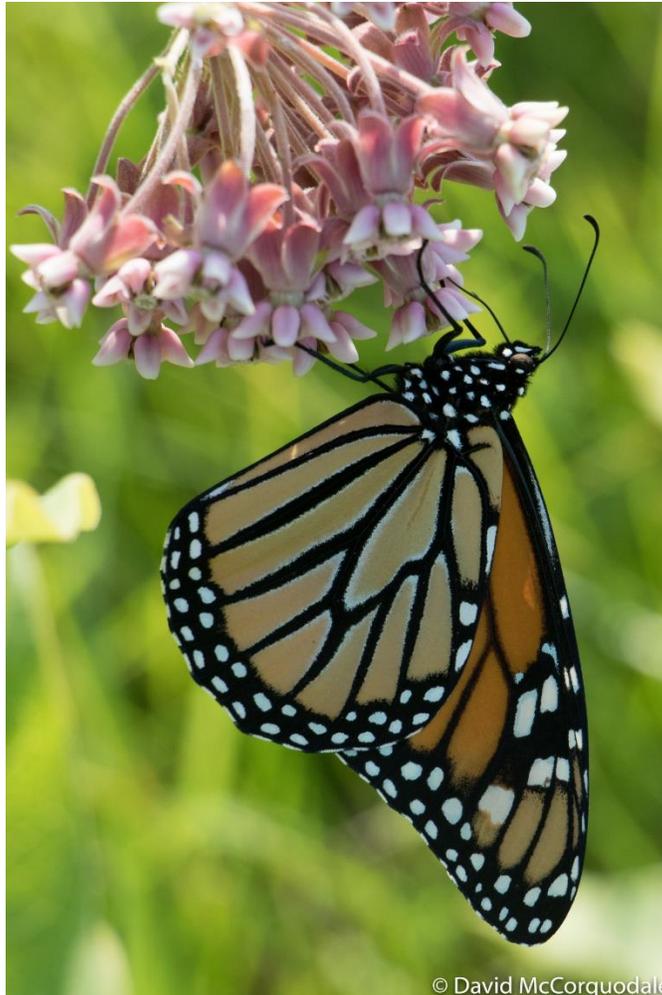


## **RECOVERY PLAN FOR MONARCH (*DANAUS PLEXIPPUS*) IN NOVA SCOTIA**



**A report prepared for the Nova Scotia Department of Natural  
Resources and Renewables**

**2021**

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Cover illustration: Nectaring adult female Monarch. Photographer: David McCorquodale

## PREFACE

This Recovery Plan was prepared by John Klymko, Atlantic Canada Conservation Centre, in consultation with the members of the Nova Scotia Insects Recovery Team, and the responsible jurisdiction, the Nova Scotia Department of Natural Resources and Renewables. The recovery plan defines the recovery goals, objectives, and actions that are deemed necessary to protect, conserve, and recover Monarch in Nova Scotia. The implementation of the recovery plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations. Therefore, some aspects of this recovery plan may not be implemented immediately, concurrently, or in their entirety.

Monarch was designated as Endangered in Nova Scotia in 2017. This is the first provincial Recovery Plan for this species.

Recovery plans are not designed to provide a comprehensive summary of the biology and status of Monarch in Nova Scotia. For more information regarding Monarch, consult the COSEWIC Status Report on Monarch (COSEWIC 2016).

Under the *Nova Scotia Endangered Species Act (2007)*, a Recovery Plan must be developed for species listed as Endangered or Threatened under the Act and include the following:

- Identification of the needs and threats to recovery of the species;
- The viable status needed for recovery;
- The options for recovery as well as the costs and benefits of these options;
- The recommended course of action or combination of actions to achieve recovery of the species;
- A schedule for implementation of the recovery plan including a prioritized listing of recommended actions;
- Identification of habitat; and
- Identification of areas to be designated as core habitat for the species.

The goals, objectives, and actions identified in this Recovery Plan is based upon the best available information on the species and is subject to modifications and/or revisions as new information becomes available. Recovery of species at risk is a shared responsibility and the collaborative approach emphasized in this document is reflective of this. Implementation of the actions and approaches identified in this plan are subject to budget constraints, appropriations, and changing priorities.

## **ACKNOWLEDGEMENTS**

The province contracted John Klymko, Atlantic Canada Conservation Data Centre, to develop the draft Recovery Plan in consultation with the Nova Scotia Insects Recovery Team. The Department would like to thank the following members of the Recovery Team for their contributions to the development of the Recovery Plan:

- Calum Ewing
- Daniel Kehler
- John Klymko
- Dr. Paul Manning
- Dr. David McCorquodale

The Department would also like to thank the following staff who supported the Recovery Team in the development of this Recovery Plan: Mark McGarrigle, Donald Sam, Dr. Donna Hurlburt, as well as the Atlantic Canada Conservation Data Centre.

## EXECUTIVE SUMMARY

The Monarch (*Danaus plexippus*) is large, showy, widespread butterfly famous for its long migration. The eastern North American population has declined by more than 50% in the past 15 years. Nova Scotia is at the northeastern edge of the species' range, and the number of Monarchs that migrate into the province varies dramatically year-to-year and is dependent on conditions elsewhere in Canada, the United States, and Mexico. Available data suggests that in Nova Scotia, the Monarch is currently at least as common as it was historically, despite declines to the overall population. The Monarch is dependent on milkweed as a larval food plant, and in Nova Scotia it feeds on Common milkweed and Swamp milkweed. The most significant threats to Monarch are the loss of overwintering habitat and the loss of larval food plants in agroecosystems through herbicide use. Both of these threats occur primarily or entirely outside of Nova Scotia. The Monarch is also threatened by severe storms at overwintering sites in Mexico, the loss of breeding habitat in the United States and Canada, the loss of nectaring habitat in the United States and Canada, and insecticide use. In Nova Scotia, the most significant threats are considered to be the loss of breeding habitat to development and habitat succession and insecticide use, but overall the level of threat in the province is relatively low.

The potential impact of conservation measures taken in Nova Scotia is limited. The province contains less than 1% of the eastern North American population, and the fate of the species in Nova Scotia is dictated by the fate of the eastern North American population as a whole. Due to these factors, the short-term and long-term goals are simply to maintain the province's Swamp milkweed population at its current size so that Monarchs that migrate into the province annually are able to breed. The population and distribution objective is to maintain the province's milkweed population at or above its size and distribution in 2021. Potential recovery actions include the protection and management of habitat containing Swamp milkweed, increasing the knowledge of milkweed distribution and abundance in Nova Scotia, and supporting NGO programs about Monarch conservation. The Monarch is not believed to be limited within the province by the availability of breeding habitat, nectaring habitat, or habitat important to migration. Therefore, due to the lack of practical conservation benefits, it is recommended that Core Habitat should not be designated at this time.

## RECOVERY FEASIBILITY

The recovery of Monarch in Nova Scotia is considered technically and biologically feasible if the following four criteria can be met:

1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.

Yes. The Monarch migrates into Nova Scotia annually. It is believed that there is one homogenous migratory population in eastern North America that overwinters in central Mexico and repopulates the eastern United States and southern Canada east of the Rockies, including Nova Scotia, each spring and summer. Nova Scotia is part of, and not distinct from, this population. This population has declined, and is the focus of conservation efforts in Canada, the United States, and Mexico. Monarchs will presumably continue to migrate into Nova Scotia as long as this population is extant.

2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.

Yes. Sufficient habitat is available in Nova Scotia to support the species at its current population size. Adult Monarchs require nectaring habitat. They also aggregate in coastal areas during migration. The importance of these sites is not well understood, but they are not believed to be limiting the adults that migrate out of Nova Scotia. Larval Monarchs only eat milkweed (mostly *Asclepias* spp.), and in Nova Scotia two species occur: Swamp milkweed (*A. incarnata*) and Common milkweed (*A. syriaca*). Swamp milkweed is a widespread wetland species that is apparently secure (ranked S4). Common milkweed is a species of well drained soils: it is sparsely scattered across the province and is most common in the Annapolis Valley. It is unclear if Common milkweed is native to the province, but nearly all extant populations are in human altered habitats.

3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.

Yes. The Monarch is threatened by the loss of overwintering habitat in Mexico, severe storms at overwintering sites in Mexico, the loss of breeding habitat in the United States and Canada, the loss of nectaring habitat in the United States and Canada, and pesticide use. In Nova Scotia, the most significant threats are the loss of milkweed habitat to development activities and natural habitat succession; direct mortality from vehicle collisions; and insecticide use. However, the overall level of threat to Monarch in the province is relatively low.

Threats with direct human causes, such as breeding habitat loss from herbicide spraying, can be avoided. Threats with indirect human causes, namely climate change, may be unavoidable but could possibly be mitigated through proactive management. Beyond Nova Scotia a significant threat is the loss of high elevation Oyamel Fir (*Abies religiosa*) forest in Mexico, which is where the eastern North American migratory population overwinters. It is predicted that habitat suitable for overwintering may be reduced by 50% by 2030 and completely eliminated by 2090 (Ramirez et al. 2015). They recommend mitigating this projected loss through proactive management measures, such as reforesting farmed areas that in future will have a climate suitable for Oyamel Fir.

4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.

The future population and distribution of Monarch in Nova Scotia is dependent on a persistence of the eastern North American migratory Monarch population, and the availability of breeding habitat in Nova Scotia in its current distribution. The objective of the recovery plan is to maintain the current milkweed population and distribution so that the adult Monarchs that arrive in Nova Scotia are able to breed.

The Recovery Team concludes that it is possible to preserve breeding habitat through various strategies including habitat conservation and management. Therefore, it is possible to maintain suitable habitat that is available to adults that migrate into the province.

**TABLE OF CONTENTS**

PREFACE .....	iii
ACKNOWLEDGEMENTS .....	iv
EXECUTIVE SUMMARY .....	v
RECOVERY FEASIBILITY .....	vi
TABLE OF CONTENTS .....	viii
LIST OF FIGURES .....	ix
LIST OF TABLES.....	ix
1. NSSARWG and/or COSEWIC ASSESSMENT SUMMARY* .....	1
2. SPECIES STATUS INFORMATION.....	1
3. SPECIES DESCRIPTION .....	2
3.1. Population and Distribution .....	3
3.2. Species Needs.....	7
3.3. Dwelling Place .....	9
4. THREATS .....	10
4.1. Threat Assessment.....	10
4.2. Description of Threats .....	18
5. POPULATION AND DISTRIBUTION OBJECTIVES .....	24
6. BROAD STRATEGIES AND GENERAL APPROACHES TO RECOVERY .....	25
6.1. Actions Completed or Underway.....	25
6.2. General Approaches to Recovery .....	27
6.3. Narrative to Support the Recovery Planning Table.....	30
7. RECOMMENDED COURSE OF ACTION FOR RECOVERY.....	32
8. IDENTIFICATION OF CORE HABITAT .....	33
8.1. Core Habitat Definition and Attributes .....	33
8.2. Activities Likely to Result in the Destruction of Core Habitat .....	38
9. MEASURING PROGRESS .....	38
9.1. Performance Indicators.....	38
9.2. Monitoring.....	39
10. REFERENCES.....	39

## LIST OF FIGURES

Figure 1. Distribution of Monarch and its subspecies in the Americas. (Pierce et al. 2015; modified in COSEWIC 2016).....	4
Figure 2. Nova Scotia Monarch records. Data from ACCDC (2021). ....	5
Figure 3. Nova Scotia milkweed records. Data from AC CDC (2021). ....	6
Figure 4. Core Habitat for Monarch in Nova Scotia. ....	34
Figure 5. Core Habitat for Kings, Annapolis, Digby, Yarmouth, Shelbourne, Queens, and Lunenburg counties. ....	35
Figure 6. Core Habitat for Cumberland, Colchester, Pictou, Halifax, and Hants counties. ....	36
Figure 7. Core Habitat for Antigonish, Inverness, Victoria, Cape Breton, Richmond, and Guysborough counties. ....	37

## LIST OF TABLES

Table 1. NatureServe conservation status ranks for the Monarch in Canada (NatureServe 2021; CESSC 2016).*	2
Table 2. Threat calculator assessment.....	10
Table 3. Recovery planning table which includes recovery measures, actions, and costs and benefits of recovery actions.....	27
Table 4. Recovery actions and implementation schedule of activities in support of recovery.....	32
Table 5. Activities which may result in the destruction of core habitat. ....	38

## 1. NSSARWG and/or COSEWIC ASSESSMENT SUMMARY\*

\* The following definitions are applicable in this section and elsewhere: NSSARWG (Nova Scotia Species at Risk Working Group); COSEWIC (Committee on the Status of Endangered Wildlife in Canada); NSESA (Nova Scotia Endangered Species Act); SARA (Species at Risk Act).

**Assessment Summary:****Common Name:** Monarch**Scientific Name:** *Danaus plexippus* (L.)**Status:** Endangered

**Reason for Designation:** This large showy species is one of the most well-known butterflies in the world. The Canadian population is migratory with two distinct pathways and cumulative threats at both overwintering sites and along the long migratory routes. The migratory group west of the Rocky Mountains moves between coastal California and southern British Columbia. The group east of the Rocky Mountains represents the vast majority of the Canadian population and moves between the Oyamel Forest of central Mexico and southern Canada east of Alberta. The overwintering sites in central Mexico are extremely small, and threats to these areas include illegal logging and agricultural development, and increased frequency and severity of storms during key congregation times. Declines of greater than 50% have occurred over the past decade. (COSEWIC 2016, p. xi)

**Nova Scotia Occurrence:** Adults have been documented in every county.

**Status History:** The Monarch was designated as Special Concern by COSEWIC in 1997 and listed as such under the federal *Species at Risk Act* in 2004. The Special Concern status was re-examined and confirmed in 2001 and 2010. In 2016 it was designated as Endangered by COSEWIC. As of February 2021, it remains listed as Special Concern under the federal *Species at Risk Act*.

It is listed as Endangered under the Nova Scotia *Endangered Species Act* (2017).

## 2. SPECIES STATUS INFORMATION

Monarch (*Danaus plexippus*), although considered globally secure, is considered nationally and provincially at risk. In Canada, it was originally assessed as Special Concern in 1997 and reassessed as Endangered in 2016 by the *Committee on the Status of Endangered Wildlife in Canada* (COSEWIC) and is listed as Special Concern on Schedule 1 of the *Species at Risk Act* (SARA, 2003). Provincially, Monarchs are listed as Special Concern under the *Ontario Endangered Species Act* (2007) and the *New Brunswick Species at Risk Act* (2013).

Table 1. NatureServe conservation status ranks for the Monarch in Canada (NatureServe 2021; CESSC 2016).\*

Global (G) Rank <sup>a</sup>	National (N) Rank <sup>b</sup>	Subnational (S) Rank <sup>c</sup>
G4	N3B,NNRM	Alberta - S3B British Columbia - S3B Manitoba - S3S4B New Brunswick - S3B,S3M Newfoundland – SNA Nova Scotia - S2B Nunavut - SNRB,SNRM Ontario - S2N,S4B Prince Edward Island - S1B Quebec - S5B Saskatchewan - S2B

<sup>a</sup> G-Rank – Global Conservation Status Rank, G1 = Critically Imperiled; G2 = Imperiled; G3 = Vulnerable; G4 = Apparently Secure; G5 = Secure

<sup>b</sup> N-Rank – Provide ranking for each province the species is found in. National Conservation Status Rank, N1 = Critically Imperiled; N2 = Imperiled; N3 = Vulnerable; N4 = Apparently Secure; N5 = Secure

<sup>c</sup> S-Rank – Sub-national (provincial or territorial) ranks, S1 = Critically Imperiled; S2 = Imperiled; S3 = Vulnerable; S4 = Apparently Secure; and S5 = Secure. B = breeding; and U = Unrankable.

\*A full list of definitions can be found in Definitions of NatureServe Conservation Status Rankings at [http://help.natureserve.org/biotics/Content/Record\\_Management/Element\\_Files/Element\\_Tracking/ETRA\\_CK\\_Definitions\\_of\\_Heritage\\_Conservation\\_Status\\_Ranks.htm](http://help.natureserve.org/biotics/Content/Record_Management/Element_Files/Element_Tracking/ETRA_CK_Definitions_of_Heritage_Conservation_Status_Ranks.htm)

### 3. SPECIES DESCRIPTION

The Monarch is a large showy butterfly, with a wingspan of 93-105 mm (Layberry *et al.* 1998). Its wings are orange with black veins and a thick black margin with white dots. Like all Lepidoptera, it has a complete life cycle. Eggs are dull green, larvae are conspicuously marked with black, white, and yellow bands, and chrysalids are pale green with a row of gold spots. Larvae feed exclusively on milkweeds (mostly *Asclepias* spp.) and in Nova Scotia it feeds on Swamp Milkweed (*A. incarnata*) and Common Milkweed (*A. syriaca*).

In Nova Scotia, Monarch adults can be confused with the Viceroy (*Limenitis archippus*); however, the Monarch is larger, has two rows of white spots on the wing margins (Viceroy has one), and lacks the black line across the hindwing that is characteristic of the Viceroy.

### **3.1. Population and Distribution**

#### 2.2.1 Global Range

The Monarch is native to the Americas, occurring from southern Canada to northern Brazil, including the Caribbean (Figure 1). There are established, non-native populations in many other regions, including Pacific Islands, Australia, Europe, and northern Africa (COSEWIC 2016). Six subspecies have been named, but in North America only the nominotypical subspecies, *D. plexippus plexippus*, occurs (NatureServe 2021).



Figure 1. Distribution of Monarch and its subspecies in the Americas. (Pierce et al. 2015; modified in COSEWIC 2016).

### 2.2.2 Canadian Range

The Monarch occurs across southern Canada, with the northern boundary of its distribution defined by the distributions of its primary larval food plants, Common Milkweed, Swamp Milkweed, and, in the west, Showy Milkweed (*Asclepias speciosa*)

(COSEWIC 2016). It breeds in all provinces but Newfoundland and Labrador (CESCC 2016).

The eastern North American population is migratory – it overwinters in central Mexico as an adult, colonizes the eastern United States and southeastern Canada each spring and summer, and has a southward migration in fall.

### 2.2.3 Nova Scotia Range

Adult Monarchs are migratory and can be found throughout Nova Scotia during the summer and early fall, including Sable Island, but they are most common in the western and southern portions of the mainland (ACCDC 2021). It can breed where milkweed is found, including gardens where it is planted. Records of adult Monarchs and immature stages (i.e. evidence of breeding) are shown in Figure 2. Wild populations of Common Milkweed and Swamp Milkweed in Nova Scotia are shown in Figure 3.

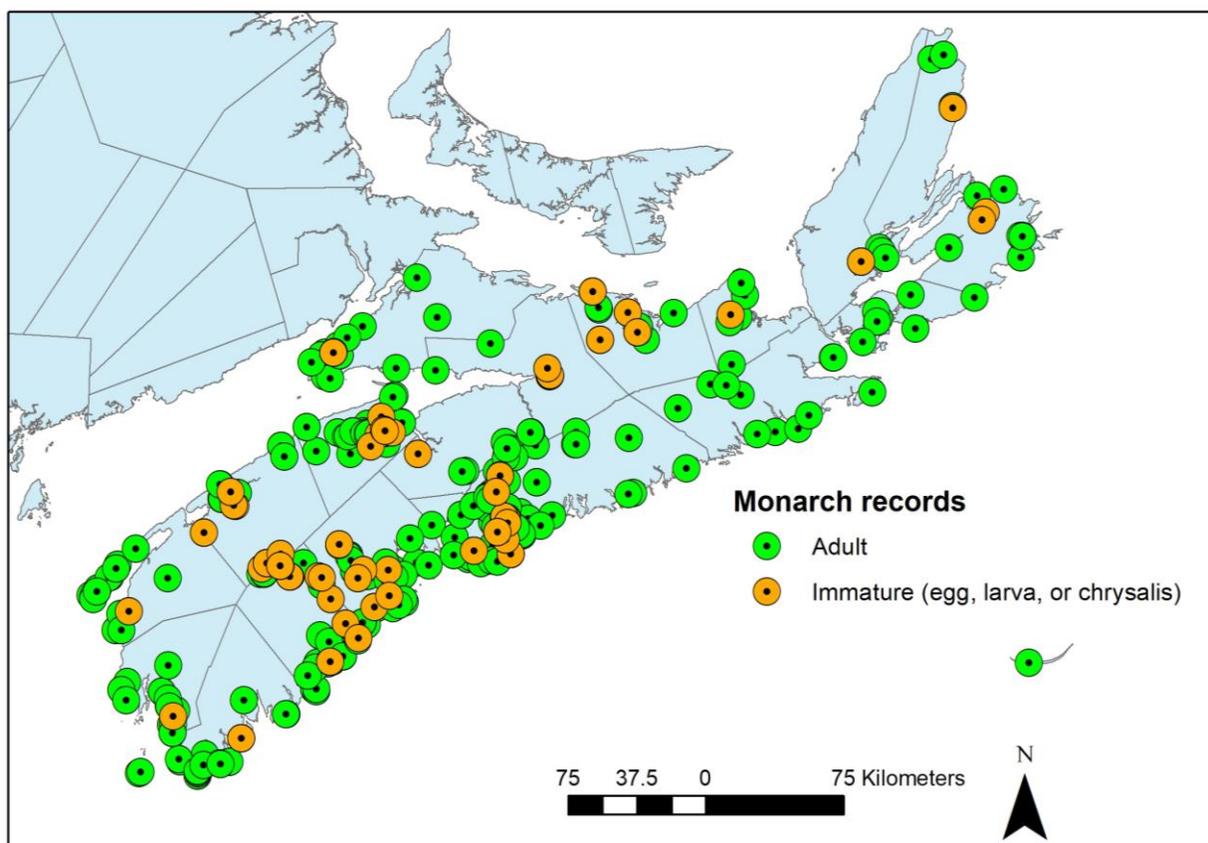


Figure 2. Nova Scotia Monarch records. Data from ACCDC (2021).

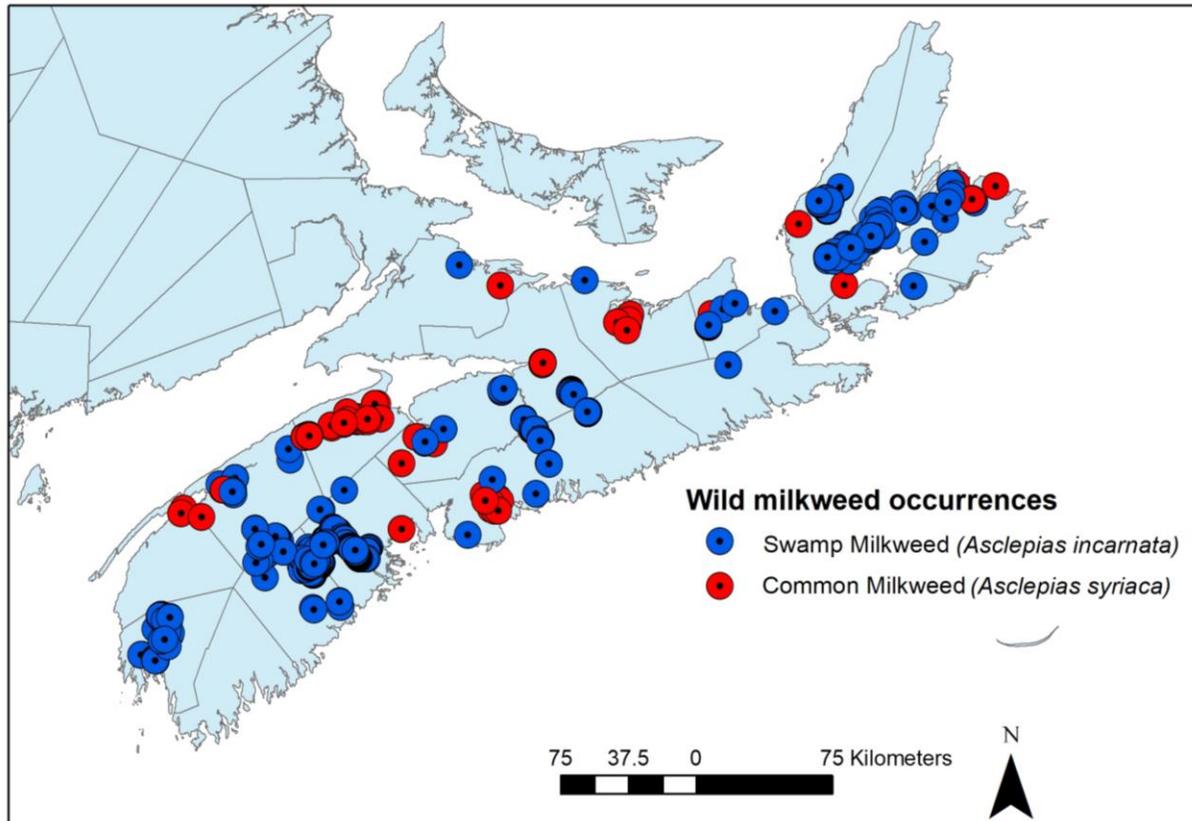


Figure 3. Nova Scotia milkweed records. Data from AC CDC (2021).

#### 2.2.4 Population Size

The size of the migratory eastern North American population is monitored by estimating the number of hectares that the overwintering colonies in Mexico cover, and between the winters of 1994-1995 and 2019-2020, that number of hectares has varied between 18.19 ha (winter of 1996-1997) and 0.67 ha (winter of 2013-2014) (Monarch Watch 2021). Using a factor of 50 million Monarchs per hectare (as per COSEWIC 2016), the population ranged from 141.5 million to 909.5 million. The summer breeding range of the eastern North American Monarch population extends from Maryland west to central Colorado in the south, north to southeastern Alberta and east to Nova Scotia (Monarch Watch 2021), an area of approximately 4,000,000 km<sup>2</sup>. Nova Scotia is 55,284km<sup>2</sup>, or 1.4% of this area. The density of Monarch in Nova Scotia is far less than that of the core of the breeding range, therefore the Nova Scotia breeding population would be much far less than 1.4% of the eastern North American population. The number of Monarchs in Nova Scotia varies year to year, and is likely dependent size of overwintering population and on the breeding conditions in spring and early summer on its northward migration.

In southern Ontario and Quebec, Monarchs produce two or three generations between June and October each year (COSEWIC 2016). In Nova Scotia, one or two generations

per year is likely more typical, as the species arrives in the province later. In Ontario, 10% of the 26,127 documented Monarch occurrences records are from on or before June 16 (Macnaughton *et al.* 2021), whereas in Nova Scotia, 10% of the 573 documented Monarch occurrences are from on or before July 7 (ACCDC 2021).

Published accounts suggest that the Monarch is at least as common or more common now than it was historically in Nova Scotia. In Perrin and Russell's (1912) catalog of the Lepidoptera of the Halifax and Digby areas, the Monarch is described as "plentiful during some seasons" on McNab's Island, Halifax County, and "always rare" in the Digby area. Ferguson (1954), in his treatment of the Lepidoptera of Nova Scotia, states that "normally only a scattering of individuals appear, even in late summer", though he does note it is occasionally common. It is remarkable that Ferguson knew of no breeding records from the province. During the Maritimes Butterfly Atlas (2010-2015), the Monarch was the 24<sup>th</sup> most frequently documented butterfly in Nova Scotia, with 230 records representing 1.5% of all observations (ACCDC 2021). During the six years of the atlas, it was most common in 2012, an excellent year for migrant butterflies in eastern Canada. In 2012 it was the 12<sup>th</sup> most reported species in Nova Scotia, with 139 records (3.5% of the year's total). It was the least common in 2013, when it was the 38<sup>th</sup> most common species with just 9 records (0.4% of the year's total). This general pattern was experienced throughout the Maritimes during the Atlas – the Monarch was common in 2012, and uncommon in the other years. Based on the relative number of observations submitted to iNaturalist, the Monarch was also common in the Maritimes in 2017, 2018, and 2019 (ACCDC 2021).

### 3.2. Species Needs

The Monarch requires the following four types of habitat for persistence: breeding, nectaring, staging and overwintering (COSEWIC 2016).

#### Breeding Habitat

Monarch larvae feed exclusively on the leaves, flowers and fruits of milkweed, and in Canada, Monarch larvae feed solely on milkweeds in the genus *Asclepias* (COSEWIC 2016). Their breeding habitat is therefore dependent on the presence of these plants, which are widespread across Nova Scotia (Fig. 3).

Swamp milkweed and Common Milkweed occur in the wild in Nova Scotia (Figure 3). Swamp milkweed is a native wetland species, occurring in marshes, fens, and rocky freshwater shorelines. It is widespread though patchily distributed. It is most abundant in southwestern Cape Breton and central southwestern Nova Scotia. Common milkweed is a species of well drained soils, and in Nova Scotia it is typically found in anthropogenic habitats like rail verges, roadsides, and old fields. It is unclear if Common milkweed is native to Nova Scotia. There may be some native populations on rivers

along the Northumberland Strait, as at Middle River of Pictou, but no clearly native populations are known (Sean Blaney, pers. comm.). Milkweeds, particularly Swamp milkweed, but also Common milkweed and Butterfly milkweed (*Asclepias tuberosa*), are widely planted as garden ornamentals or to specifically attract Monarchs, as Monarchs readily use cultivated milkweed for reproduction. Monarch reproduction (presence of immature stages) has been documented in every county of Nova Scotia except for Guysborough and Richmond counties (see Figure 2, ACCDC 2021).

#### Nectaring Habitat (modified from ECCC 2016)

Nectaring habitat occurs throughout the breeding range of the Monarch in various environments ranging from native grasslands to home gardens and roadsides, and it is widespread and common in Nova Scotia. Adult Monarchs feed on a variety of wildflowers, including goldenrods (*Solidago* spp. and *Euthamia* spp.), asters (primarily *Symphyotrichum* spp.), as well as milkweeds and Red Clover (*Trifolium pratense*) (COSEWIC 2016, ACCDC 2021). Monarchs also use a variety of garden plants as nectar sources. Nectar sources are vital to Monarch survival, but are particularly important during the fall migration when sugars from the nectar are converted to the fat that provides Monarchs with energy for flight and successful overwintering (Davis et al. 2012).

#### Staging habitat (modified from ECCC 2016)

During migration, staging areas are important for enabling the Monarch to feed, build fat reserves, and to rest at night before resuming flight (Davis et al. 2012). 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).

Communal roosts of migrating adults occur at staging areas adjacent to large geographic obstacles like large waterbodies. Southern Ontario and southern Quebec harbour the most significant Monarch breeding areas in Canada (COSEWIC 2016). All of the sites where large roosts have been documented are in these areas. Long Point, Rondeau Provincial Park, Point Pelee National Park and Presqu'île Provincial Park are important staging areas where Monarchs cluster before crossing the Great Lakes. The departure of hundreds of thousands of Monarchs from Point Pelee has been observed numerous times (Wormington 1994; 1997; 2008). In the fall, large concentrations of migrating Monarchs also aggregate in specific areas in southern Quebec, such as along Valleyfield and Missiquoi bays (Handfield et al. 1999). Wormington (2008) emphasizes that at Point Pelee at least, very large concentrations are not common. They may occur several times in a season, or they may not occur at all, and they are a weather-driven phenomenon.

In late summer and early fall, Monarch numbers build in coastal areas of Nova Scotia, particularly in the southwest. Seventy-five specimens were collected in a single day in the Vogler's Cove area on 28 September, 1949 (Ferguson 1954), and at least 60 were observed in a weedy coastal field at the Western Head Lighthouse on 21 August 2012

(AC CDC 2021). Concentrations have been observed at the Baccaro Point radar station and Hog Yard Cove on Brier Island (B. Toms, pers. comm. 2021), and the mouth of the Gaspereau River, near Grand Pré (D. Sam, pers. comm. 2021). Observations of Monarchs communally roosting in Nova Scotia are few. One example is nine roosting together at Chebogue Point on 13 September 2018 (see <https://inaturalist.ca/observations/16517922>).

#### Overwintering habitat (modified from ECCC 2016)

Overwintering sites, which are essential for Monarch survival, are only known to occur in very restricted areas, with unique habitat characteristics. None are in Nova Scotia or Canada. The Eastern population of Monarch, which includes Monarchs in Nova Scotia, overwinter in the Oyamel Fir forests of central Mexico (Urquhart 1976; Slayback et al. 2007). Millions of adult Monarch aggregate on Oyamel Fir forest 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). Oyamel Fir forests are specialized high-altitude ecosystems that occur only between elevations of 2,400 m and 3,600 m. 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). The Oyamel Fir trees provide Monarchs with cover and protection 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<sup>2</sup> (WWF 2013); however, suitable forested areas within the appropriate elevation cover only approximately 562 km<sup>2</sup> (Slayback et al. 2007). Within this 562 km<sup>2</sup> 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).

### **3.3. Dwelling Place**

The dwelling for this species refers to any milkweed plant that supports eggs, larvae, or a chrysalid. The individual plant itself is a necessary component of these stages of the species life cycle.

## 4. THREATS

### 4.1. Threat Assessment

The Monarch threat assessment is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threat classification system (IUCN 2012). Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (in this case, the province of Nova Scotia). Limiting factors are not considered during this assessment process. For purposes of the threat assessment, only present and future threats are considered. Historical threats, indirect or cumulative effects of the threats, or any other relevant information that would help understand the nature of the threats are presented in Section 4.2 *Description of Threats*.

The threats calculator and descriptions are adapted from COSEWIC 2016.

Table 2. Threat calculator assessment.

Threat #	Threat description	Impact <sup>a</sup>	Scope <sup>b</sup>	Severity <sup>c</sup>	Timing <sup>d</sup>	Comments
1	Residential & commercial development	Low	Small	Moderate - Serious	High	
1.1	Housing & urban areas	Low	Small	Moderate - Serious	High	Housing developments, particularly shoreline cottage development in southwestern Nova Scotia, have the potential to destroy larval habitat (i.e. wild populations of milkweed) and nectaring habitats. Some developments would also create larval and nectar habitat where none existed before through the planting of milkweed and

Recovery Plan for the Monarch

2021

Threat #	Threat description	Impact <sup>a</sup>	Scope <sup>b</sup>	Severity <sup>c</sup>	Timing <sup>d</sup>	Comments
						important nectar sources in gardens.
1.2	Commercial & industrial areas	Negligible	Negligible	Serious	High	Developments could destroy larval and nectaring habitats, but the overall footprint of such developments is small.
1.3	Tourism & recreation areas	Negligible	Negligible	Negligible	High	Developments could destroy larval and nectaring habitats, but the overall footprint of such developments is negligible.
2	Agriculture & aquaculture	Negligible	Negligible	Serious	High	
2.1	Annual & perennial non-timber crops	Negligible	Negligible	Serious	High	The conversion of old field habitat to farmland is a potential threat to nectaring and breeding habitat. Between 2006 and 2011, the total farm area grew from 403,044 ha to 412,000 ha (Anonymous 2011). The overall amount of old field or similar larval and nectar habitat lost to agricultural conversion in the next ten years will be negligible
2.2	Wood & pulp plantations	Negligible	Negligible	Moderate	High	The conversion of old field habitat to Christmas tree plantation poses some threat, but the overall footprint is not great, and tree farms may still offer some nectaring opportunities.
2.3	Livestock farming & ranching					Not applicable

Recovery Plan for the Monarch

2021

Threat #	Threat description	Impact <sup>a</sup>	Scope <sup>b</sup>	Severity <sup>c</sup>	Timing <sup>d</sup>	Comments
2.4	Marine & freshwater aquaculture					Not applicable
3	Energy production & mining	Negligible	Negligible	Moderate	High	
3.1	Oil & gas drilling					Not applicable
3.2	Mining & quarrying	Negligible	Negligible	Moderate	High	The expansion of quarries destroys old field habitat, but the overall footprint is negligible, and Common Milkweed and a variety of nectar sources may colonize abandoned quarries and quarry margins.
3.3	Renewable energy					Not applicable.
4	Transportation & service corridors	Negligible	Pervasive	Negligible	High	
4.1	Roads & railroads	Low	Pervasive	Negligible	High	Road mortality is the threat, as well as roadside maintenance activities that included pesticide application. The maintenance of roadside vegetation also creates open habitat that Monarchs use.  In Nova Scotia, all adults cross roads, therefore the scope is pervasive, but a small proportion are hit, so severity is considered negligible.
4.2	Utility & service lines	Not a threat	Small	Neutral or potential benefit	Moderate	Not considered a threat. The creation of utility and service lines, or their maintenance, would keep habitats open and milkweeds would grow in these

Recovery Plan for the Monarch

2021

Threat #	Threat description	Impact <sup>a</sup>	Scope <sup>b</sup>	Severity <sup>c</sup>	Timing <sup>d</sup>	Comments
						areas.
4.3	Shipping lanes					Not applicable
4.4	Flight paths					Not applicable
5	Biological resource use	Negligible	Negligible	Unknown	High	
5.1	Hunting & collecting terrestrial animals	Negligible	Negligible	Unknown	High	There is some collecting of Monarchs for specimens but number taken are small.
5.2	Gathering terrestrial plants					Not applicable
5.3	Logging & wood harvesting	Not a threat	Small	Neutral or potential benefit	High	Logging is a threat to overwintering sites in Mexico. In Nova Scotia, logging may be beneficial overall in that it creates nectaring habitat. The potential benefit is lessened by the use of herbicides that target dicotyledonous plants in clearcuts.
5.4	Fishing & harvesting aquatic resources					Not applicable
6	Human intrusions & disturbance					Not applicable
6.1	Recreational activities					Threats posted by butterfly rearing and releases is addressed under Threat 8. At the overwintering sites ecotourism poses a threat.

Recovery Plan for the Monarch

2021

Threat #	Threat description	Impact <sup>a</sup>	Scope <sup>b</sup>	Severity <sup>c</sup>	Timing <sup>d</sup>	Comments
6.2	War, civil unrest, & military exercises					Not applicable
6.3	Work & other activities					Not applicable
7	Natural system modifications	Negligible	Negligible	Unknown	High	Not applicable
7.1	Fire & fire suppression	Negligible	Negligible	Unknown	High	The threat of wildfire at the overwintering sites is possible, although the overwintering sites are spread over a large area and the possibility of fire affecting all sites at once is considered negligible.
7.2	Dams & water management/use					Not applicable
7.3	Other ecosystem modifications					Not applicable.
8	Invasive & other problematic species, genes & diseases	Low	Small	Slight	High	
8.1	Invasive non-native/alien species/diseases	Unknown	Unknown	Unknown	High	Non-native diseases are addressed here. Non-native plants threaten milkweed stands by displacing them in some areas, like southern Ontario, but this is not considered a threat in Nova Scotia. Captive-raised Monarchs can be heavily infested with the protozoan parasite <i>Ophyrocystis elektroscirrha</i> , the bacteria <i>Serratia</i> , the fungus <i>Nosema</i> , and cytoplasmic viruses and

Recovery Plan for the Monarch

2021

Threat #	Threat description	Impact <sup>a</sup>	Scope <sup>b</sup>	Severity <sup>c</sup>	Timing <sup>d</sup>	Comments
						potentially transmit these to wild populations.
8.2	Problematic native species/diseases	Low	Small	Slight	High	The loss of old field habitat to succession, by native woody species, eliminates nectaring habitat and Common milkweed habitat. The loss of Common milkweed is the most serious threat.
8.3	Introduced genetic material	Unknown	Unknown	Unknown	High	There's some potential for genetic material to be introduced via butterfly releases, but the impact is unknown.
8.4	Problematic species/diseases of unknown origin					Not applicable
8.5	Viral/prion-induced diseases					Not applicable
8.6	Diseases of unknown cause					Not applicable
9	Pollution	Low	Small	Extreme	High	
9.1	Domestic & urban waste water					Not applicable
9.2	Industrial & military effluents					Not applicable
9.3	Agricultural & forestry effluents	Low	Small	Extreme	High	Insecticides kill Monarchs either through direct application or drift. Improved control of weeds in cash crops can eliminate Common Milkweed from fields. It's likely that most of the loss that will happen as a result of improved weed control

Recovery Plan for the Monarch

2021

Threat #	Threat description	Impact <sup>a</sup>	Scope <sup>b</sup>	Severity <sup>c</sup>	Timing <sup>d</sup>	Comments
						happened in the past 20 years with the widespread adoption of genetically modified crops.
9.4	Garbage & solid waste					Not applicable
9.5	Air-borne pollutants	Unknown	Small	Unknown	High	Pesticide contaminated dust from agricultural fields is a potential threat.
9.6	Excess energy					Not applicable
10	Geological events					Not applicable
10.1	Volcanoes					Not applicable in Canadian range
10.2	Earthquakes/tsunamis					Not applicable in Canadian range
10.3	Avalanches/landslides					Not applicable in Canadian range
11	Climate change & severe weather	Low	Small	Slight	Continuing	Applicable to overwintering occurrence. Affect in Nova Scotia considered negligible.
11.1	Habitat shifting & alteration	Low	Small	Slight	Continuing	Applicable to overwintering sites. Habitat shifting and alteration will likely affect 1% of the habitat at the overwintering sites in the next decade.
11.2	Droughts	Low	Small	Slight	Continuing	Applicable to overwintering sites. Applicable to forest habitats at overwintering sites and nectaring habitat in the southern portion of their migratory route.

Threat #	Threat description	Impact <sup>a</sup>	Scope <sup>b</sup>	Severity <sup>c</sup>	Timing <sup>d</sup>	Comments
11.3	Temperature extremes	Low	Small	Slight	Continuing	Applicable to overwintering sites. Applicable to forest habitats at overwintering sites where frost and temperature extremes will likely affect 1% of the population.
11.4	Storms & flooding	Low	Small	Slight	Continuing	Applicable to overwintering sites. Storms and flooding will likely affect 1% of the habitat at the overwintering sites.
11.5	Other impacts					Not applicable
12	Other options					Not applicable
12.1	Other threat					Not applicable

<sup>a</sup> **Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment timeframe (e.g., timing is insignificant/negligible or low as threat is only considered to be in the past); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.

<sup>b</sup> **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11-30%; Small = 1-10%; Negligible < 1%).

<sup>c</sup> **Severity** – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11-30%; Slight = 1-10%; Negligible < 1%; Neutral or Potential Benefit ≥ 0%).

<sup>d</sup> **Timing** – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.

## 4.2. Description of Threats

Major threats which are thought to have driven declines in Monarch are discussed here, in order as they appear in Table 2 Threat calculator assessment. It should be noted that no threat was assessed as greater than L in terms of impact.

### **Residential and Commercial Development - Housing and Urban areas (L)**

The primary threat under this section is shoreline cottage development in southwestern Nova Scotia. The footprint of such developments is relatively low, and the severity of impact (i.e. the proportion of milkweed that is destroyed) would vary site to site, but overall it is likely moderate. Some developments would also create larval and nectar habitat where none existed before through the planting of milkweed and important nectar sources in gardens.

### **Agriculture and Aquaculture - Annual and Perennial Non-timber Crops (Negligible)**

The abundance of milkweed throughout both Canada and the United States has declining from the conversion of farmland or agricultural areas into larger and more intensive industrial agricultural use (COSEWIC 2016). In addition, the conversion of old field habitat to farmland is a potential threat to nectaring and breeding habitat.

Data on milkweed population trends in Canada and Nova Scotia are unavailable. However in the United States, loss of milkweed is one of the most important factors in the decline of eastern Monarchs. Since the late 1990s, Common Milkweed has undergone a massive decline in the Midwest United States (Jepsen et al. 2015, Pleasants 2017).

The intensification of agriculture, and improved weed control which is addressed under **Threat 9 Pollution**, are believed to be the factors that have driven the decline of milkweeds in the United States. Canadian croplands, particularly in the prairies and southern Ontario, have undergone similar changes in agricultural practices although there is no current data or analysis available (COSEWIC 2016). In Nova Scotia, Common milkweed is listed as a noxious weed under the Agriculture Weed Control Act (R.S.N.S. 1989, c. 501)

Between 2006 and 2011, the total farm in Nova Scotia area grew from 403,044 ha to 412,000 ha (Anonymous 2011). This additional hectareage covers about 0.16% of the province. The overall amount of old field or similar larval and nectar habitat lost to agricultural conversion in the next ten years will be negligible. Because neither Common milkweed nor Swamp milkweed are common in low-intensity agricultural settings in Nova Scotia (e.g., pasture, hayfields), agricultural intensification is unlikely to have any significant impact on milkweed populations. In southern Ontario and the American Midwest, Common milkweed is often common in low-intensity agricultural fields and is lost to intensification.

**Transportation and Service Corridors - Roads and Railroads (Negligible)**

Vehicle strikes pose a threat to adult Monarchs and maintenance to travel corridors threatens breeding and nectaring habitat. Therefore, this threat is treated in two parts.

*Road mortality to Monarchs:*

Monarch road kills increased with increased traffic volume, road width, and mowing (Skórka et al. 2013). Relative to other parts of North America where the Monarch is more common, the road network in Nova Scotia is sparse.

*Road maintenance activities:*

While road verges provide some nectaring and larval habitat for the Monarch, excessive mowing and use of herbicides on roadsides could kill caterpillars and remove milkweeds and nectaring plants. The number of milkweed stems within mowed verges in Nova Scotia is not great, and it is not a significant part of the milkweed population.

Milkweeds exposed to road salt runoff have higher sodium content than milkweeds grown away from roads (Snell-Rooda et al. 2014). Monarch caterpillars raised on roadside milkweeds had lower survival rates. Among the survivors, males had increased muscle mass and females had greater neural investment (Snell-Rooda et al. 2014). The implications for Monarch fitness are unknown.

**Biological Resource Use - Hunting and Collecting Terrestrial Animals (Negligible)**

There is incidental collection of eggs and caterpillars for rearing, although the number of specimens collected is unknown. Currently, there are few restrictions on the importation and movement of Monarchs from one geographic location to another in Canada and certainly there is importation of Monarchs from places such as Ontario because of the perception this will enhance populations in Nova Scotia. Captive rearing of Monarchs provides no long-term conservation benefit to the species, and may in fact, pose risks to the species recovery. For example, captive-reared Monarchs show poor migration ability (Tenger-Trolanger et al. 2019, Davis et al. 2020). See **Threat 6.1** for threats associated with parasites and protozoans; and **Threat 8.3** for threats associated with the introduction of genetic material.

**Biological Resource Use - Logging and Wood Harvesting (Not a Threat)**

In Nova Scotia, the creation of early successional habitat through forestry activities likely increases nectar availability and may have an overall benefit.

Forest loss and degradation at the overwintering sites in Mexico was considered a more of a threat in the past than at present; although this threat continues. A total of 4300 ha (8%) of Oyamel Fir forest within the Monarch Butterfly Biosphere Reserve was lost or disturbed between 1986 and 2012, largely to logging (Ramirez et al. 2015). Even small

scale logging is a potential threat because openings and thinned areas in the forest expose overwintering Monarchs to winter storms, cold temperatures and wet conditions, potentially causing mortality (Jepsen et al. 2015, Williams and Brower 2015). Logging for both commercial harvest and domestic use for building material, firewood, and charcoal has occurred in this area since the late nineteenth century (Ramirez et al. 2015). Although logging is prohibited in the core of the reserve, illegal logging continues (Jepsen et al. 2015). In 2015, loggers illegally cut 10 ha of forest on Sierra Chincua, only 600 m from where Monarchs were roosting (Davis and Linton 2016).

### **Human intrusions and disturbance - Recreational Activities (Negligible)**

Unsustainable ecotourism is a potential threat to overwintering Monarchs in Mexico (COSEWIC 2016). The effects have not been quantified but some researchers suspect that disturbance and habitat degradation may be harming Monarchs. The overwintering sites in Mexico have an estimated 100,000 to 150,000 annual visitors (Vidal et al. 2014). Disturbance of overwintering Monarchs in California was not listed as a threat in a review of the conservation status of Monarchs in the United States (Jepsen et al. 2015).

### **Natural System Modifications - Fire and Fire suppression (Negligible)**

Although not thought to be a major threat present in Nova Scotia, fire and activities that use fire has a potential impact on the overwintering population in Mexico. At the overwintering sites in Mexico, 45 fires occurred in the Monarch Butterfly Biosphere Reserve in 2012, covering 176.6 ha or 0.31% of the reserve (Martinez- Torres et al. 2015). Most were caused by agricultural activities, campfires, or forestry activities, with only one originating from a lightning strike (Martinez-Torres et al. 2015). The historical forest regime of the Oyamel Fir, the impacts of fire suppression, and effectiveness of reforestation efforts remain poorly understood.

### **Invasive and Other Problematic Species and Genes- Invasive / Non-native Alien Species (Unknown)**

The release of commercially bred Monarchs (see **Threat 8.3**) has the potential to transmit disease and parasites (North American Butterfly Association 2014, Altizer et al. 2021). Captive-raised Monarchs can be heavily infested with the protozoan parasite *Ophyrocystis elektroscirrha*, the bacteria *Serratia*, the fungus *Nosema*, and cytoplasmic viruses. High OE parasite load can lead to decreased larval survival, smaller adult sizes, and reduced lifespans (Altizer and Oberhauser 1999); there is also the potential to impact fitness and migration success due to susceptibility to wing damage (Davis and de Roode 2018). Transmission of these diseases from captive-raised to wild Monarchs is possible but has not been demonstrated (COSEWIC 2016).

**Invasive and Other Problematic Species and Genes - Problematic Native Species/Diseases (L)**

The loss of old field habitat to succession, by native woody species, eliminates nectaring habitat and Common milkweed habitat. The loss of Common milkweed is the most serious threat. While this threat applies to old field habitat throughout the region, old field habitat remains common.

**Invasive and Other Problematic Species and Genes - Introduced Genetic Material (Unknown)**

The release of commercially bred Monarchs at weddings and other events has been identified as a potential threat to wild Monarch populations through the introduction of undesirable genetic traits (North American Butterfly Association 2014), but the scale of the practice is unknown in Canada (COSEWIC 2016). The level of genetic diversity in captive Monarchs is unknown but mixing with wild populations could cause inbreeding depression and introduction of deleterious adaptations and potentially reduced survivorship of wild Monarchs (Altizer et al. 2021) and impede the scientific study of Monarch movement (Pyle 2015).

**Pollution - Agricultural and Forestry Effluents (L)**

The loss of milkweed in the American Midwest that has been identified as particularly threatening to the eastern North American Monarch population (Hartzler 2010, Pleasants and Oberhauser 2013, Pleasants 2017, Thogmartin et al. 2017, Zaya et al. 2017). It is estimated that 58% of the milkweed population in the US Midwest was lost from the landscape between 1999 and 2010, and better weed control through the application of glyphosate to glyphosate-resistant crops was largely responsible (Pleasants and Oberhauser 2013).

Glyphosate-resistant crops have been widely adopted in Canada, and the resulting loss of Common milkweed from farmland through glyphosate application is a threat to Monarch in Canada (COSEWIC 2016). However, Common milkweed was never common in agricultural fields in Nova Scotia, and it likely is more common overall in the province now than it was historically. It was described as “sparingly introduced at scattered places in the Annapolis valley” and at Mabou by Roland (1946). More recently it has been described as “scattered in the centre of the province, with many collections made in the Annapolis Valley” (Munro et al. 2014). Available records bear out this description – 66 of the 124 available records are from the Annapolis Valley, all in Kings County. In Nova Scotia, Common milkweed typically occurs in ruderal habitats associated with rail verges, edges of towns, and road verges. Whatever loss of Common milkweed there will be to improved weed control offered by herbicide-resistant crop use in agricultural fields in Nova Scotia Much has probably already been realized, therefore the abundance of Common milkweed in agricultural fields in Nova Scotia is not expected to change significantly in the future.

Increased herbicide use may also reduce populations of flowers that provide nectar throughout Monarch migration routes. Monarchs increase their feeding rates while migrating south, particularly as they reach Texas and northern Mexico. Nectar is converted to lipids and used as an energy source by overwintering Monarchs (Alonso-Mejía et al. 1997). Declining nectar supplies have been proposed as a possible contributing factor in overwinter declines (Inamine et al. 2016). The impact of herbicide use on nectar availability in Nova Scotia is unknown, but it is unlikely to be significant.

Neonicotinoid insecticides were introduced in the 1990s and include imidacloprid, clothianidin, thiamethoxam, acetamiprid, thiacloprid, and dinotefuran. Neonicotinoids are approved for use as seed treatments, soil applications, and foliar sprays on oilseeds, grains, pulse crops, fruits, vegetables, greenhouse crops, ornamental plants, and Christmas trees in Canada (Health Canada 2016). The use of neonicotinoid insecticides has increased substantially in recent years and has been implicated in declines of non-target species (Douglas et al. 2014, Jepsen et al. 2015).

Neonicotinoids persist in soil and are translocated to plant tissues to levels potentially lethal to non-target insects (Goulson 2013). Monarch caterpillars were fed milkweed leaves with levels of clothianidin similar to milkweeds exposed to spray from a treated field. Exposed caterpillars grew more slowly than unexposed caterpillars (Pecenka and Lundgren 2015). A neonicotinoid insecticide (imidacloprid) applied to soil was translocated to milkweed tissues, causing reduced survival of Monarch caterpillars feeding on the leaves, but not nectaring adults (Krischik et al. 2015). Sub-lethal impacts of neonicotinoids on bees and other invertebrates include altered foraging behaviour, reduced reproduction, and greater susceptibility to pathogens (Goulson 2013, van der Sluijs et al. 2013). The impact of neonicotinoids use on nectar availability in Nova Scotia is unknown, but it is unlikely to be significant.

### **Pollution - Airborne Pollutants (Unknown)**

During agricultural crop management practices, the soil is tilled before sowing a field and significant dust can form and dissipate into the airspace. Depending on the weather (e.g., dry or windy conditions), this dust can blow long distances and/or linger in the area for a few days. The residual pesticides mixed in the soil become airborne with the dust, and eventually settle on plants, including milkweeds within adjacent areas. For example, Bt corn is a genetically modified crop that is an indirect threat to Monarchs. Bt refers to the bacterium *Bacillus thuringiensis*, from which a gene that produces a protein toxic to Lepidoptera caterpillars. This gene has been genetically incorporated into corn making it less palatable to Lepidoptera caterpillar, and reducing the need for pesticide application on the crop. Laboratory studies have showed that Bt corn pollen blown onto milkweed leaves which are then consumed by Monarch caterpillar caused reduced growth and survival (Losey et al. 1999). Conversely, subsequent field studies found that concentrations of pollen were unlikely to significantly harm caterpillar (Pleasants 2015).

### **Climate change and Severe Weather (L)**

The impacts of climate change on Monarch breeding dynamics are complex and require additional study (Zipkin et al. 2012). Climate change could act on Monarchs through a number of mechanisms including severe weather (e.g., early or late season frost at overwintering sites and throughout migratory range), heat stress and loss of milkweeds in the breeding range, altered timing of migration, and loss of overwintering habitat due to habitat shifting. Modelling of future climate scenarios suggests that climate change will have an effect on overwintering Monarchs in Mexico. It is difficult to assign an impact; however, climate change will likely affect 1% of the population at the overwintering sites.

### **Climate Change and Severe Weather - Habitat Shifting and Alteration (L)**

Asynchrony between milkweed development and Monarch migration is a potential threat (Robinson et al. 2009). Butterflies exhibited a stronger response to climate shifts than their food plants, which could result in Monarchs starting northward migration before milkweeds are available for caterpillar food (Parmesan 2007). One climate change model predicts that Monarch-preferred breeding temperature and precipitation will move northward within the next 50 years (Batalden et al. 2007). Monarchs and milkweeds will need to expand their range northward under this scenario (Batalden et al. 2007). In contrast, another model suggests that climate change during the breeding season is unlikely to cause eastern Monarch population declines (Zalucki et al. 2015).

Changing climate could also alter habitat in the overwintering habitats. As the climate becomes warmer, the area of suitable habitat for Oyamel Fir is predicted to decline by 50% by 2030 and completely disappear by 2090 as tree mortality increases due to pests and disease (Ramirez et al. 2015).

### **Climate Change and Severe Weather - Droughts (L)**

Increased drought stress associated with climate change may make Oyamel Fir more vulnerable to diseases and insect pest including bark beetles (*Scolytus* spp.) (Ramirez et al. 2015).

### **Climate Change and Severe Weather - Temperature Extremes (L)**

Caterpillar exposure to continuous high temperatures (36°C) resulted in higher mortality, longer development time, and lighter adult mass (York and Oberhauser 2002). However, temperatures fluctuating between 27°C and 36°C resulted in very little mortality and shorter development times than controls.

### **Climate Change and Severe Weather - Storms and Flooding (L)**

Storms at the overwintering sites in Mexico can cause catastrophic mortality to Monarchs during the months when butterflies are roosted at these sites. A storm in

January 2002 killed an estimated 500 million overwintering Monarchs or about 75% of the population at the time. Heavy rain and snow caused extreme wetting of butterflies and was followed by temperatures dropping as low as -4°C resulting in hypothermia and mortality (Brower et al. 2004). A rain and sleet storm accompanied by strong winds on March 7 - 11 2016 buried large numbers of Monarchs in sleet and mortality was estimates to be between 30% and 40% at several colonies (Brower et al. 2017). Mortality was estimated at 3 - 50% of the overwintering population, although many Monarchs had already left on their northward migration and avoided the storm. One climate model predicts that cool weather precipitation will increase and cause more frequent large-scale Monarch mortality events (Oberhauser and Peterson 2003). The scope and severity of winter storms at the overwintering sites is substantial, but the impact on the longer ten-year time frame is hard to estimate.

## 5. POPULATION AND DISTRIBUTION OBJECTIVES

### *Viable status for recovery*

The long-term recovery goal is to a) maintain populations of Swamp and Common milkweed in Nova Scotia to provide sufficient breeding habitat for the current abundance of Monarch, and b) to mitigate significant threats within the province. As the Nova Scotia population is part of the single eastern migratory population, the Nova Scotia population will continue to be at risk as long as the eastern migratory population is at risk. Given the complexities and issues surrounding the greater eastern population (of which the Nova Scotia population is a part of) and challenges on the wintering grounds, quantifying what would constitute a viable status for recovery is not currently possible.

### *Population and distribution objective*

The population and distribution objective is to maintain the province's milkweed population at or above its size and distribution in 2021. The distribution of Swamp milkweed and Common milkweed in 2021 is shown in Figure 3. Swamp milkweed's distribution has likely changed little in the last century while the distribution of Common Milkweed has increased significantly in the same time frame. The abundance of the two milkweed species is not well known; the abundance of Swamp milkweed in the last century has likely declined somewhat while the abundance of Common milkweed has increased greatly in the same time frame.

### *Rationale*

The province's Monarch population size varies year-to-year and is made up entirely of immigrants from the west and south. Based on the geographic size of Nova Scotia, its location (Nova Scotia and New Brunswick are the furthest from the overwintering sites of any region in North America where monarch regularly occurs), and the relative density of milkweed on the landscape, the provincial population is likely less than 1% of the eastern North American population. A lack of genetic structure suggests that North

America's migratory Monarchs form one homogeneous population (Lyons et al. 2012), meaning that the fate of the Monarch in Nova Scotia is that of the entire migratory population, and the Nova Scotia population will be at risk as long as the entire migratory population is at risk. Therefore, the overall strategy of maintaining the current milkweed population and mitigating significant threats will give the Monarchs that do reach Nova Scotia the best chance of reproducing and contributing to the overall size of the migratory population.

## 6. BROAD STRATEGIES AND GENERAL APPROACHES TO RECOVERY

### 6.1. Actions Completed or Underway

This list is not exhaustive, but is meant to highlight important developments in Monarch recovery that has been undertaken in the recent past:

- *Monarch and milkweed occurrence documentation.*
  - Citizen Science. The Monarch is a conservation icon and occurs in easy to access habitats. Therefore, it is an ideal focus for citizen-scientists. Note that the observations of the projects listed below are not mutually exclusive – some observations have been submitted to two or three different projects.
    - The Maritimes Butterfly Atlas, a citizen-science project which documented the occurrence of all butterfly species in the Maritimes, captured 230 Monarch occurrence records from across Nova Scotia between 2010 and 2015.
    - iNaturalist, an global online citizen-science data-collection portal launched in 2008, has amassed 484 Monarch occurrence records from across Nova Scotia (iNaturalist 2021). There are also collected 126 observations of Swamp Milkweed and 145 records of Common Milkweed from the province.
    - eButterfly, an online citizen-science data-collection dedicated to North American butterfly observations, captured 286 Monarch occurrence records from across Nova Scotia since its launch in 2012. Note that many records were submitted to the Maritimes Butterfly Atlas through eButterfly, so the two datasets are not mutually exclusive.
  - Botanical inventories conducted by the ACCDC. The occurrence of Swamp Milkweed was documented in detail whenever it was encountered by ACCDC botanists conducting vegetation surveys in Nova Scotia until the end of 2015 (in 2015 the conservation status of Swamp Milkweed was

reassessed from S3 [Vulnerable] to S4 [Apparently Secure], which resulted in fewer details being documented when the species is present at a site). Between 2000 and 2015, ACCDC staff documented 586 occurrences of Swamp Milkweed, including 554 records with coordinates accurate to 20m or less (ACCDC 2021).

- *Habitat creation/stewardship.* In the breeding range of the Monarch, habitat creation and stewardship typically involves enhancing garden and old field habitat for Monarchs by planting and encouraging milkweed and nectar sources.
  - Monarch Waystation Program. This international program run by Monarch Watch creates “waystations” - *places that provide resources necessary for monarchs to produce successive generations and sustain their migration* (<https://monarchwatch.org/waystations/>). There are 24 waystations in Nova Scotia registered with Monarch Watch (Monarch Watch 2021a).
  - The Butterfly Club. Created in 2008 by the Mersey Tobeatic Research Institute (MTRI) and Species at Risk Stewardship biologists from Kejimikujik National Park, the Butterfly Club encourages people in Nova Scotia and the Maritimes to create Monarch-friendly gardens by growing Swamp Milkweed and not using pesticides. Those who join the club receive a kit with information about the Monarch and two Swamp Milkweed plants. As of 2019, the club had over 2000 members (Crowley 2020).
- *Education and awareness.* The Monarch is an icon of conservation, and there have been many educational programs about the Monarch in Nova Scotia. Kejimikujik National Park and MTRI have been involved in public education since 2008. Together they run the Butterfly Club, which has over 2000 members, and offer interpretive programming. Crowley (2020) provides a summary of activities that Kejimikujik National Park and MTRI conducted between 2008 and 2019.
- *Monarch tagging.* Monarch Watch runs a program wherein adult butterflies are captured and then tagged with a uniquely coded sticker. When these stickers are recovered, the travel history of the individual is revealed (Monarch Watch 2021b). Hundreds of Monarchs have been tagged in Nova Scotia and a few have been recovered in Mexico (Crowley 2020; Bogan 2021).

**6.2. General Approaches to Recovery**

Table 3. Recovery planning table which includes recovery measures, actions, and costs and benefits of recovery actions.

Recovery Measures	Threat(s) Addressed*	Actions	Priority **	Cost** *	Benefit
<b>Habitat Protection, Management, and Stewardship</b>					
Protect high quality breeding habitat.	1.1, 1.2, 2.1, 8.2, 9.3	<ul style="list-style-type: none"> <li>Develop best management practices which allow for landowners with high quality habitat to manage their land in a manner beneficial to Swamp milkweed survival.</li> <li>Incentivize the protection of private land.</li> </ul>	L	\$	Protection of breeding habitat.
<b>Surveys and Monitoring</b>					
Increase knowledge of milkweed distribution and abundance in NS. Increase knowledge of the distribution of breeding Monarchs	1.1, 1.2, 2.1	<ul style="list-style-type: none"> <li>Develop and implement standardized survey protocols to support recovery objectives.</li> </ul>	M	\$	Identification and quantification of high quality breeding habitat. Quantification of the relative contribution different regions make to the reproduction of Monarch in Nova Scotia.
<b>Communication, Outreach, and Education</b>					
Support NGO public outreach efforts	1.1, 1.2, 2.1, 8.1 8.2, 9.2	<ul style="list-style-type: none"> <li>Provide logistical support and complementary information aligned with recovery plan to NGO efforts to engage the public.</li> </ul>	H	\$\$	Raise awareness and understanding amongst the general public of the recovery actions being undertaken in NS. Raise awareness and understanding amongst the general public.
<b>Law, Policy, and Enforcement</b>					

Recovery Plan for the Monarch

2021

<p>Re-examine the need to list Common Milkweed as a noxious weed in NS under the <i>Agricultural Weed Control Act</i></p>	<p>2.1</p>	<ul style="list-style-type: none"> <li>• Work with Department of Agriculture to evaluate whether it is necessary to continue listing Common milkweed as a noxious weed and determine how much Common Milkweed is being eradicated under the <i>Agricultural Weed Control Act</i>.</li> </ul>	<p>L</p>	<p>\$</p>	<p>Knowledge of what impact the listing of Common Milkweed has on the populations of that plant and what impact it may have on Monarch habitat.</p>
<p>Investigate prevalence of milkweed in agroecosystems</p>	<p>2.1</p>	<ul style="list-style-type: none"> <li>• Work with Department of Agriculture to determine distribution and abundance of Common milkweed in agroecosystems, and to determine the threats to it.</li> <li>• If necessary, work with Department of Agriculture to develop policies for restrictions on noxious weed control methods, in particular seasonal restrictions tied to important life history characteristics (such as breeding requirements),</li> </ul>	<p>L</p>	<p>\$</p>	<p>Protection of breeding habitat.</p>
<p><b>Research to Address Knowledge Gaps</b></p>					
<p>Investigate the relative contribution that the Nova Scotia breeding population makes to the eastern North American overwintering population</p>	<p>1, 8, 9, 11</p>	<ul style="list-style-type: none"> <li>• Determine the rate of success, in terms of reaching overwintering grounds, of Monarchs leaving Nova Scotia.</li> </ul>	<p>H</p>	<p>\$\$</p>	<p>An understanding of the potential impacts that Monarch conservation in Nova Scotia has on the eastern North American Monarch population.</p>

\*Threat or Limitation should refer to the IUCN Threat Classification Table Rankings. Either the first level or second level threat ranking can be used depending on how the Broad Strategy affects the threat. Multiple threats can be addressed under a single Recovery Measure.

\*\*Priority should be classified as High(H), Medium(M), or Low(L). "Priority" is a qualitative measure of the relative degree to which an approach will have a positive impact on the recovery objective. High priority conservation approaches are considered those most likely to have an immediate and/or direct influence on reaching the management objective for the species. Medium priority conservation approaches may have a less immediate or less direct influence on reaching the management objective but are still considered important measures to implement. Low priority conservation approaches will likely have an indirect or gradual influence on reaching the management objective and are more tied to increasing knowledge or public perception/education.

\*\*\*Use the following to assign a cost estimate to proposed activities: Cost categories: \$ = < 10 000; \$\$ = 10 000-50 000; \$\$\$ = 50 000-100 000; \$\$\$\$=>100 000.

### **6.3. Narrative to Support the Recovery Planning Table**

#### Habitat Protection, Management, and Stewardship

Protecting breeding habitat is the primary objective to Monarch conservation in Nova Scotia, and most other recovery measures are linked to it. Swamp milkweed occurs on both private and public land. Developing best management practices for private landowners with high quality habitat can prevent the inadvertent destruction of Swamp milkweed. Incentivization of private land protection where possible would also benefit the species and help achieve recovery objectives.

#### Surveys and Monitoring

Surveying for new occurrences of milkweed will increase our knowledge of milkweed abundance and distribution in Nova Scotia. Swamp milkweed has been relatively well surveyed in many regions (e.g. lakeshores in southwestern Nova Scotia, wetlands and southern Cape Breton) by ACCDC botanists and others where surveys of at risk plant species produced incidental records of Swamp milkweed (until 2015, Swamp milkweed was ranked S3 (Vulnerable) in Nova Scotia, meaning detailed notes about its occurrences were documented during botanical surveys; it is currently ranked S4 (Apparently Secure), meaning detailed notes of occurrence are not necessarily taken). Areas likely to yield many new occurrences should be identified with inputs from botanical experts. Common milkweed has not been well documented during general botanical inventories because it tends to grow in disturbed habitat that receive little attention. Such areas could be targeted by skilled botanists, or citizen science observations could be elicited.

Systematic surveys for monarch larvae, which could be coupled with surveys for milkweed, will identify regions and habitats that are most important to Monarch breeding. To date most known breeding records are from southwestern Nova Scotia, and a large proportion are from cultivated milkweed (ACCDC 2021). Citizen scientist observations could also be elicited, from both wild and cultivated milkweed. Knowing the relative contribution of wild milkweed to monarch breeding will aid with the prioritization of recovery efforts.

#### Communication, Outreach, and Education

The conservation of Monarch in Nova Scotia is complicated by the fact that the species is a migrant whose abundance varies greatly annually. It is also an iconic species to conservation, and many individuals and organizations have already invested significantly in supporting the species. Therefore, it is important that the recovery plan be clearly communicated to the public, and that matters such as rearing are explicitly addressed.

Excellent outreach and education programming is already being delivered by NGOs; the continued support of these programs will be important to ongoing recovery activities. It

is important to educate the public on activities that not just support recovery efforts, but also those which may violate the Act (such as rearing of individuals).

### Law, Policy, and Enforcement

The listing of milkweed species under provincial noxious weed acts is seen as an impediment to Monarch conservation (e.g. COSEWIC 2016, ECCC 2016). Therefore, the rationale for listing Common milkweed as a noxious weed in Nova Scotia should be examined. If there is a need to maintain it on the noxious weed list, an explanation should be communicated to the public.

The prevalence of Common milkweed in Nova Scotia's agroecosystems has not been quantified. A better understanding of the species' prevalence is an important step in refining weed control policies and practices.

### Research to Address Knowledge Gaps

Nova Scotia's Monarch population is a small part of the overall eastern North American migratory population. It is not well understood what contribution Nova Scotia makes, in terms of producing adult Monarchs that successfully migrate to wintering grounds, to the overall population, though it is likely a small contribution. Better data will help inform future conservation decisions and guide future conservation efforts in Nova Scotia.

It should be noted that there is extensive public awareness of Monarch and its status as an at-risk species. This has resulted in public interventions (such moving of individual caterpillars or chrysalids to enhance survival, planting of small quantities of milkweed, and predator exclusion measures) which have not been proven to be beneficial to the long-term recovery of the species. Based upon the current and historic knowledge of the species status in Nova Scotia, recovery objectives, and current threats, the Recovery Team is of the opinion that the captive rearing of Monarch provides no benefit to the recovery of the population in Nova Scotia and is not recommended or promoted as an activity that supports recovery of the species. The active management of habitat, through the removal of native predators, is also not a recommended approach to recovery.

## 7. RECOMMENDED COURSE OF ACTION FOR RECOVERY

Table 4 provides the recommended course of actions for recovery of the species and the timeframe for completing these actions.

Table 4. Recovery actions and implementation schedule of activities in support of recovery.

Recovery Actions	Implementation Schedule
<b>Habitat Protection, Monitoring, and Stewardship</b>	
<i>Recovery Measure 1.1 Protect high quality breeding habitat.</i>	
Action 1.1.1. Develop best management practices which allow for landowners to manage their land in a manner beneficial to the species survival.	2021-2026
Action 1.1.2 Investigate options for incentivizing the protection of private land with tax breaks, the allocation of total-amount or matching funds for land purchases for conservation purposes, and other means that encourage the protection of land.	2021-2026
<b>Surveys and Monitoring</b>	
<i>Recovery Measure 2.1 Increase knowledge of milkweed distribution and abundance and Monarch breeding distribution and abundance in NS</i>	
Action 2.1.1 Identify areas not or inadequately surveyed for milkweed	2021-2022
Action 2.1.2 Develop a milkweed and Monarch larval survey protocol and work with NGOs and the public to encourage its use.	2021-2026
Action 2.1.3 Investigate feasibility of modeling habitat for milkweed presence	2021-2022
<b>Communication, Outreach, and Education</b>	
<i>Recovery Measure 3.1 Support NGO public outreach efforts</i>	
Action 3.1.1 Identify key information about Monarch conservation in Nova Scotia that need to be communicated to the public, and make that information available to NGOs	2021-2022
Action 3.1.2 Collaborate with NGOs on ongoing and new initiatives, and regularly bring NGOs together to optimize synergies	2021-2026
<b>Law, Policy, and Enforcement</b>	
<i>Recovery Measure 4.1 Re-examine the need to list Common milkweed as a noxious weed in NS under the Agricultural Weed Control Act</i>	
Action 4.1.1 Explore need to keep Common milkweed on the provincial noxious weed list with the Department of Agriculture	2021
Action 4.1.2 Work with Department of Agriculture to determine the distribution and abundance of Common milkweed in agroecosystems, and to determine the threats to it. If necessary, work with Department of Agriculture to develop policies for restrictions on noxious weed control methods, in particular seasonal restrictions tied to important life history characteristics (such as breeding requirements)	2021-2026
<b>Research to Address Knowledge Gaps</b>	
<i>Recovery Measure 5.1 Investigate the relative contribution that the Nova Scotia breeding population makes to the eastern North American overwintering population</i>	
Action 5.1.1 Determine the recovery rate at overwintering sites of Monarchs tagged in Nova Scotia to date	2021-2022
Action 5.1.2 Determine feasibility of further investigating migrant survivorship through tagging or other means, such as stable isotope analysis	2021-2022
Action 5.1.3 If it is demonstrated to be feasible, initiate new migrant survivorship project	2022-2026

## 8. IDENTIFICATION OF CORE HABITAT

Under the Nova Scotia Endangered Species Act, Core Habitat is defined as “specific areas of habitat essential for the long-term survival and recovery of endangered or threatened species and that are designated as core habitat pursuant to Section 16 or identified in an order made pursuant to Section 18.”

### 8.1. Core Habitat Definition and Attributes

A definition for Monarch Core Habitat is included here using the best available information at the time of writing; however, given the knowledge gaps and anticipated increases in our collective knowledge of this species’ needs in Nova Scotia, this definition should be updated as soon as new information is available.

During migration, Monarchs require areas to rest, feed, and avoid inclement weather. Monarchs occasionally stage in large numbers during migrations where open water limits their travel. In Canada, significant staging areas are known to occur along the north shore of the Great Lakes in southern Ontario. There Monarchs congregate in large numbers in trees until weather conditions, such as favorable winds, permit them to cross the water. Presently, there are no sites in Nova Scotia known to regularly host aggregations of a size significant enough for them to be considered essential to the species’ survival and recovery. In general, habitat availability during migration is not thought to be limiting. Therefore, habitat used during migration is not included as part of the species’ Core Habitat.

During the breeding season, Monarchs rely on milkweed species as a larval food source. Two milkweed species occur in the wild in Nova Scotia: Swamp milkweed and Common milkweed. Swamp milkweed is a generally uncommon native species that occurs throughout the province on freshwater shorelines, wetland edges, and damp meadows. In patches of habitat where Swamp milkweed does occur it is generally common, occurring in scattered patches. Common milkweed is rarer. It is generally found in well drained soils in anthropogenic habitats (e.g., roadsides and rail verges). Like Swamp milkweed, Common milkweed is patchily distributed, and it can be abundant at the sites where it does occur. In addition to wild occurrences, milkweed is grown as garden plant, often for the purpose of making food available for Monarch breeding.

The availability of milkweed dictates whether Monarchs that migrate into Nova Scotia can breed, therefore the presence of milkweed is essential to the long-term survival of a Monarch breeding population in Nova Scotia. Therefore, Core Habitat is defined as areas of natural habitat where Swamp milkweed is present: wetlands and watercourses associated with occurrences of Swamp milkweed, with a 20 m buffer applied to these features (Figure 4 to Figure 7). Core Habitat is defined in such a way as to protect both the Swamp milkweed occurrence as well as the ecological function of the habitat through the protection of the watercourse or wetland the occurrence is associated with.

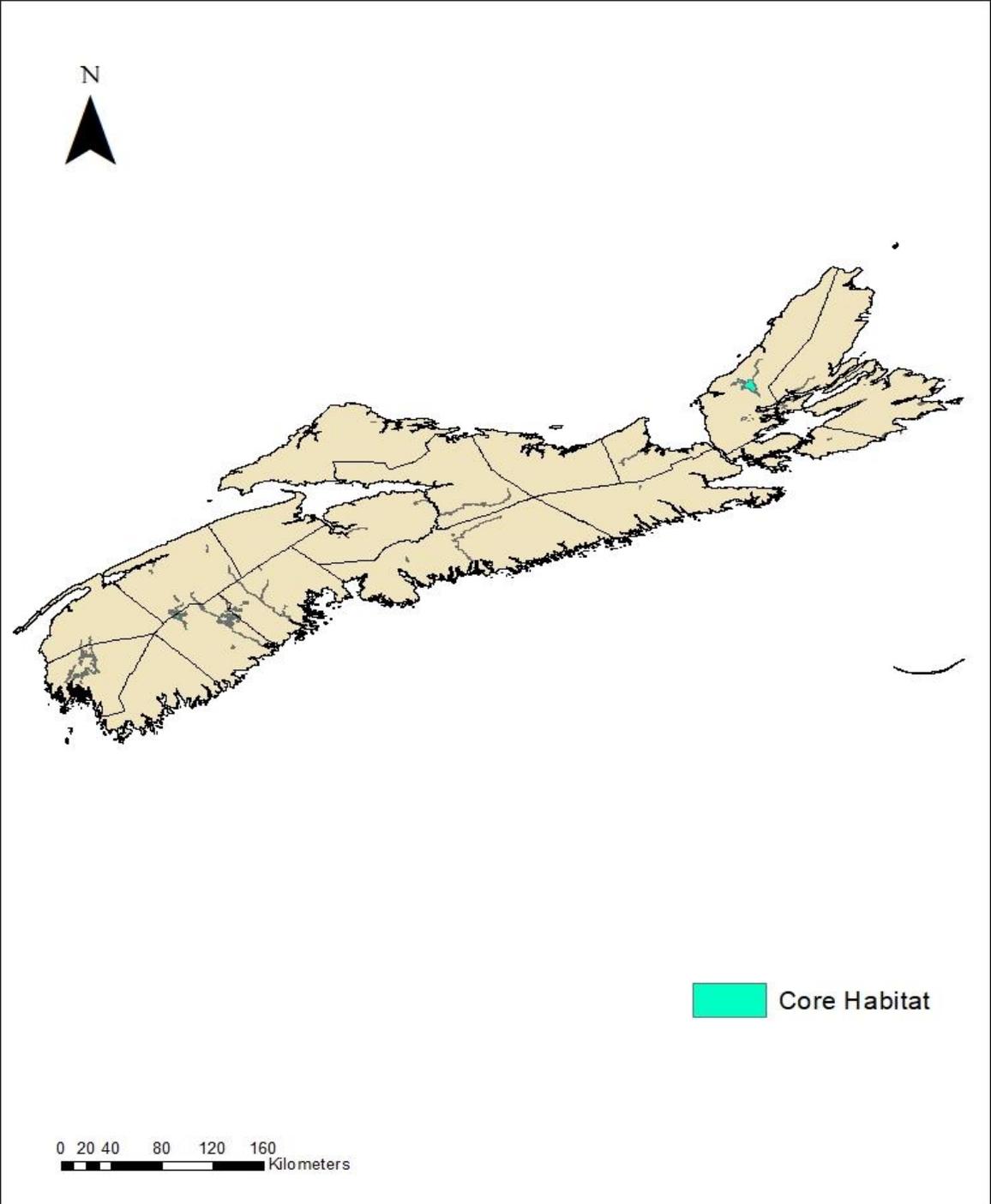


Figure 4. Core Habitat for Monarch in Nova Scotia.

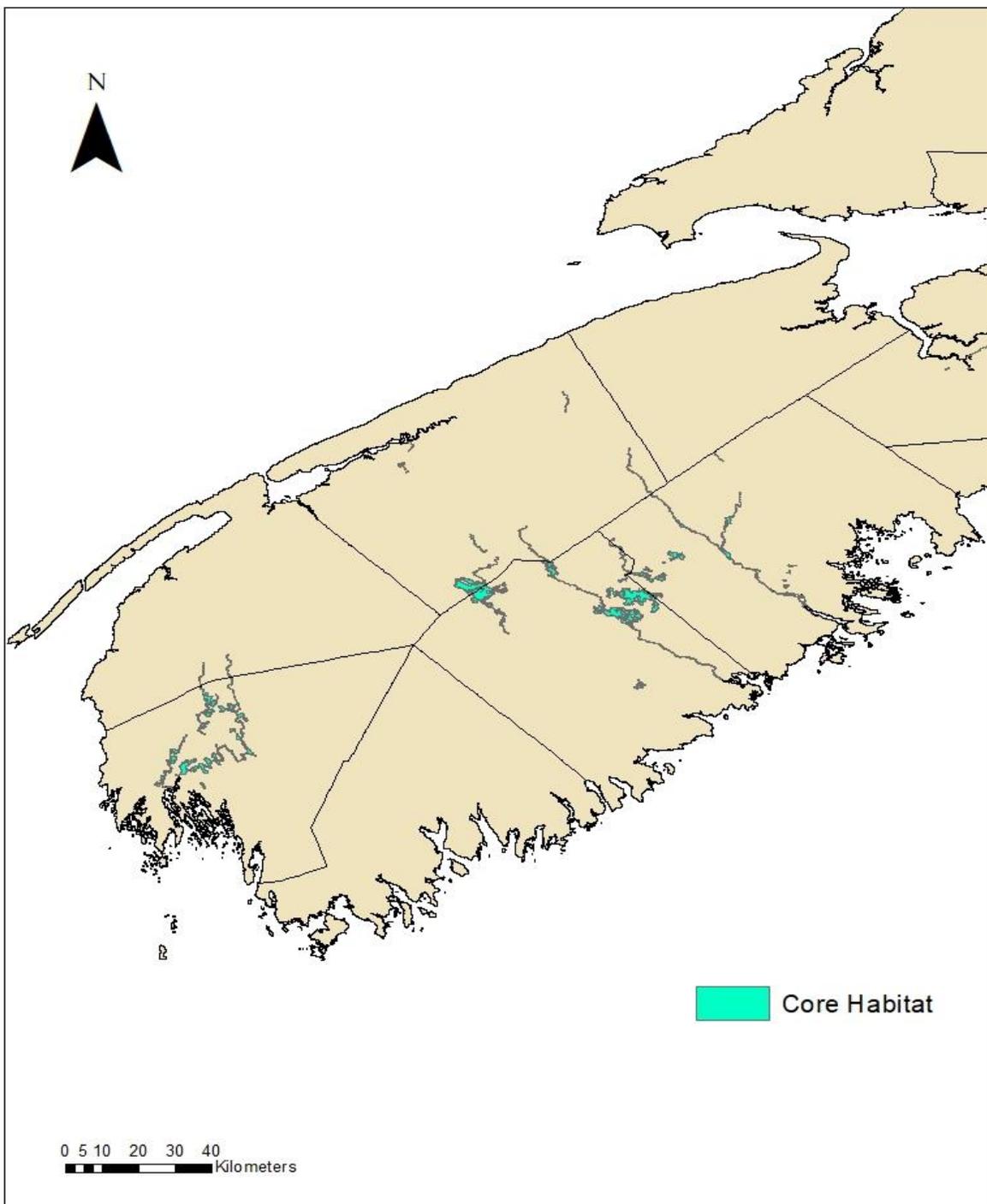


Figure 5. Core Habitat for Kings, Annapolis, Digby, Yarmouth, Shelbourne, Queens, and Lunenburg counties.

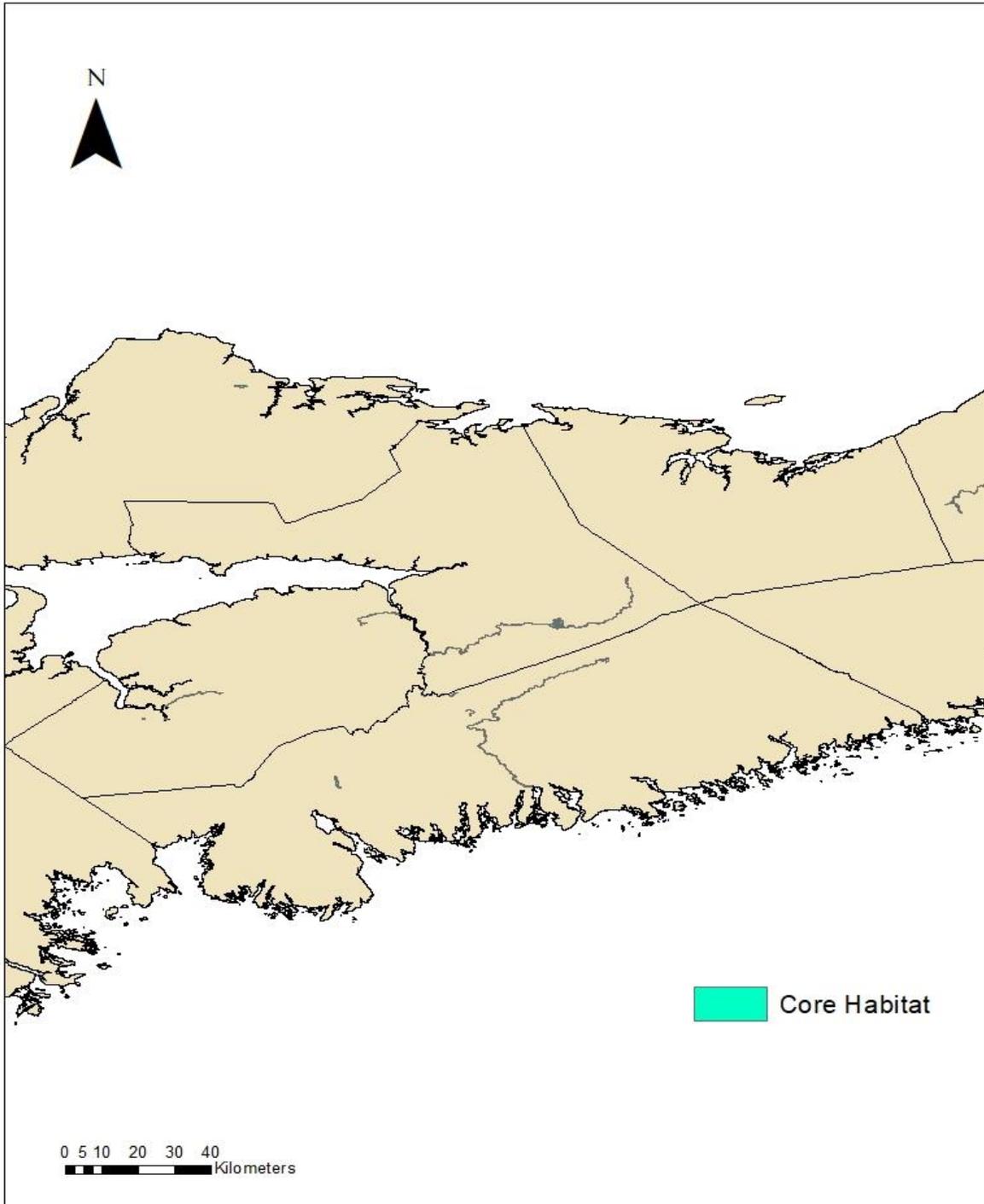


Figure 6. Core Habitat for Cumberland, Colchester, Pictou, Halifax, and Hants counties.

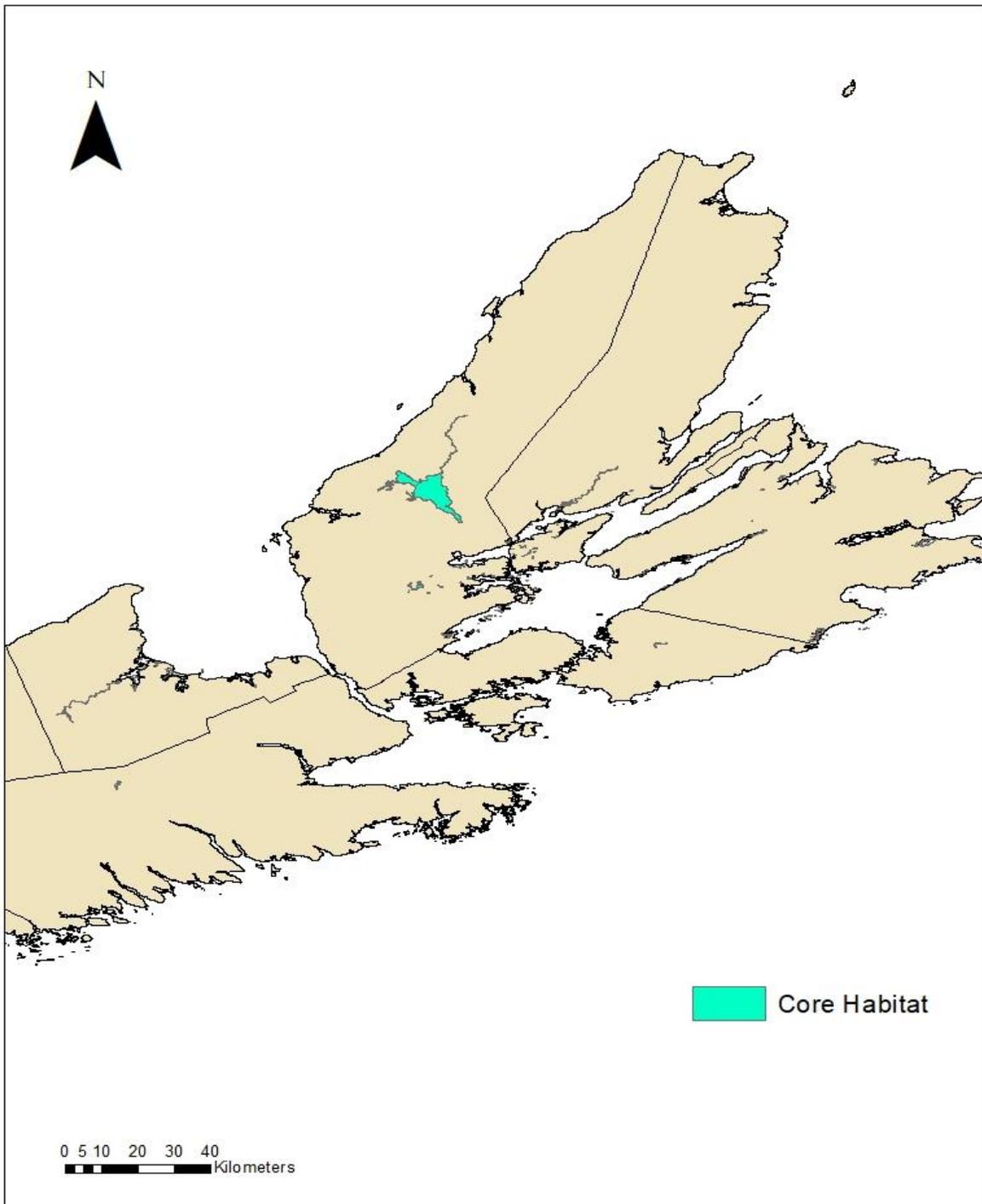


Figure 7. Core Habitat for Antigonish, Inverness, Victoria, Cape Breton, Richmond, and Guysborough counties.

There is no evidence that the current population of milkweed limits the number of Monarchs that can reproduce (e.g., even in years when Monarchs are relatively abundant, such as in 2012, many milkweed stems were not utilized by Monarch larvae). Neither of the milkweed species occurring in Nova Scotia are themselves considered at risk (most or all populations of Common milkweed are non-native, and it is likely more common now than it was historically, and Swamp milkweed is ranked S4 (Apparently Secure) (ACCDC 2021)). Therefore, it is apparent that the size of the Nova Scotia Monarch population is limited by the number of Monarchs that immigrate into the province annually, not the amount of breeding habitat available. Monarch breeding habitat is not imperiled, and it is likely there are no Monarch conservation benefits to be achieved through its protection. Based upon this assessment, it is recommended that Core Habitat not be designated at this time.

## 8.2. Activities Likely to Result in the Destruction of Core Habitat

Table 5. Activities which may result in the destruction of core habitat.

Description of Activity	Rationale
Developments that destroys shoreline vegetation communities	Infilling and vegetation clearing associated with shoreline development could reduce or eliminate Swamp milkweed populations
Off-highway vehicle use	Vehicle use that destroys vegetation along shorelines or in wetlands could reduce or eliminate Swamp milkweed populations
Shoreline alterations including mowing and raking, construction of boat docks and launches, wharves, and breakwaters	All these activities have the potential to directly reduce or eliminate Swamp milkweed populations
Water level alterations through damming	Alterations that flood or desiccate existing shorelines destroy Swamp milkweed habitat.

## 9. MEASURING PROGRESS

### 9.1. Performance Indicators

The performance indicators identified below are a means by which progress towards population and distribution objectives for Monarch can be measured

Table 6. Performance measures used to determine whether Monarch recovery objectives are being met.

Performance Measure	Check-in
<b>Planning:</b>	
Number of Recovery Team meetings to discuss recovery activities and assess performance to date (minimum one per year)	Annually
Number of initiatives and groups involved in delivering conservation messaging	Annually
Number of individuals or teams assigned to, or supported to implement, recovery-related projects such as land protection efforts, habitat mapping, the production of educational material, etc.	Annually
<b>Conservation:</b>	
Number and type of communication products produced and distributed that target general public, cottage owners, and others identified in the recovery actions table	Annually
Amount of habitat surveyed for milkweed and Monarch larvae	Every five years
Amount of breeding habitat documented	Every five years
Amount of breeding habitat protected	Every five years

## 9.2. Monitoring

Monitoring will be done every five years at a subset of Swamp milkweed populations spread throughout the province. Monitoring will consist of a Swamp milkweed stem count and the documentation of threats.

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