarium/)

### *Conservation and stewardship*

Xerces Society for Invertebrate Conservation (Milkweeds Guide)
(http://www.xerces.org/milkweeds-a-conservation-practitioners-guide/)
Monarch Butterfly Fund (http://www.monarchbutterflyfund.org/)
Monarch Butterfly Club (www.facebook.com/MonarchButterflyClub)
Nature Canada Monarch Guide (http://www.naturecanada.ca/take_action_monarch_guide.asp)

### *Research*

Monarch Alert (http://monarchalert.calpoly.edu/index.html)
Monarch Monitoring Project (http://www.monarchmonitoringproject.com/)
Tactics and Vectors (http://www.erin.utoronto.ca/~w3gibo/)
Texas Monarch Watch (http://www.texasento.net/dplex.htm)
FrostLab (http://www.queensu.ca/psychology/frost/AnimalNavigation.html )

### *Resources*

Commission for Environmental Cooperation (CEC). 2008. North American Monarch Conservation Plan. Quebec, Canada.159 pages. (http://www.cec.org/Page.asp?PageID=1225&SiteNodeID=599)

Commission for Environmental Cooperation (CEC). 2009. Monarch Butterfly Monitoring in North America: overview of initiatives and Protocols. Quebec, Canada. 54 pages. (http://www.cec.org/Page.asp?PageID=30101&ContentID=17397&SiteNodeID=484)