

# American Chaffseed (*Schwalbea americana*) Five-Year Recovery Plan

December 7, 2020

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Photo by David B. Snyder

## Objective

The New Jersey Forest Service, Office of Natural Lands Management (ONLM), seeks to secure viable populations of the federally and state listed (Endangered) *Schwalbea americana* (American chaffseed) in New Jersey. This includes protection, monitoring and management of the last remaining natural population in the state, successfully establishing ten viable populations of the species throughout its historic range in New Jersey, and conducting research

to advance our understanding of the species' biology, management and recovery over the next five years in order to ensure its survival and recovery.

## **Background**

*Schwalbea americana* L. (American chaffseed) is a hemiparasitic, herbaceous perennial plant species in the Broomrape Family (Orobanchaceae) that occupies coastal plain forests and other isolated areas in Eastern North America. Formerly occurring from Massachusetts to Texas, populations have disappeared from the northern half of the species' historic range north of North Carolina, with the exception of the two remaining known occurrences in New Jersey and Cape Cod, Massachusetts. *Schwalbea* was formerly widespread in the New Jersey Pine Barrens, with 19-20 populations known from six coastal counties. However, due to fire suppression and resulting forest succession, suburban development, incompatible right-of-way maintenance, and off-road vehicles, by the late 1980's only a single natural population remained in New Jersey in Brendan T. Byrne State Forest, Burlington County.

*Schwalbea* occurs in open habitats on sandy, acidic soils within the Pine Barrens, typically in seasonally moist areas along wetland ecotones, which support a high diversity of herbaceous plant species. Individuals may produce multiple stems from a single base but are not clonal in their growth form. Flowering stems are typically up to 60 cm in height and may contain several dozen flowers, each pollinated by bumblebees or through self-pollination, and typically containing approximately 200 seeds. The seeds are tiny, fragile and contained in a netted sac-like structure, i.e., the "chaff," which give the plant its name. Lacking substantial energy reserves, upon germination the seeds require the establishment of parasitic connections with a host plant to survive and grow in its early stages of development. Because such hemiparasites are capable of photosynthesis, individuals do not depend upon these parasitic relationships once established. *Schwalbea* is known to be capable of parasitizing a wide variety of host plants (Musselmann and Mann, 1977), but it has exhibited preferences for species in the Asteraceae family with abundant roots near the surface of the soil, including *Chrysopsis mariana* (Maryland golden aster) in New Jersey (Kelly, 2006) and *Pityopsis graminifolia*

(narrowleaf silkgrass) in southern states (Helton, et al. 2000). Although seed dormancy has been documented for several years in controlled conditions, experiments in New Jersey found viability to diminish after 1-2 years in the field (Kelly, 2006).

The last remaining natural population in New Jersey was monitored periodically by local botanists in the 1970's and 1980's, but its occurrence on the edge of a county road resulted in repeated impacts by mowing during the growing season, dumping, vehicles and other disturbances typical of roadside areas. The population also experienced a dramatic decline in the late 1980's as a result of road widening activities, which destroyed the largest of four colonies comprising the population and led to substantial declines in others. Beginning in 1993, a cooperative agreement was established between the NJ Department of Environmental Protection, ONLM, and the US Fish and Wildlife Service (USFWS) to conduct systematic monitoring and management of the population (NJDEPE, 1993). These activities primarily consisted of the following: annual summer census to monitor population trends; maintenance of habitat conditions by prescribed burning; implementing compatible mowing schedules, and/or selective hand cutting; and extensive biological research to better understand the biology of the species and to develop techniques for propagation and recovery (Kelly, 2006).

Results from the annual censuses at the Brendan T. Byrne State Forest population found *Schwalbea* to number from 58-144 individuals throughout the 1990's. This small population size and vulnerability to disturbance made the establishment of additional populations at other, more secure sites a priority for its conservation in New Jersey and recovery in the Northeast (USFWS, 1992). In addition to population monitoring, research has been conducted to gain basic information about the biology and life history of the species, primarily focused on germination, growth and other techniques required for propagation and reintroduction of the species (Obee, 1995; Obee and Cartica, 1997; Yurlina, 1998; Van Clef, 2000; Van Clef, 2001; Kelly, 2003). The first 10 years of research in the 1990's were largely unsuccessful at advancing our understanding of the species or its recovery. Multiple experiments in both the greenhouse and the field involving tens of thousands of seeds, for example, failed to produce even a single

viable plant for reintroduction (Obee, 1995; Yurlina, 1998; Van Clef, 2000; Cartica et al., 1999). Although the seeds tended to germinate readily, most seedlings reached no more than a few centimeters in height, and few survived beyond their first growing season. As Yurlina (1998) observed, “Out of the 171 seeds that germinated in the lab, none of the dozen seedlings that persisted through four months of replete greenhouse care were in any way developed enough to be transplanted outside.” These efforts included a variety of potential host species, soil types, seed storage conditions, and other treatments used (Obee, 1995; Yurlina, 1998).

Similar problems stymied efforts to propagate *Schwalbea* from seed in the field. In the largest of the seed addition experiments (Van Clef, 2000), only 35 of 9,000 seeds planted near the Canal Colony germinated, and none of these survived. Similarly, no germination was observed in two other experiments at this location (Obee, 1995; Yurlina, 1998), in seed plots placed adjacent to existing colonies (Yurlina, 1998), or at two other historic *Schwalbea* sites in Wharton State Forest, where a total of 800 seeds were planted (Cartica et al., 1999). In another case, only five of 155 seedlings potted with and without *Schizachyrium scoparium* host plants in the field survived until the end of the growing season and none returned the following year (Obee and Cartica, 1997).

Even researchers from Atlanta Botanical Garden (ABG), who had prior success with propagation of *Schwalbea* from southern populations as well as other hemiparasitic species in the Orobanchaceae family, were unsuccessful in rearing New Jersey *Schwalbea* (Van Clef, 2000; Determann et al., 1999). Thousands of seeds and hundreds of potential host plants were sent to ABG in 1999 with the hopes that viable plants would be produced and later returned to New Jersey for outplanting in the field. Although some success was initially observed, these propagation efforts eventually ran into similar difficulties as previous efforts, and in the end, no viable plants were produced. Despite the successful propagation of 74 plants from seed in 1999, only 14 successfully overwintered and none of these survived, with or without host plants (Determann, 2001). An additional 1,700 *Schwalbea* seedlings produced in May 2001 and transplanted to pots with *Ilex glabra* also failed to survive, apparently due to a failure to take to

these host plants (Denhof, pers. comm.). Given these continual setbacks, the prevailing view by the end of the decade was that the New Jersey population, which was extremely small and isolated from neighboring populations, was suffering from inbreeding depression and was not capable of successful reproduction.

These perspectives rapidly changed in 2001, however, when a major increase was observed in the Brendan T. Byrne State Forest *Schwalbea* population, from 130 individuals to more than 600 (Figure 1; Kelly and Cartica, 2002), and intensive research was initiated to identify the conditions responsible for this dramatic increase. This research focused not only on the increase in numbers, but on the spatial distribution of the population increase, which exhibited a distinct clustering pattern that had not been noticed in previous years. Investigations into the soil, water and plant community characteristics associated with these clusters found them to be significantly different than immediately adjacent areas (Kelly, 2006), and subsequent experiments found each of these factors to be biologically significant for the life history of the species. The soil outside of the clusters, for example, was found to inhibit *Schwalbea* germination, possibly due to greater acidity in these areas, and certain plant species in the Asteraceae (especially *Chrysopsis mariana*, Maryland golden aster) were discovered to be preferred hosts for *Schwalbea* compared to other woody or grass species also occurring in the area.

By incorporating this new knowledge of microhabitat conditions into subsequent greenhouse propagation efforts, in 2005 *Schwalbea* was able to be successfully grown for the first time in nearly 15 years of effort. These conditions also proved useful as indicators of suitable microhabitats for *Schwalbea*, which allowed for the assessment and identification of suitable sites for reintroduction. Combined, these efforts led to the first successful reintroduction of approximately 50 *Schwalbea* individuals at three sites in the New Jersey Conservation Foundation's Franklin Parker Preserve in 2006 and 2008. These outplantings were highly successful, with approximately 50% survival of initial plantings after 10 years, as well as

successful flowering and seedling recruitment, which was observed in 2011, 2014, 2017 and 2019.

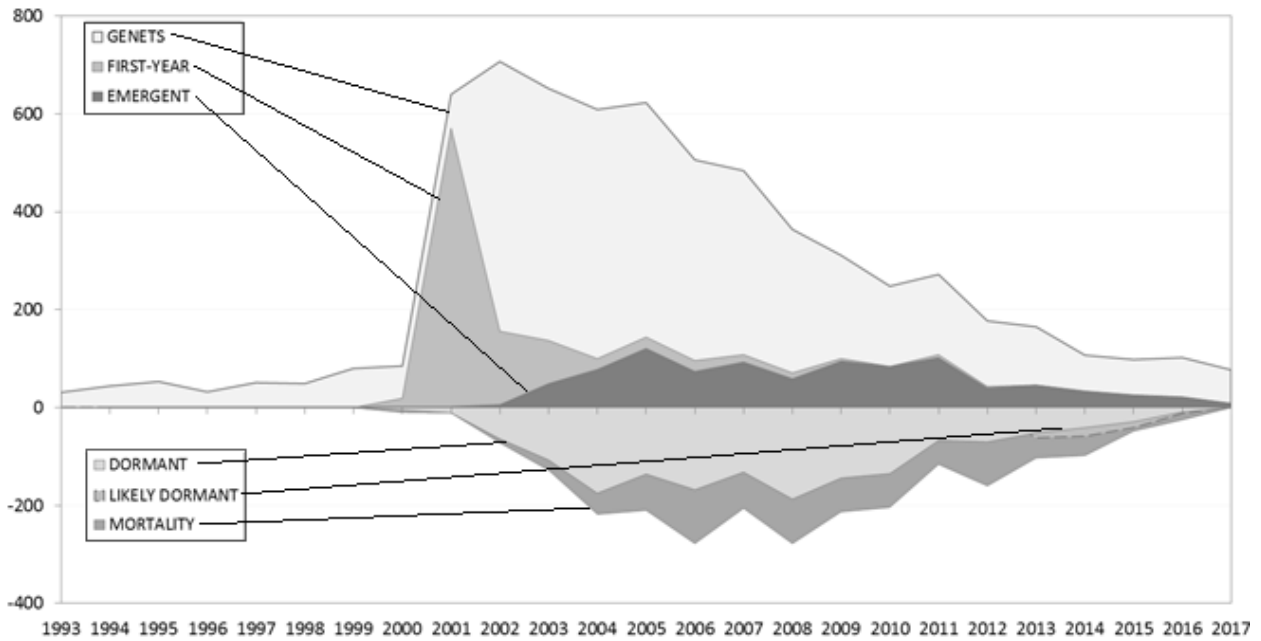
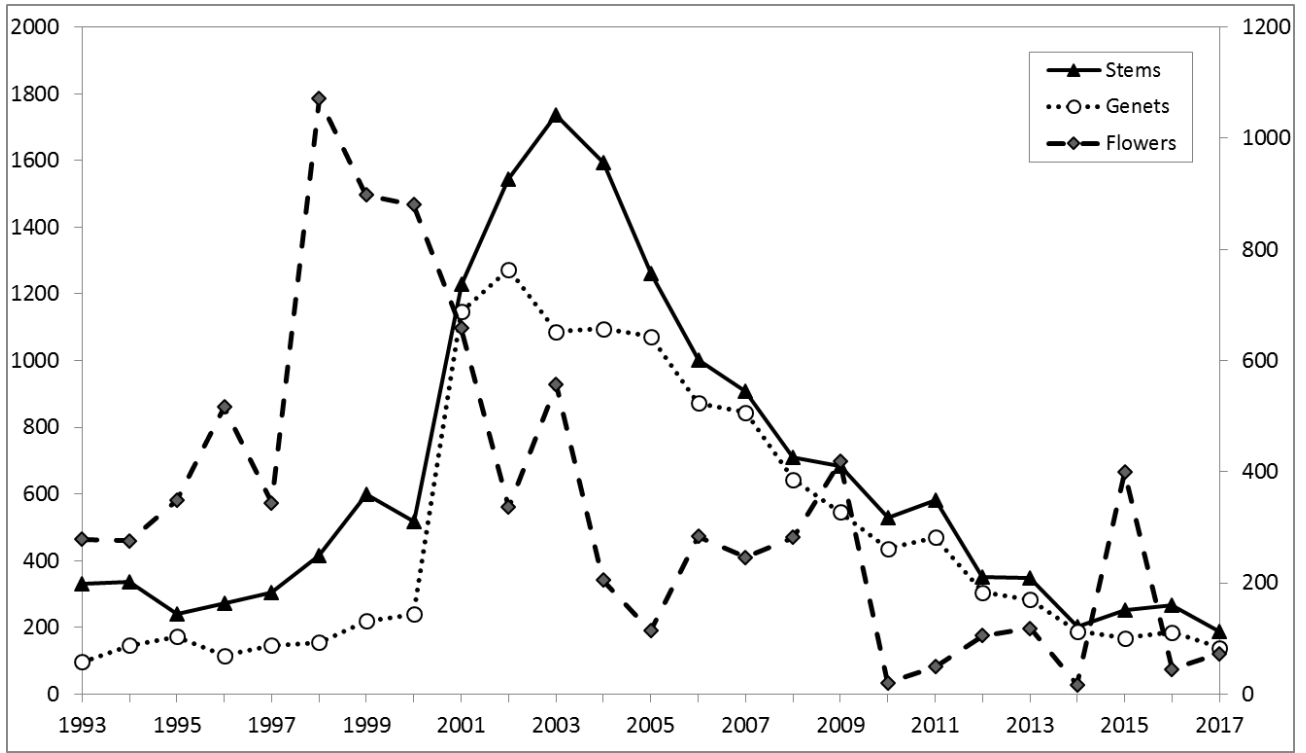
Despite these successes, the natural population has undergone a consistent long-term decline from its peak in 2001-2005 to only 83 individuals in 2017 (Figure 1), with four out of six colonies along the roadside disappearing entirely, and others numbering less than five individuals in most years. Although the habitat was managed to counteract these declines (prescribed burning in 2015 and 2018; mowing in 2020), the increased *Schwalbea* flowering stimulated by the management did not translate into similar levels of seedling recruitment and establishment as was observed in 2001-2003. This may have been due to unfavorable weather conditions and/or deterioration of the conditions of the site. Changes in plant community conditions and water table data, possibly due to hydrological alterations from adjacent cranberry agriculture or maturing adjacent pine forest, suggest that the site is drier than in the past, which is less conducive to seed germination and/or seedling survival. Whatever the cause, the substantial declines in the natural population reinforce the imperative to establish additional populations to enhance the long-term viability of *Schwalbea* in New Jersey and the northern portions of its range.

#### **U.S. Fish and Wildlife Service Recovery Plan**

The U.S. Fish and Wildlife Service (USFWS) adopted a Recovery Plan for *Schwalbea* in 1995, the stated goal of which was to remove American chaffseed from the Federal list of endangered and threatened wildlife and plants (USFWS, 1995).

According to the plan, the following recovery tasks are to be completed prior reclassification of the species: “(1) Protect extant populations and manage habitat. (2) Expand the extent of *Schwalbea* in the northern portion of the current range. (3) Investigate best management techniques. (4) Investigate the species' biology. 4.1 Conduct research to obtain more comprehensive information on life history. (5) Investigate genetic variability. 6. Monitor populations. (7) Review recovery progress and revise recovery plan as necessary.”

Figure 1. *Schwalbea* population trends in New Jersey and demographics of main colony



This five-year recovery plan is consistent with the USFWS's recovery plan and aims to contribute to the recovery plan's stated goal.

### **Restoration Plan Components**

Based on the status and history of monitoring and management of *Schwalbea* in New Jersey, the following is recommended for implementation by the ONLM in cooperation with the USFWS during 2021 through 2025 to secure the species' continued existence in the state.

**Component 1: Annual Monitoring** - Continue annual summer censuses of both the natural and outplanted experimental *Schwalbea* populations, recording primary demographic indicators (max. stem height, # stems, # flowers/stem, leaf damage, stem damage). Analysis of 25+ years of monitoring data should be conducted to summarize basic demographic patterns and life history (e.g., longevity, dormancy, growth, etc.) of the natural and experimental *Schwalbea* populations in New Jersey.

**Component 2: Habitat Management** - Maintain suitable habitat conditions at the natural and experimental population sites by mowing, cutting, prescribed burning, silvicultural practices, and/or other methods, as needed. Experiments should also be conducted to test strategies for habitat improvement, expansion and creation using a variety of techniques (e.g., fire, mowing, planting, soil disturbance, seeding and/or other methods). In order to inform management, environmental monitoring of relevant habitat conditions should be implemented at each population and/or potential outplanting area, specifically with regard to water table depth, host plant availability, and/or other indicators of suitable habitat. Priority should be given to the following: a) maintaining suitable habitat conditions at the existing *Schwalbea* population or other sites; b) expansion of existing occurrences into immediately adjacent areas of suitable habitat; c) restoration of suitable conditions at historic sites; and d) creation of new areas of habitat suitable for outplanting where none currently exists.

**Component 3: Greenhouse and *In Situ* Propagation** - Maintain and expand greenhouse



propagation for reintroduction and research. In order to be consistent with the best practice guidelines for endangered plant species propagation (USFWS & NOAA 2000, CPC 2019, USFWS 2012), the ONLM will: a) utilize multiple propagation facilities to reduce risk of failure (Duke Farms, Raritan Valley Community College, and/or others); b) limit annual seed collection to  $\leq 5\%$  of total seed production in order to minimize impacts to populations; c) maintain detailed records of provenance, and ensure proper segregation and isolation of plant and soil material from different sites in order to avoid genetic or other cross-contamination; d) train and coordinate staff with prior experience in native and/or rare plant species propagation to utilize species-specific protocols; and e) monitor and collect data on the success of these activities. Research should be conducted to optimize propagation strategies, including seed stratification measures, seed addition treatments vs. outplantings in the field, preferred growing conditions, timing and greenhouse and outplanting activities, variation in root availability between potential host species and growing conditions (e.g., fire), or other factors.

**Component 4: *Ex Situ* Population Establishment** - Establishment of permanent *ex situ* populations should be explored at appropriate facilities, including botanical gardens, research institutions or elsewhere, as insurance against possible loss of populations in the wild.

**Component 5: Surveys for *De Novo* Populations and Suitable Reintroduction Sites** - Continue surveys for both *de novo* and/or historic populations and for suitable reintroduction sites within the historic range of the species on both State and non-State properties. Searches should focus on ecotonal areas that have experienced regular or frequent mowing, burning or other disturbances that are likely to be conducive to the establishment of suitable host plant communities.

**Component 6: Biological Research** - Conduct research into relevant aspects of the biology and life history of *Schwalbea* as needed. This may include host-parasite relations, pollination biology, genetics, etc.

### **Activities for 2021-2025:**

1. Continue annual monitoring activities at the natural and outplanted experimental *Schwalbea* populations to inform population/site management. Analyze past census results to contribute to our understanding of the population biology and dynamics of *Schwalbea* in New Jersey. (Component 1)
2. Maintain and enhance habitat quality in the vicinity of existing *Schwalbea* sites in order to facilitate expansion of the species populations into those areas. Conduct research into habitat enhancement and management techniques to increase efficiency of future efforts. Implement these techniques to enhance and/or create suitable habitat at a minimum of three sites. (Component 2)
3. Expand and enhance propagation efforts to a minimum of two facilities, increase the number of plants available for reintroduction each year, and conduct research into propagation and reintroduction methods in order to increase efficiency of future efforts. (Component 3)
4. Identify and assess a minimum of three new reintroduction sites within the known historic range of *Schwalbea* in New Jersey and attempt to reintroduce the species to them. Establish a minimum of one *ex situ* population at an appropriate local institution. (Components 4-5)

### **Activity Schedule 2021-2025:**

#### **Year 1 – 2021**

- Initiate planning and re-establish working partnerships between state, local and federal agencies, private sector and NGOs.
- Conduct annual summer census, including outplanted populations.

- Analyze results from 25+ years of *Schwalbea* monitoring, biological research and/or prior reintroduction efforts and produce manuscript(s) for publication.
- Collect seed and initiate greenhouse propagation at Duke Farms and RVCC. Collect host seed, plants, and/or soil for propagation, restoration and experimentation.
- Initiate planning and approval processes for prescribed burning and habitat management to be conducted during 2022 at natural population site and experimental outplanting sites by coordinating with respective agencies and staff.
- Begin planning and implementation of habitat enhancement/expansion at natural and/or outplanting sites. Coordinate habitat management of outplanting sites with project partners.
- Conduct experiments on propagation methods, including seed stratification techniques, timing of outplanting activities, and sowing of seeds vs. seedlings in greenhouse flats.
- Conduct surveys for *de novo*/historic populations and suitable habitat in vicinity of historic sites (Ocean and Burlington Counties).
- Develop a Controlled Propagation and Reintroduction Plan for *Schwalbea* in NJ and including propagation protocols, individual reintroduction plans for experimental populations in the field, and plans for *ex situ* population establishment at 1-3 sites.
- Initiate outreach with prospective partners for establishing permanent *ex situ* populations at regional botanical gardens, research facilities, or other suitable managed environments.

## **Year 2 – 2022**

- Conduct annual summer census, including all outplanted populations. Respond as needed to results of census.
- Conduct prescribed burning and vegetation management at natural and experimental populations as needed to enhance habitat quality and stimulate flowering. Conduct habitat enhancement activities planned in 2021. Initiate planning and approval processes for prescribed burning and habitat management to be conducted during 2023.

- Continue greenhouse care of *Schwalbea* propagated in 2021. Collect seed and initiate second year of greenhouse propagation. Adjust greenhouse conditions based on results of 2021 greenhouse propagation to enhance success. Collect host seed, plants, and/or soil for propagation, restoration and experimentation.
- Continue *Schwalbea* propagation research and associated experiments.
- Conduct surveys for *de novo*/historic populations and suitable habitat in vicinity of historic sites (Atlantic and Cape May Counties).
- Complete reintroduction plans for 1-3 sites and implement pilot outplanting of *Schwalbea* at 1-3 sites.
- Continue planning and coordination with project partners to establish an *ex situ* population at a botanical garden or other local research facility. Develop plans for implementation.

### **Year 3 – 2023**

- Conduct annual summer census, including all outplanted populations. Respond as needed to results of census.
- Monitor results and continue experimentation into habitat expansion/creation. Conduct habitat management activities planned in 2022. Initiate planning and approval processes for 2024 habitat management at outplanting and/or historic sites, as needed.
- Collect seed for third year of greenhouse propagation. Initiate experiments on host root availability or other relevant factors on *Schwalbea* survival and establishment. Collect host seed, plants, and/or soil for propagation.
- Conduct surveys for *de novo*/historic populations and suitable habitat in vicinity of historic sites (Cape May, Cumberland or Salem counties).
- Continue pilot outplanting of *Schwalbea* at predetermined reintroduction sites and monitor success of previous plantings.
- Begin implementation of *ex situ* population establishment at appropriate local institution.

### **Year 4 – 2024**

- Conduct annual summer census, including all outplanted populations. Respond as needed

to results of census. Initiate planning and coordination for surveys in 2025.

- Conduct habitat management activities planned in 2022. Continue habitat management/expansion/creation research, and monitor results. Implement habitat enhancement/creation at a minimum of three sites.
- Collect seed for fourth year of greenhouse propagation. Initiate experiments on host root availability or other relevant factors on *Schwalbea* survival and establishment. Collect host seed, plants and/or soil for propagation.
- Continue pilot outplanting of *Schwalbea* at predetermined locations, including initiation of third site planting if needed. Monitor survival and success of previous year's outplanting. Establish one *ex situ* population at a botanical garden or research facility.
- Conduct surveys for *de novo*/historic populations and suitable habitat in vicinity of historic sites (Cape May, Cumberland, or Salem counties).
- Continue to implement *ex situ* population establishment at local institution.

#### **Year 5 – 2025**

- Conduct annual summer census, including all outplanted populations. Respond as needed to results of census.
- Conduct prescribed burning and vegetation management at natural and outplanted populations as needed to enhance habitat quality and stimulate flowering.
- Continue implementation of habitat enhancement/creation at three sites and monitor and analyze success.
- Outplant *Schwalbea* to augment populations at three locations established in 2023-2024.
- Conduct surveys for *de novo*/historic populations and suitable habitat in vicinity of historic sites (Cape May, Cumberland, or Salem counties).
- Monitor and analyze success of *ex situ* population establishment at local institution.
- Analyze results from past five years of restoration research, develop 5-year plan for 2026-2030, and produce 5-year report and/or manuscript(s) for publication.

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