Life and Death of the Beach Vole (*Microtus breweri*) on Muskeget Island, Massachusetts.

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*Fig. 1 The skull of a Gray Seal (*Halichoerus grypus*) on Muskeget Island, Massachusetts. This island is the southernmost breeding ground for this species in the world.* © Lily C. Morello

Partner Organizations and Gift-in-Kind Contributors:

Nantucket Conservation Foundation
for supplying the necessary tools for trapping
Nantucket Land Bank
for granting permission to collect on property
Crocker Snow, Jr.
for providing accommodations and land access
Dr. Samuel Telford
for being a consistent source of advice
Nicholas Tepper
for acquiring all necessary permits
Quinn Sullivan
for his skills and knowledge
Toby Sackton
for providing transportation
Scott Boyscher
for sharing expert nautical advice
Caleb Kardell
for his generosity
Carl Sjolund
for his support

Inception and Impetus for Research

The Beach Vole (*Microtus breweri*), a close relative of the Meadow Vole (*Microtus pennsylvanicus*) is the only endemic vertebrate species in the Commonwealth of Massachusetts. (Tamarin, 1977) (Tamarin et al, 1987) A single population exists on Muskeget Island, a remote uninhabited island in the Nantucket archipelago, 98.7 hectares (244 acres) in area. Muskeget Island is largely inaccessible; it is surrounded by shoals which makes nautical navigation difficult, and the island's only airstrip is designated for emergency purposes only. Two-thirds of the island is owned by acclaimed journalist and head coach of the Harvard Polo Club, Crocker Snow, Jr. The other third is owned by Nantucket Land Bank, and managed by Massachusetts Audubon Society. Two small freshwater marshes exist on the island however, the water levels of these swales have decreased as a result of unseasonal drought in recent years. A single unoccupied house remains standing on the southeast side of the island: a former Humane Society shack now owned by the Snow family.

Crocker Snow, Jr. has written extensively about *M. breweri*, including an illustrated book for children, *The Mouse That Owns An Island* (2016). Correspondence was initiated in March of 2022 with Snow regarding the possibility of conducting a general population survey of *M. breweri*, the impetus being that there has not been a field assessment for population since the early 1990s (Telford, pers. comm.) Dr. Robert Stevenson of University of Massachusetts had collected several specimens on the island in 2015 however, this data remains unpublished. **It is the firm belief of this author that *M. breweri* should continue to be a subject of research**, as there are numerous factors that stand to limit or potentially cause decline in this unique population, being that a) Muskeget Island is a low-lying sandy island with a maximum elevation of fourteen feet and is therefore extremely susceptible to sea-level rise and erosion, b) *M. breweri* is listed as Vulnerable according to the IUCN Red List, (Linzey et al, 2017) and c) there has been a considerable increase of the highly pathogenic bacterium *Francisella tularensis* in coastal Massachusetts, which is linked to the infectious disease Tularemia or "Rabbit Fever". (Telford, pers. comm)

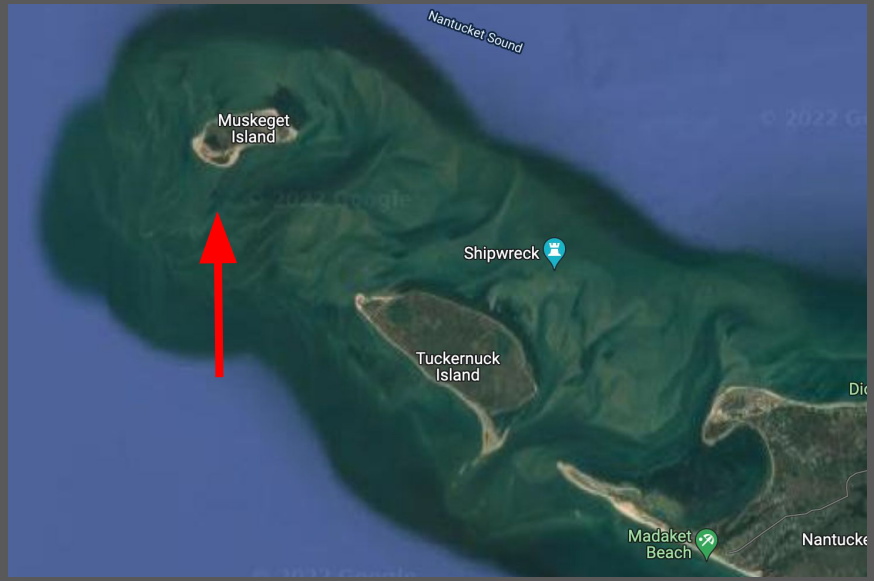

Fig. 2 Muskeget Island as it appears from space, in relationship to nearby Tuckernuck Island and Nantucket Island. The shoals surrounding Muskeget are evident in this satellite imagery. On both Tuckernuck and Nantucket M. pennsylvanicus *is abundant, although it is absent on Muskeget, where* M. breweri *is the only vole species.* © Google Maps 2022

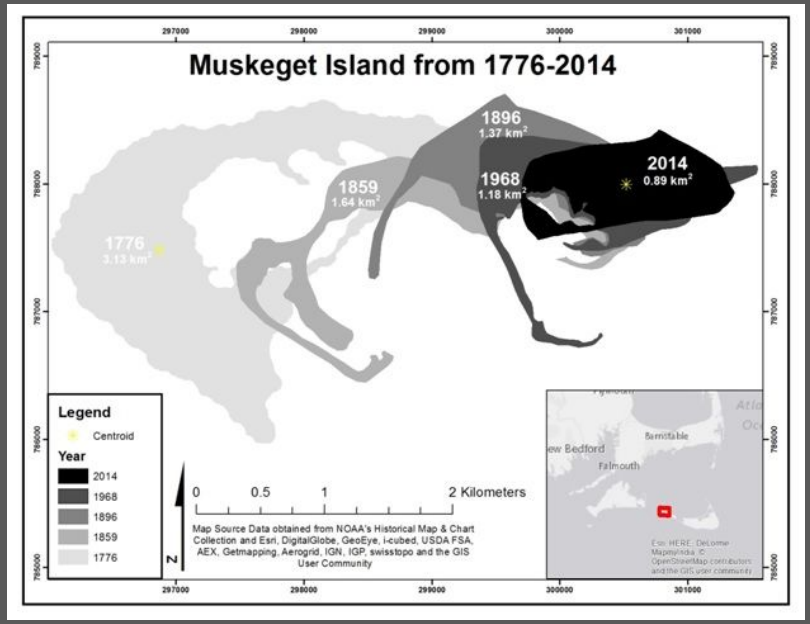

Fig. 3 Muskeget Island has changed considerably over the last 240 years, having lost ⅔ of its area, and having shifted 2.3 miles to the east. Historically, several islands have existed near and around Muskeget, including Adams, South Point, and Gravelly Islands. © Jared Muehlbauer

*Fig. 4 An adult Beach Vole (*M. breweri*) being scruffed in the field on August 22, 2022. This is potentially the first published color photograph of this species since 2002.* © Lily C. Morello

Chronology and Procedure

After preparing an initial research proposal, the author was able to arrange a meeting at Harvard University in April 2022 with the following stakeholders: Mark Omura (Collection Manager of Mammalogy at Harvard Museum of Comparative Zoology), Dr. Robert Stevenson (Professor of Biology at University of Massachusetts, Boston) and Crocker Snow, Jr. (majority landowner of Muskeget Island). The latter was responsible for introducing us to an additional undergraduate student, Quinn J. Sullivan (Assumption University) who shared a profound interest in the vole. This meeting resulted in the agreement that Harvard MCZ would allow us to collect data from their 160+ specimens of *M. breweri*, and that any specimens that we would collect during the 2022 field season be donated to Harvard University, pending the approval of our Scientific Collection Permit.

In May 2022, Morello, Sullivan, and myself met at Harvard MCZ with Omura to retrieve physiological measurements of the cranial features in *M. breweri*. We collected quantitative data on condylobasal length, zygomatic breadth, interparietal length, interorbital constriction, postorbital constriction, and sex. We had planned on meeting for a third time later that month, but COVID-19 prevented this from occurring. There are plans to continue this data collection process in Fall 2022.

In June 2022, our team was finally able to procure a Scientific Collection Permit from MassWildlife. This was largely thanks to fellow amateur mammalogist Nicholas Tepper, whose established background in *Microtus* trapping provided the qualifications necessary for obtaining a permit. Morello, Sullivan, and myself were signed on as sub-permittees. A few days later on June 9, Tepper was involved in a serious vehicle accident involving a westbound train outside of Kinsley, Kansas in the line of duty as a seasonal field technician. He remains in a comatose state at the time of this writing. It has been with great sadness that we have continued this work in his absence.

Fig. 5 The two undergraduate researchers, Skyler K. Kardell (left) and Lily C. Morello (right) on Muskeget Island. This house is owned by Crocker Snow, Jr. and is the only remaining structure on the island. © Caleb Kardell

Fig. 6 The Sherman traps used to capture both Microtus *and* Peromyscus *were set at dusk each day. Rubber boots were necessary due to the high density of Poison Ivy (*Toxicodendron radicans*) on the island. The author is pictured here carrying a box of traps to the survey site.* © Lily C. Morello

*Fig. 7 The Beach Vole (*M. breweri*) prefers dense undergrowth of Poison Ivy (*T. radicans*).This species is comparatively tame to other members of the genus* Microtus*, and can sometimes be quite approachable. Several instances occurred during trapping when a vole would scurry off beneath our legs.* © Lily C. Morello

Chronology and Procedure, cont'd.

In late August 2022, Lily C. Morello and the author were able to confirm the dates with Crocker Snow, Jr. for performing field research on Muskeget Island. Nantucket Conservation Foundation (NCF) supplied us with the Sherman traps necessary for trapping, sixty of which were requested in total. We are particularly indebted to resident science staff member Danielle O'Dell, for her generosity and support in this matter. Our departure from Nantucket took place on Saturday, August 20. We returned from Muskeget on Wednesday, August 24.

In addition to the sixty Sherman traps, Morello and myself also brought ingredients used to make "bait balls" in order to set the traps, as well as tools used for scruffing and data collection. Our "bait balls" consisted of a mixture of smooth peanut butter, "old-fashioned" whole oats, and vanilla extract. These mixtures were rolled up in sheets of wax paper, in order to prevent damage to the inside of the traps caused by the melting peanut butter. All sixty traps were set and baited by 16:00 for each day we stayed on the island. The traps were then deployed in a designated survey site no later than sundown. The island was divided into four designated survey sites for the four nights we would stay there. The sixty Sherman traps would then be collected during the first hour of daylight in the following morning.

In order to prevent any damage from occurring to the traps, all sixty units were cleaned thoroughly each day, washed with freshwater, and set with new "bait balls". Members of the genus *Microtus* are infamous for their propensity to foul a Sherman trap, mainly through their ability to chew through bait. A common bycatch of trapping was the White-footed Mouse (*Peromyscus leucopus*), the only other rodent species on Muskeget Island. *Peromyscus* are smaller, quicker, and generally more abundant than *Microtus*.

Fig. 8 "Bait Balls" were made using peanut butter, whole oats, and vanilla extract. The author is shown mixing these items together. © Lily C. Morello

Fig. 9 Traps were set in the evening, and later checked at daybreak. Oftentimes, the duration of this process exceeded two hours. Specimens were assessed in the field for sex, age, and ectoparasites. © Skyler K. Kardell

*Fig. 10 An adult Beach Vole (*M. breweri*) being scruffed in the field on August 22, 2022. In the background is Muskeget Island in its entirety, attesting to this species small and diminishing range.* © Lily C. Morello

Results and Conclusions

In total, we caught nineteen Beach Voles (*M. breweri*) during our four nights spent trapping on the island. Of these nineteen individuals, we collected three as specimens, which were later donated to Harvard University. Additionally, we trapped thirty-one White-footed Mice (*P. leucopus*). Only one individual was collected as a specimen. Having divided the island into four sectors, we identified the south side of the island (both the southwest and southeast trapping sites) as the most productive area for rodents: we caught fourteen total individuals of both *Microtus* and *Peromyscus* at each site.

The west side (both the northwest and southwest trapping sites) of the island proved to be the most productive area for trapping *M. breweri*. At both locations, we observed that 50% of captures were *M. breweri*. The southeast corner of the island was the least productive site for trapping *M. breweri*. We caught only two individuals at this site, representing just 16.6% of the captures there. We did not detect symptoms of Tularemia in any of the rodents we captured.

	M. breweri	*P. leucopus*	Total	% *M. breweri*
Northwest Sector	6	6	12	0.50
Northeast Sector	4	6	10	0.40
Southwest Sector	7	7	14	0.50
Southeast Sector	2	12	14	0.16

Frequency of *Microtus breweri* from Total Sites Surveyed 2022

Fig. 11 Table showing the occurrence and frequency of M. breweri *at selected trapping sites. Frequencies were highest on the west side of the island, while the southeast sector had the lowest frequency.*

Fig. 12 We selected four trap sites, each with varying proximity to fresh water. M. breweri *showed a preference for habitat types with a mixture of cedars and open fields, found primarily on the west side of the island. The northwest sector encompassed the remnants of the Holdgate house, which is believed to provide additional habitat for both rodent species.* © Google Maps 2022

Further Questions for Research

This was a very basic population assessment, consisting of a simple presence/absence survey. Tamarin (1977) included body weight, fat index, lactation, pregnancy, and breeding condition in its evaluation of population density in *Microtus*. These criteria were not met in this study, mainly due to the inexperience of the two undergraduate researchers in collecting small mammals.

The undergraduate students involved in this project gained valuable experience and skill sets by working with professionals in the field of mammalogy. The author has personally benefited from the shared knowledge and expertise of Mark Omura, Dr. Robert Stevenson, and Dr. Samuel Telford. Further research is needed in determining if there are any infectious diseases present in the population, as has been discussed with Dr. Telford, who is interested in pursuing the pathology of tick-borne illnesses in *M. breweri*, specifically in relation to the Mouse Tick (*Ixodes muris*), which has a type locality on Muskeget Island. Dr. Stevenson, who has been primarily interested in the taxonomic status of *M. breweri* as a valid species, is also curious about the current population dynamics of *M. breweri*. Omura, has been involved in the curatorial aspect of this research, in his role as Collection Manager of Mammalogy at the Harvard MCZ.

With this being said, there are several different ways in which this project can advance. Further research is needed in all three categories of inquiry. This work may also establish the groundwork for future graduate opportunities and research positions. From an organizational perspective, this project has assisted the author in gaining valuable connections with members of various institutions and partner organizations, which ties in with one of the core tenets of the Connecticut College Career Preparation curriculum: Networking. The author was also required to exhibit professionalism and communication skills at various instances, which also links to the course.

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