AREA OF FOREST OCCUPIED BY THE COLONIES OF MONARCH BUTTERFLIES IN MEXICO DURING THE 2022-2023 OVERWINTERING PERIOD.

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Executive Summary

During the second half of December of 2022, 11 colonies of monarch butterflies -three in the state of Michoacán and eight in the State of Mexico- were recorded to occupy a total of 2.21 hectares (*ha*) of forest, this represents a 22% decrease in relation to the area recorded in 2021 (2.84 *ha*). Six colonies (1.52 *ha*) were located inside of the Monarch Butterfly Biosphere Reserve (MBBR), and five (0.69 *ha*) were located outside of the MBBR. In Atlautla, east of the State of Mexico, a colony occupied 0.019 *ha* of forest. Additionally, two sites outside of the Monarch Region were reported to have isolated groups of butterflies present, however, they did not form colonies.

Introduction

The monarch butterflies (*Danaus plexippus*) that overwintering in Mexico migrate from the Great Lakes region in Canada and the United States of America; their overwintering forests are located on the border of Michoacán and the State of Mexico (Fig. 1), and their main threats are: i. the decline of milkweed at reproduction sites in the United States due to the use of herbicides; ii. land use change in North America and forest degradation in Mexico; and iii. climate change (Pleasants & Oberhauser, 2012; Vidal *et al*. 2013, Zylstra *et al.*, 2021). The WWF-Telmex Telcel Foundation Alliance and the National Commission of Natural Protected Areas (CONANP) systematically monitored the overwintering of the monarch butterfly since 2004. In this report we include the area of occupied forests by the colonies of monarch butterflies in December of 2022; the smallest occupied area was recorded in 2013-14 with 0.67 hectares (*ha*) and the largest occupied area was recorded in 1996-97 with 18.19 *ha* (Rendón-Salinas *et al.* 2005-2021; Vidal y Rendón-Salinas, 2014).

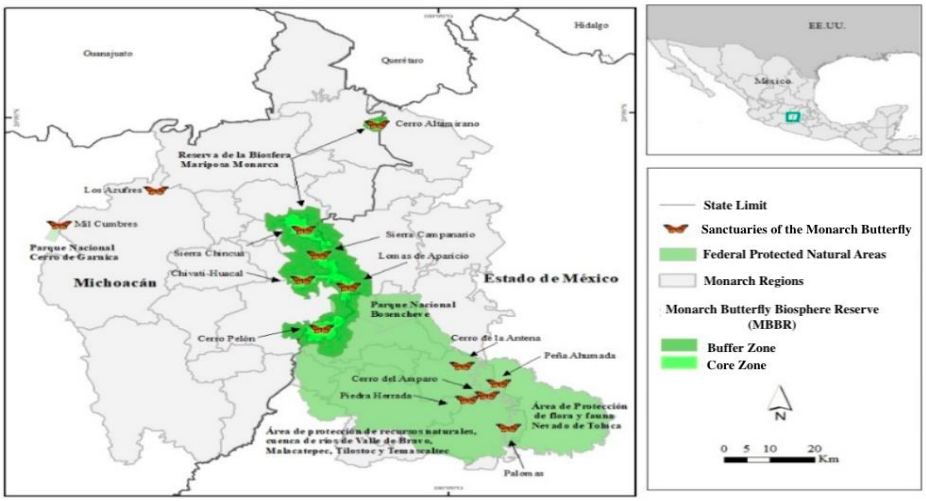

Figure 1. The Monarch Region includes the Monarch Butterfly Biosphere Reserve (MMBR) and other seven sanctuaries outside.

Method

Starting in December, each of the 13 overwintering sanctuaries inside and outside of the "Monarch Region" were visited twice a month; when a colony was found its location was established with a Garmin® Geo positioning device in UTM projection, with WGS 84 datum. The perimeter of the forest occupied by the butterflies was determined from the tree that was found on the highest point of the slope, then we recorded the direction and distance of the consecutive and peripheral tress of the colony. The polygonal perimeter data was processed with the ArcView 3.3 geographic information system (GIS) to establish the area occupied by the colonies (Vidal y Rendón-Salinas, 2014). The Atlautla colony was also visited, whose area is not counted in the historical graph as it is located outside of the Monarch Region.

Results

In the second half of December 2022, 11 colonies of the monarch butterflies were recorded -three in Michoacán and eight in the State of Mexico-, which occupied a total area of 2.21 *ha* of forest. Six colonies (1.52 *ha*) were located within the MBBR, while five (0.69 *ha*) were located outside of the reserve (Table 1). This area represents a decrease of 22% compared to the area occupied in 2021 which was 2.84 *ha* (Fig. 2). In the Monarch Region the largest colony (0.797 *ha*) was located in Ejido El Rosario (Sierra Campanario Sanctuary) and the smallest colony (0.004 *ha*) was located in Ejido El Potrero (Cerro de la Antena Sanctuary). The Atlautla colony adjacent to the Iztaccihuatl-Popocatepetl National Park, which is outside of the Monarch Region occupied an area of 0.019 *ha* of forest. Additionally in the State of Mexico, isolated groups of monarch butterflies were recorded in the municipalities of Santiago Tuanguistenco and Jiquipilco, but they did not form colonies.

Table 1. Forest area occupied by monarch butterfly colonies throughout the second half of December 2022.

Location	*State*	*Sanctuary*	*Colonies(agrarian properties)*	*Area (ha)*
Inside the Monarch Butterfly Reserve (MBBR)	State of Mexico	Cerro Pelón	E. El Capulín	0.040
			E. Mesas Altas de Xoconusco	*
			C.I. San Juan Xoconusco	*
			B.C. San Pablo Malacatepec	0.141
		Sierra Campanario	E. San Joaquín Lamillas	*
			E. La Mesa	0.041
	Michoacán	Cerro Altamirano	E. Contepec	*
		Cerro Pelón	E. Nicolás Romero	*
		Chivatí-Huacal	C.I. Carpinteros	0.065
			C.I. Donaciano Ojeda	*
		Sierra Campanario	E. El Rosario	0.797
		Sierra Chincua	Propiedad Estatal	0.433
			Propiedad Federal	*
			E. Cerro Prieto	*
			E. El Calabozo Fracción 1	*
		Lomas de Aparicio	E. Crescencio Morales	*
			Area Occupied Inside the MBBR	1.517
Outside the MBBR	State of Mexico	Cerro del Amparo	E. San Francisco Oxtotilpan	0.086
		Palomas	E. San Antonio Albarranes	0.176
		Piedra Herrada	E. San Mateo Almomoloa	0.106
		Peña Ahumada	E. Ojo de Agua	0.318
		Cerro de la Antena	E. El Potrero	0.004
	Michoacán	Los Azufres	P.P. San Andrés	*
		Mil Cumbres	E. Río de Parras	*
			Area Occupied Outside the MBBR	0.690
Total Occupied Area				2.207

E=Ejido; C.I.=Indigenous Community; P. P.=Small Property; B.C.=Communal Property; * No colony present.

Note: except for Small Property, all other are agrarian properties that exist in Mexico.

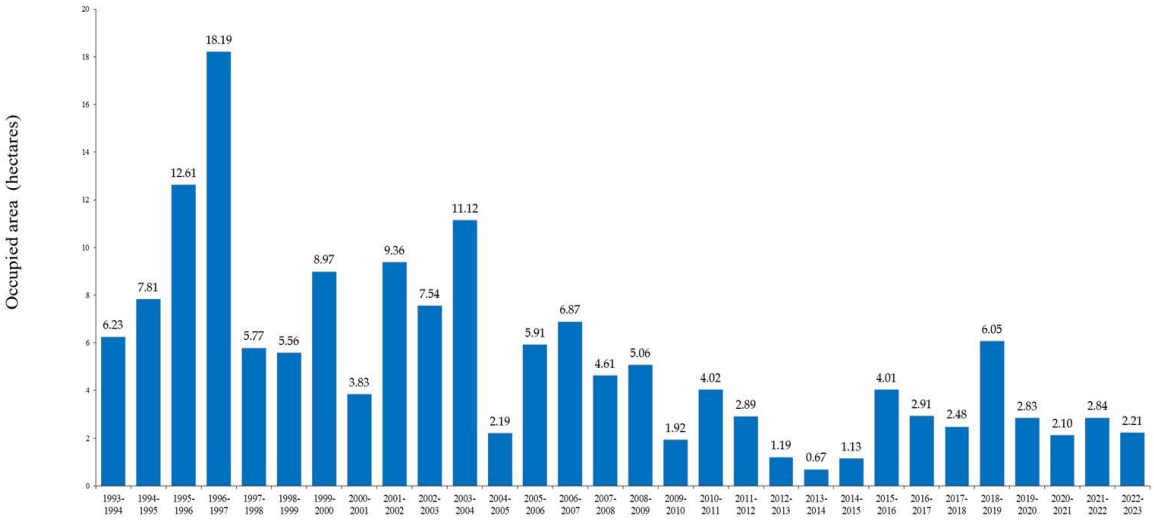

Figure 2. Forest area occupied by the monarch butterfly colonies in Mexico from 1993-1994 to 2022-2023.

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References

Pleasants, M.J. & Oberhauser, S.K. 2012. Milkweed loss in agricultural fields because of herbicide use: effect on the monarch butterfly population. Insect Conservation and Diversity, The Royal Entomological Society, 10 pp.

Rendón-Salinas, E., A. Valera-Bermejo, M. Cruz-Piña, S. Rodríguez-Mejía y C. Galindo-Leal. 2005. Monitoreo de las colonias de hibernación de mariposa Monarca: superficie forestal de ocupación en diciembre de 2005a. WWF-México, DF, reporte inédito, 6 pp.

Rendón-Salinas, E., S. Rodríguez-Mejía, M. Cruz-Piña y C. Galindo-Leal. 2006. Monitoreo de las colonias de hibernación de mariposa Monarca: superficie forestal de ocupación en diciembre de 2006. WWF-México, DF, reporte inédito, 6 pp.

Rendón-Salinas, E., N. Acevedo-Hernández, S. Rodríguez -Mejía, y C. Galindo-Leal. 2007. Monitoreo de las colonias de hibernación de mariposa Monarca: superficie forestal de ocupación en diciembre de 2007. WWF-México, DF, reporte inédito, 8 pp.

Rendón-Salinas, E., C. A. Valera-Bermejo y F. Martínez-Meza. 2008. Monitoreo de las colonias de hibernación de mariposa Monarca: superficie forestal de ocupación en diciembre de 2008. WWF- México, DF, reporte inédito, 8 pp.

Rendón-Salinas, E., C. A. Valera-Bermejo, S. Rodríguez-Mejía y F. Martínez-Meza. 2009. Monitoreo de las colonias de hibernación de mariposa Monarca: superficie forestal de ocupación en diciembre de 2009. WWF-México, DF, reporte inédito, 8 pp.

Rendón-Salinas, E., C. A. Valera-Bermejo, M. Cruz-Piña y F. Martínez-Meza. 2010. Monitoreo de las colonias de hibernación de mariposa Monarca: superficie forestal de ocupación en diciembre de 2010. WWF-México, DF, reporte inédito, 8 pp.

Rendón-Salinas, E., S. Rodríguez-Mejía, M. Cruz-Piña, C. A. Valera-Bermejo y F. Martínez Meza. 2011. Monitoreo de las colonias de hibernación de mariposa Monarca: superficie forestal de ocupación en diciembre de 2011. WWF-México, DF, reporte inédito, 8 pp.

Rendón-Salinas, E. y G. Tavera-Alonso. 2012. Monitoreo de la superficie forestal ocupada por las colonias de hibernación de la Mariposa Monarca en diciembre de 2012. WWF-México, DF, reporte inédito, 6 pp.

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 2013. WWF-México, DF, reporte inédito, 5 pp.

Rendón-Salinas, E., A. Fajardo-Arroyo y G. Tavera-Alonso. 2014. Superficie forestal ocupada por las colonias de hibernación de la Mariposa Monarca en diciembre de 2014. WWF-México, DF, reporte inédito, 4 pp.

Rendón-Salinas, E., F. Martínez -Meza y A. Fajardo-Arroyo. 2015. Superficie forestal ocupada por las colonias de hibernación de la Mariposa Monarca en diciembre de 2015. WWF-México, DF, reporte inédito, 3 pp.

Rendón-Salinas, E., F. Martínez -Meza, M. Cruz-Piña y A. Fajardo-Arroyo. 2016. Superficie forestal ocupada por las colonias de hibernación de la Mariposa Monarca en México en la temporada 2016-2017. WWF-México, DF, reporte inédito, 3 pp.

Rendón-Salinas, E., F. Martínez -Meza, A. Martínez-Pacheco y M. Cruz-Piña. 2017. Superficie forestal ocupada por las colonias de hibernación de la Mariposa Monarca en México en la temporada 2017-2018. WWF-México, DF, reporte inédito, 3 pp.

Rendón-Salinas, E., F. Martínez-Meza, M. Mendoza-Pérez, M. Cruz-Piña, G. Mondragón-Contreras y A. Martínez-Pacheco. 2018. Superficie forestal ocupada por las colonias de mariposas Monarca en México durante la hibernación de 2018-2019. WWF-México, DF, reporte inédito, 4 pp.

Rendón-Salinas, E., F. Martínez-Meza, M.A. Mendoza-Pérez, M. Cruz-Piña, G. Mondragón-Contreras y A. Martínez-Pacheco. 2019. Superficie forestal ocupada por las colonias de mariposas Monarca en México durante la hibernación de 2019-2020. WWF-México, Ciudad de México, reporte inédito, 4 pp.

Rendón-Salinas, E., F. Martínez-Meza, M.A. Mendoza-Pérez, M. Cruz-Piña, G. Mondragón-Contreras y A. Martínez-Pacheco. 2020. Superficie forestal ocupada por las colonias de mariposas Monarca en México durante la hibernación de 2020-2021. WWF-México, Ciudad de México, reporte inédito, 4 pp.

Rendón-Salinas, E., A. Fernández-Islas, M.A. Mendoza-Pérez, M. Cruz-Piña, G. Mondragón-Contreras y A. Martínez-Pacheco. 2021. Superficie forestal ocupada por las colonias de mariposas Monarca en México durante la hibernación de 2021-2022. WWF-México, Ciudad de México, reporte inédito, 4 pp.

Vidal, O., J. López-García y E. Rendón-Salinas. 2013. Trends in deforestation and forest degradation after a decade of monitoring in the Monarch Butterfly Biosphere Reserve in Mexico. Conservation Biology. http://onlinelibrary.wiley.com/doi/10.1111/cobi.12138/full

Vidal, O. & E. Rendón-Salinas. 2014. Dynamics and trends of overwintering colonies of the monarch butterfly in Mexico. Biological Conservation. http://www.sciencedirect.com/science/article/pii/S0006320714003589

Zylstra E.R., L. Ries, N. Neupane, S. P. Saunders, M.I. Ramirez, E. Rendon-Salinas, K. S. Oberhauser, M. T. Farr y E. F. Zipkin. Changes in climate drive recent monarch butterfly dynamics. Nature Ecology and Evolution. Vol. 5. October 2021. www.nature.com/natecolevol