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Citizen science engagement reveals patterns of long-term persistence of an at risk butterfly in three metropolitan centers

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Abstract

Insect declines have been documented for about twenty years worldwide, and the more recent Bee Colony Collapse Disorder has brought public attention to the issue. With this in mind, the persistence and thriving of an iconic, once-extirpated butterfly, the Atala (*Eumaeus atala*), in three major metropolitan centers located in southeastern Florida is remarkable and deserves close examination as to how it happened. The Atala butterfly is a charismatic species mostly residing in an urban dominated landscape, and has been a prime target of citizen science engagement since the second re-discovery of the species in 1979 in coastal Miami. Three citizen science actions were instrumental in this recovery: reintroductions, year-long population monitoring afterwards, and participation in annual butterfly counts. In this research, we analyzed three different sets of monitoring data gathered by citizen volunteers to help us determine factors that may influence the Atala butterfly's persistence. We found that the most labor- and time-demanding citizen science data allowed us to define fine scale population phenological dynamics enabling us to quantify the anecdotal biannual "crash and eruption" cycles, while the median level long-

term engagement data revealed a coarse, multiple year crash and eruption population cycle. Our analyses illustrated that the contribution of on-going data collection gained through committed citizen science actions play a critical part in the species conservation strategy, allowing us to apprehend new integral knowledge of the butterfly's biology, as well as factors influencing its population persistence and distribution.

Introduction

Declining butterfly and other insect populations have been reported in scientific journals for decades (Thomas et al., 2004, Dirzo et al., 2014, Wagner et al., 2021). Butterflies are among the few insects that have been monitored over long time periods of time, beginning in 1830 by the Proceedings of the Royal Society B in Britain. In the United States, concern for insects was illuminated by the Xerces Society for Invertebrate Conservation, founded by Robert Michael Pyle in 1971. Named after the first butterfly to become extinct in the United States, Xerces has been carefully observing dragonflies, fireflies, butterflies, bees and other insects, often using trained citizen scientists (Pyle, 2012).

The appearance of "Bee Colony Collapse Disorder" in 2006 brought awareness of insect pollinators to the mainstream, but scientists were aware long before this (Allen-Wardell et al., 1998), including the environmental factors that may have caused the declines, e.g. wide spread herbicide and pesticide usages, and habitat deterioration and loss (Berenbaum et al., 2007, Sánchez-Bayo and Wyckhuys, 2019).

In 1992, Jeffrey Glassberg created the North American Butterfly Association (NABA), which also promotes and utilizes trained citizen scientists to monitor butterfly populations, researching migration, distribution and range patterns, to assess conservation statuses nationwide. NABA's annual butterfly counts are modeled after National Audubon Society's annual Christmas bird counts, held for over 120years nation wide (Pranty and Anderson, 2022).

An iconic and charismatic Florida hairstreak butterfly called the Atala (*Eumaeus atala)* was thought to be extinct as early as 1937 in Florida (Klots, 1951) because its sole host plant, the only native North American cycad locally known as "coontie" (*Zamia integrifolia*), had been exploited to near extinction by the early settlers for flour production (Small, 1921). The coontie is still listed as "Commercially Exploited" by the State of Florida (Coine and Garland, 2003) and is currently very rare in natural areas.

The Atala butterfly was rediscovered a second time in 1979 after the first recovery attempt was decimated by Hurricane Donna in 1960 (Rawson, 1961). It has greatly recovered over

the past twenty plus years, as more of its host plants were raised in nurseries (Haynes, 2000) and incorporated into gardens and public venues. The native plant was increasingly used in ornamental landscaping over that time, where it is also known to cause serious pest management issues because the butterfly's larvae cause severe herbivory (Culbert, 1994, Koi and Hall, 2016). However, residential gardens also planted coontie and nectar resources, playing a critical role in the insect's recovery. We delve further into the vital role of these gardens in a companion paper to this publication.

To further understand the Atala butterfly's dynamic life cycle fluctuations, the environmental factors influencing its survival and persistence, as well as to document its newly expanding range and distribution, we examined three different sets of data collected by volunteer citizen scientists in NABA. Our questions were: (1) What does each of the data sets inform us about the butterfly's dynamic population patterns? (2)What do the fine and coarse grain scale analyses tell us?, (3) What factors may influence the presence of the Atala?, and (4) What is the current conservation status of the butterfly?

In addition, a fourth data set compares "Presence-Only" records sent to the first author from 2004 to 2022 by citizens not associated with the first three data sets. These individuals recorded the Atala in various locations, sending photographs and/or videos. This data set was not analyzed except to note types of locations where the Atala was seen, and was used to visually compare the presented range to the iNaturalist data.

Section snippets

Study species

The study species, the Atala butterfly (*Eumaeus atala)*, is a native subtropical hairstreak found in Florida, the Caribbean and Cuba (Klots, 1951, Smith et al., 1994) which has been documented by members of the North American Butterfly Association (Fig. 1A-C) and other volunteers. It is a specialist, using only cycads as a larval host plant, and has a strong site fidelity once established (Whittaker and Salzman, 2020). However, the colonies "wink in and out" of existence in erratic cycles…

Statistical analyses

Bayesian Regression…

Data set #1 residential garden life stage counts

The records clearly showed a crash-eruption cycles (Fig. 2). Wild colonies self-established in two gardens (PB1, PB3), and are still extant. One property (BC2) had one introduction and has reestablished on its own without intervention since, including 2023. One garden, BC1, had a natural population in the 'crash cycle' when one introduction was made, which flourished and became a source for reintroductions to other gardens.

Two volunteers from NABA, one from Miami-Dade and another from Broward,…

Discussion

Our study is certainly not the first to use citizen science for monitoring a species, but ours is unique in regard to the intensity with which our dedicated volunteers counted life stages of the Atala in specific gardens for a year or more, as well as supplied data during annual NABA counts.…

Conclusion

All in all, our data sets indicate that the Atala is one of the few insects that has documented increases in population, range and distribution, including the silver-spotted skipper(Davies et al., 2005), Fender's blue (Bonoan et al., 2021) and even a few Monarch butterfly locales (Davis et al., 2021). Even with the very destructive hurricanes in 2004 & 2005, the annual NABA counts took place before the storms arrived, and Atala butterfly activity continued after the storms passed. The Atala…

CRediT authorship contribution statement

Sandy Koi: Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization. **Adrian Figueroa:** Writing – review & editing. **Hong Liu:** Writing – review & editing, Supervision, Methodology.…

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.…

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Recommended articles

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Biological Conservation (2005)

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Changing distribution patterns of an endangered butterfly: Linking local extinction patterns and variable habitat relationships
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Worldwide decline of the entomofauna: A review of its drivers

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