A Species Recovery Plan for the Extirpated Rwanda Water Lily (*Nymphaea thermarum*).

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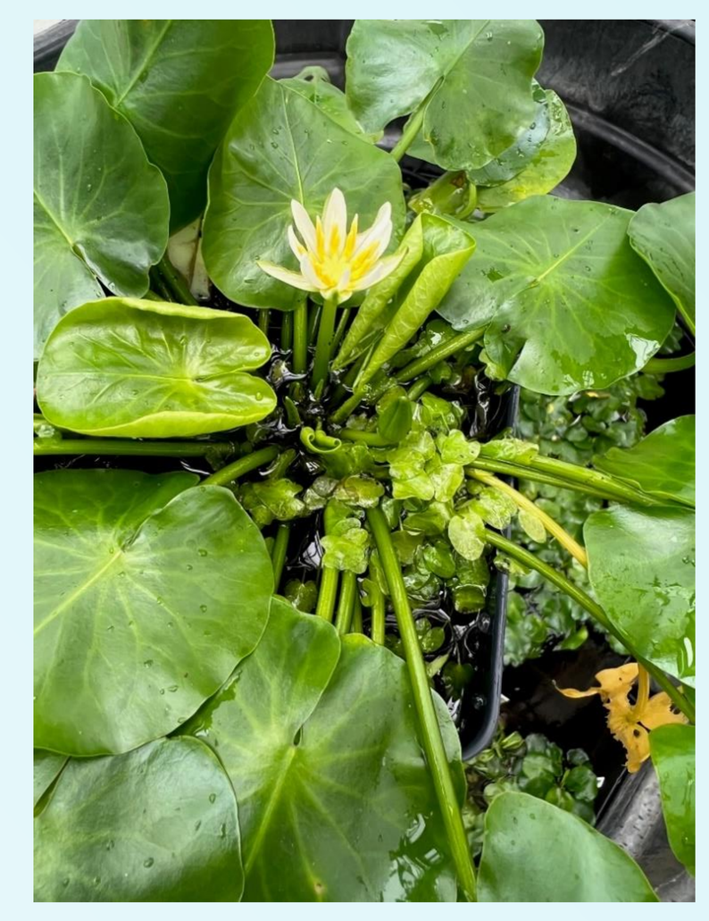
Introduction

Nymphaea thermarum Eb.Fisch. (Nymphaeaceae) is known as the smallest water lily in the world and is endemic to Rwanda. It was first identified in 1987 from a vegetation survey in the Amashyuza Hot Spring in the Western Province. Between 1988 and 2005, the increased use of the hot spring resulted in disastrous changes to both the water lilies' habitat and the spring's water flow. This resulted in a decrease in the population of the water lily.



A survey in 2009 identified that the original collection site had become severely altered by human activities and consequently the species was declared Extinct in the Wild (EW) by the International Union for the Conservation of Nature Red-list.

In Rwanda, there has been no extirpated plant species reintroduced to date. Since 2010, the Rwanda water lily has been successfully conserved ex-situ through an international network of botanical gardens including Harvard University, Missouri Botanical Garden, the Royal Botanic Gardens at Kew, England and in Bonn, Germany. In collaboration with Harvard University's Arnold Arboretum, seed was repatriated to Rwanda for germination and cultivation trials.

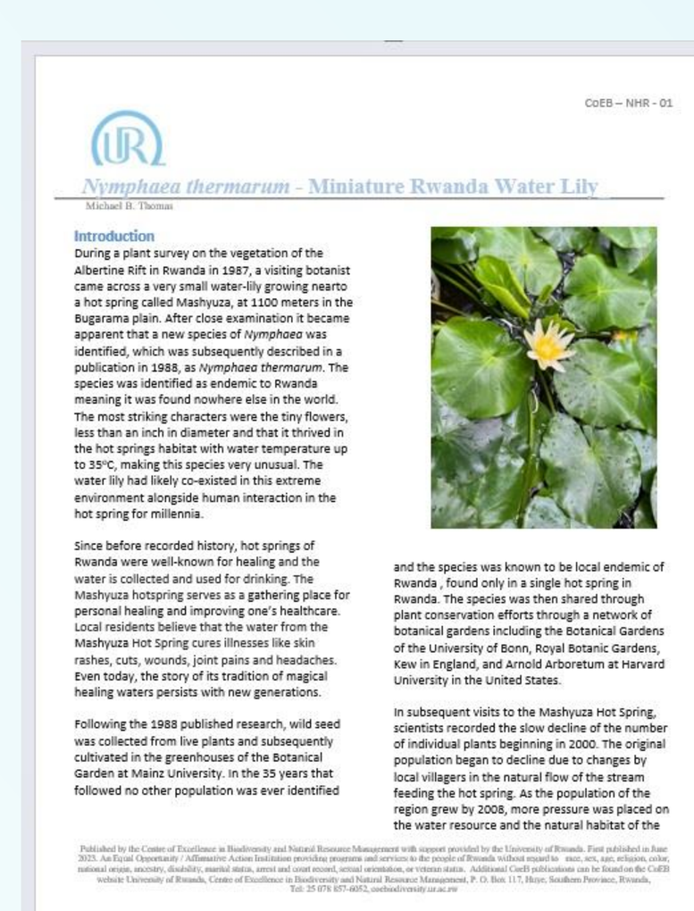


Objectives

- Develop a draft species recovery plan

- Repatriate seed, germinate and propagate *Nymphaea thermarum* in Rwanda for evaluation of the cultivation potential and evaluation for out planting mature plants to its native habitat

- Plan to initiate a local seed source through ex-situ cultivation and harvest the seed of locally grown plants in Rwanda



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Nymphaea thermarum - Miniature Rwanda Water Lily

Michael B. Thomas

Introduction

During a plant survey on the vegetation of the Albertine Rift in Rwanda in 1987, a visiting botanist came across a very small water-lily growing nearto a hot spring called Mashyuza, at 1100 meters in the Bugarama plain. After close examination it became apparent that a new species of *Nymphaea* was identified, which was subsequently described in a publication in 1988, as *Nymphaea thermarum*. The species was identified as endemic to Rwanda meaning it was found nowhere else in the world. The most striking characters were the tiny flowers, less than an inch in diameter and that it thrived in the hot springs habitat with water temperature up to 35°C, making this species very unusual. The water lily had likely co-existed in this extreme environment alongside human interaction in the hot spring for millennia.

Since before recorded history, hot springs of Rwanda were well-known for healing and the water is collected and used for drinking. The Mashyuza hotspring serves as a gathering place for personal healing and improving one's healthcare. Local residents believe that the water from the Mashyuza Hot Spring cures illnesses like skin rashes, cuts, wounds, joint pains and headaches. Even today, the story of its tradition of magical healing waters persists with new generations.

Following the 1988 published research, wild seed was collected from live plants and subsequently cultivated in the greenhouses of the Botanical Garden at Mainz University. In the 35 years that followed no other population was ever identified and the species was known to be local endemic of Rwanda , found only in a single hot spring in Rwanda. The species was then shared through plant conservation efforts through a network of botanical gardens including the Botanical Gardens of the University of Bonn, Royal Botanic Gardens, Kew in England, and Arnold Arboretum at Harvard University in the United States.

In subsequent visits to the Mashyuza Hot Spring, scientists recorded the slow decline of the number of individual plants beginning in 2000. The original population began to decline due to changes by local villagers in the natural flow of the stream feeding the hot spring. As the population of the region grew by 2008, more pressure was placed on the water resource and the natural habitat of the

Methods and Materials

In collaboration with Harvard University's Arnold Arboretum, 300 seeds were repatriated to Rwanda in August 2022 for a germination and propagation trial. A formal permit for living plant material for non-commercial purposes agreement was processed.




The following methodology was used:

- Seeds were placed in local unfiltered tap water until seeds germinated, approximately 10 days.
- Local clay-based topsoil was used to transfer germinated seedlings into pots.
- Seedlings were grown indoors without any standardized greenhouse climate control.
- Standard 10 cm nursery pots were used for transplanting seedlings.
- Three seedlings per pot were established into 60 nursery pots and submerged into 6 x 11-13 liter locally sourced non-standardized containers.
- Water was periodically added to the containers.
- The water level only slightly covered the black pots and was not filtered, aerated or circulated.
- Propagation was conducted indoors using only a natural seasonal sunlight cycle throughout the cultivation.
- Temperature was monitored with a digital thermometer.
- Locally sourced dry goat manure was macerated and supplemented periodically directly into the water.
- Water pH was not monitored.

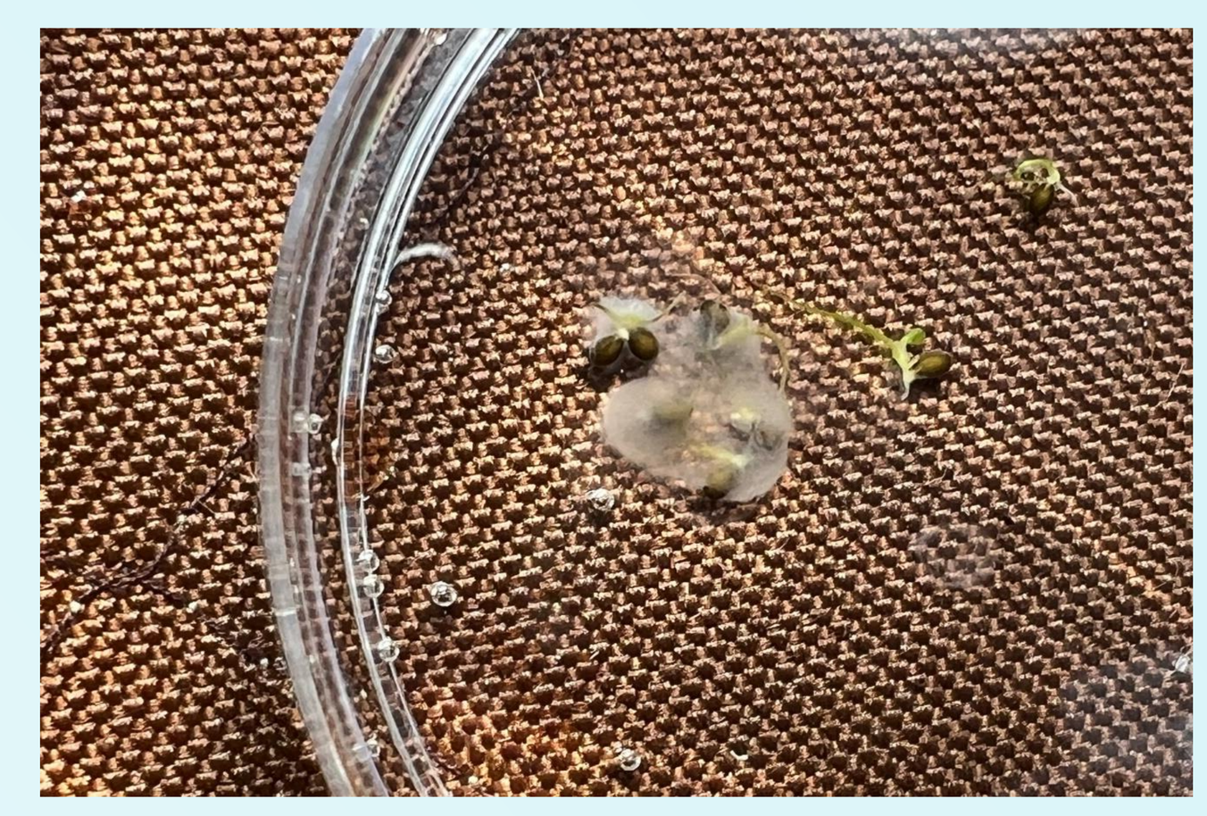


During the propagation trial, we had a preliminary visit to the Amashyuza Hot Spring for evaluation as a proposed future out planting site. We also initiated development of a draft species recovery plan as well as an educational extension publication.

Results

After 2 weeks, 200 seeds germinated in about 14 days. Some seeds and seedlings died from a fungal infection. One hundred and eighty seedlings were planted with locally sourced topsoil in 60 black plastic pots. Plants were monitored weekly for 20 weeks. Water temperature ranged from 19-21oC.

At the conclusion of 6 months, fifty-one plants were successfully cultivated. Algae blooms were problematic and due primarily to the inability to easily change the water which resulted in a slow decline of water quality. The slow attrition of plants was attributed to a rapid increase and competition from algae growth. No adult plants survived to the reproductive flowering stage.



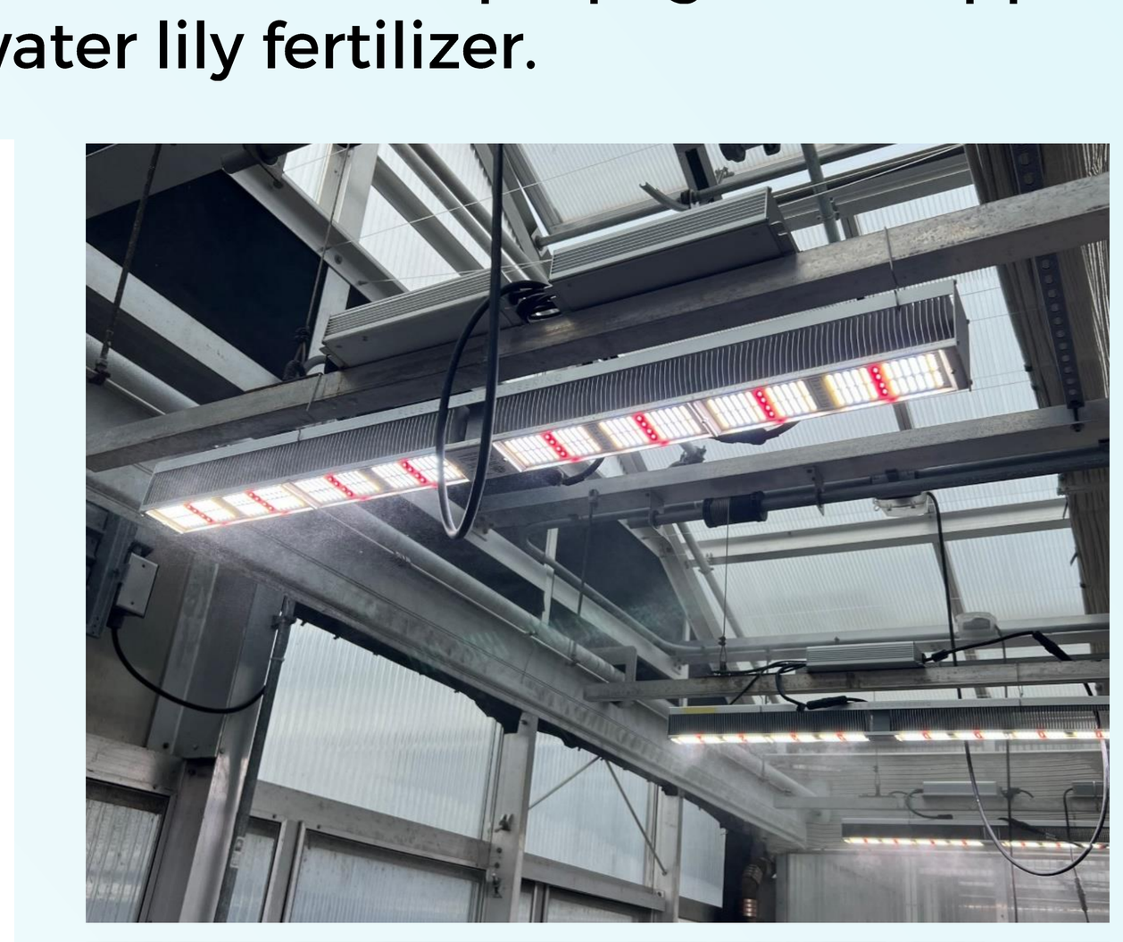
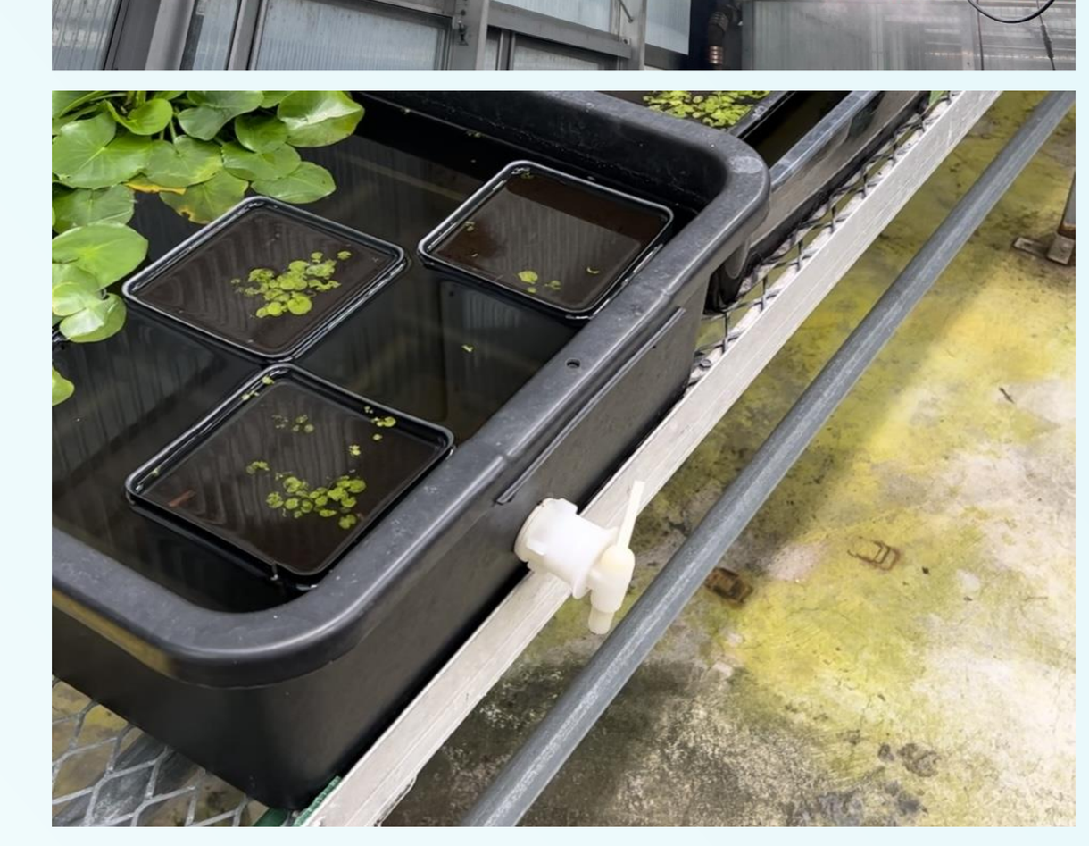



Conclusion

Seed of *N. thermarum* were successfully repatriated and propagated primarily using local supplies and materials. However, the quality of the supplies and cultivation techniques did not result in a high percentage of seedings reaching maturity. Improvements in a high-quality plant nursery facility, improved topsoil mix, improved water quality, artificial indoor lighting, and the application of fertilizer developed specially for water lilies is needed. These few changes would likely maximize production and improve the success of the future propagation program.

Continuing Research

The development of an ex-situ collection and species recovery plan is key to the future reintroduction of *N. thermarum* back into the native habitat where it once thrived. We are now planning the construction of a new nursery to improve the growing as well as the application of improved topsoil planting mix, horticultural propagation supplies, specialized lighting , and equipment and specialized water lily fertilizer.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