Via Electronic Mail

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Re: Support for Listing Horseshoe Crab as Species of Special Concern in Massachusetts

The horseshoe crab evolved over 400 million years ago, back when Gondwana was a supercontinent and tens of millions of years before the first dinosaur walked the Earth. Surviving nearly unchanged throughout eons, this living fossil inhabits Massachusetts's unique oceans and beaches. The horseshoe crab is valuable to Massachusetts in many ways: its eggs feed shorebirds, its blood protects humans, and its body provides fishers with bait.

Due to decades of deliberate persecution, commercial harvesting for bait, bleeding by the biomedical industry, and coastal development of the horseshoe crab's habitat, this ancient animal is in peril in Massachusetts. Their population has been in steep decline and is projected to decline much further. The expansion of the biomedical industry, impending climate change, and creeping sea level rise will continue to put unrelenting pressures on the horseshoe crab for years to come.

The Center for Biological Diversity writes in support of the petition to list the horseshoe crab as a species of concern on the Massachusetts endangered species list. As a keystone species to Massachusetts' coastal ecosystems, the source of human-saving blood, and an inspirational creature in its own right, this species deserves legal protection.

I. The Horseshoe Crab Meets Listing Criteria for a Species of Concern Under the Massachusetts Endangered Species Act

The Massachusetts Endangered Species Act (MESA) "establishes a comprehensive approach to the protection of the Commonwealth's Endangered, Threatened, and Special Concern species and their habitats."[1] A species must be eligible under MESA to warrant listing. Whether a species warrants listing depends on three core criteria: threats to the species, downward population trend, and rarity.[2] MESA *requires* the Director to list a species as one of special concern when, as here, the species has "suffered a decline that could threaten the species if allowed to continue unchecked."[3]

The horseshoe crab must be listed under MESA because it has suffered a decline that, if left unchecked, will threaten the species. In Massachusetts the horseshoe crab experiences myriad concrete and species-specific threats, including the biomedical industry, sea level rise, harvest for bait, climate change, and coastal development. Evidence suggests a decades long downward population trend of Massachusetts' horseshoe crabs, which is projected to decrease further in the future. Other states, the IUCN, and Nature Serve have listed New England horseshoe crabs, which MESA weighs in favor of the 'rarity' criteria. Since the horseshoe crab faces many threats, is much depleted, and is rare in the eyes of MESA, MassWildlife must list it as a species of special concern.

A. The Horseshoe Crab is Eligible for Listing

The horseshoe crab is eligible for MESA listing. A species is eligible if it is a native plant or animal that has been documented within Massachusetts in the last 25 years and has habitat within the state. The horseshoe crab is eligible for listing because it is an extant animal native to Massachusetts. Massachusetts beaches and state jurisdictional oceans are habitat for the horseshoe crab's reproduction, foraging, and shelter.

B. Threats to the Horseshoe Crab are Numerous, Concrete, Specific, and Severe

The MESA guidelines provide that "[c]oncrete, species-specific threats must be identified for any given listing proposal."[4] Primary threats identified by the guidelines include habitat loss and degradation, and population-threatening levels of disruption of nesting, breeding, and feeding.[5] The threats posed to the Massachusetts horseshoe crab by the biomedical industry, bait industry, climate change, sea level rise, and coastal development are each substantial on their own. Unfortunately for the crab, each of these threats is currently intensifying. Combined, these myriad, escalating threats paint a dire picture for Massachusetts horseshoe crab populations.

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[1] 321 CODE OF MASS. REGS. § 10.01(2) (West 2023)
[2] *Id.* § 10.03(5)
[3] *Id.* § 10.03(6)(c) ("The Director *shall* list as a species of Special Concern any species of plant or animal which has been documented by biological research and inventory to have suffered a decline that could threaten the species if allowed to continue unchecked or that occurs in such small numbers or with such a restricted distribution or specialized habitat requirements that it could easily become threatened within Massachusetts." [emphasis added]).
[4] NATURAL HERITAGE & ENDANGERED SPECIES PROGRAM LISTING ENDANGERED SPECIES IN MASSACHUSETTS 11 (2008) (hereinafter Mesa Listing Guidelines).
[5] *Id.*

The harvest for bleeding by the biomedical industry is a concrete and unique threat to Massachusetts horseshoe crabs. That the threat is species-specific needs no explanation: other species are not tapped for their highly valuable blood. Bleeding is a concrete threat because up to 30% of crabs whose blood is drawn die.[6] Since data is confidential, the public does not know what percentage of bled crabs die in Massachusetts.

The threat posed by the biomedical industry is increasing in Massachusetts. In 2008 New Jersey, home to one of the most substantial horseshoe crab populations, closed its shores to horseshoe crab bleeding.[7] This move limited horseshoe crab supply for the biomedical industry, which increased pressure on New England populations. This increased pressure resulted in the opening of a second bleeding facility in Massachusetts in the summer of 2022.[8] Since the data is confidential, the public cannot know how much the biomedical bleeding threat has increased with the opening of a second facility. There is no current quota or limit on biomedical bleeding of horseshoe crabs in Massachusetts.[9] But two facilities surely poses a larger threat to the population than one.

Massachusetts is an outlier from other states when it comes to bait harvesting. Harvest has decreased in all other northeast states with a fishery (Rhode Island, Connecticut, and New York) since 2016.[10] Of the mid-Atlantic states that harvest for bait, Maryland, Delaware, and parts of Virginia prohibit harvest of female crabs.[11] New Jersey, South Carolina, and Georgia have no bait harvest whatsoever.[12] The Massachusetts harvest, in contrast, has increased significantly, from 110,000 in 2016 to 156,000 in 2021.[13] From 2016 to 2021, no other state saw an increase in bait harvest without prohibiting harvest of female crabs. While the bait industry declines in other states, its intensification in Massachusetts continues to threaten horseshoe crab populations.

NOAA ranked the horseshoe crab as having as having a "very high" vulnerability to climate change-associated risks, such as sea level rise.[14] Sea level rise, combined with coastal hardening, and existing erosion are threats that, when combined, will squeeze horseshoe crabs' essential spawning habitat into progressively smaller areas. As a baseline, nearly four-fifths of Massachusetts' ocean-facing beaches are currently experiencing erosion.[15] On the seaward side, sea level rise will cause the ocean to progress further up the beach. On the landward side, coastal

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[6] Jordan Krisfalusi-Gannon et al., *The Role of Horseshoe Crabs in the Biomedical Industry and Recent Trends Impacting Species Sustainability*, 5 FRONTIERS IN MARINE SCI. (2018).
[7] 2021 REVISION TO THE ADAPTIVE RESOURCE MANAGEMENT FRAMEWORK AND PEER REVIEW REPORT, ASFMC 17 (2021).
[8] *See id*. at 5 (2018); David Abel, *They're Bleeding Horseshoe Crabs on the Cape and Some Advocates are Worried*, BOSTON GLOBE (July 17, 2022).
[9] 2019 HORSESHOE CRAB BENCHMARK STOCK ASSESSMENT AND PEER REVIEW REPORT, ASFMC 6 (2019).
[10] REVIEW OF THE INTERSTATE FISHERIES MANAGEMENT PLAN: 2021 FISHING YEAR, ASFMC 6 (2021).
[11] *Id*.
[12] *Id*.
[13] *Id*.
[14] *Horseshoe Crab* – Limulus Polyphemus, NOAA, https://www.st nmfs.noaa.gov/Assets/ecosystems/climate/images/species-results/pdfs/Horseshoe_Crab.pdf
[15] James F. O'Connell, *Shoreline Armoring Impacts and Management Along the Shores of Massachusetts and Kauai*, *Hawaii*, *in* PUGET SOUND SHORELINES AND THE IMPACTS OF ARMORING – PROCEEDINGS OF A STATE OF THE SCIENCE WORKSHOP 67, 70 (Hugh Shipman et al. eds., 2009).

hardening to protect property will prevent new sediment from nourishing beaches and will prevent beaches from migrating inland.[16] Since horseshoe crabs need beaches to reproduce, any reduction of beaches will negatively impact the species. While some of Massachusetts' horseshoe crab populations reside within wildlife refuges with minimal coastal development, many do not. As sea levels rises, and as property owners seek to protect their buildings, horseshoe crab spawning beaches will shrink. This is the sort of "habitat loss and degradation" MESA weighs in favor of listing.[17]

No other species faces the concrete, species-specific, intensifying, and combined threats from biomedical bleeding, bait harvesting, and spawning habitat disappearance. These multiple threats to horseshoe crabs will not be mitigated without the legal protection afforded by MESA.

C. Data Suggests a Downward Population Trend of Massachusetts' Horseshoe Crab

There is enough data to show a long-term pattern of decline in the Massachusetts population of horseshoe crabs. MESA weighs a long-term, downward population trend in favor of listing.[18] The downward population trend "must be documented across multiple years, often decades."[19] However, the MESA guidelines do not require perfect data. Instead, the Guidelines recognize that "[n]ot all desirable biological information will be available for all species."[20] The Guidelines also allow a downward population trend to be "extrapolated from mortality rate or other demographic data."

i. Existing Data Shows a Downward Population Trend in New England

Though the existing data is imperfect, it demonstrates and projects a decreasing population of horseshoe crabs in New England.[21] This data has convinced the IUCN, Nature Serve, and scientists to categorize horseshoe crabs as vulnerable because of alarming drops in population.

A 2016 meta-study on the conservation status of the horseshoe crab concluded that it is vulnerable to local extirpation, with the risk "elevated in the New England area as evidenced by continuing declines understood to be caused by over-harvest."[22] This study used dozens of data sets to determine population trends. Every data set was selected by the Atlantic States Marine Fisheries Council. Data from New England went back to 1959. Results showed that if New England's horseshoe crab population continues the trajectory it has been on since 1959, it will be reduced by 92% from current levels in the next 40 years.[23] A recent study confirmed the vulnerability of New England's crabs, finding that the Long Island Sound population was

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[16] *See id*. at 66–67.
[17] *See* MESA Listing Guidelines at 11.
[18] 321 CODE OF MASS. REGS. § 10.03(5)(b) (West 2023); Mesa Listing Guidelines at 10–11.
[19] *Id.*
[20] MESA Listing Guidelines at 3.
[21] Unfortunately, there is not long-term data specifically focused on the population of horseshoe crabs in Massachusetts. While there is better data on New England horseshoe crabs than Massachusetts in particular, the data tends to come from surveys that are targeted at species other than horseshoe crabs.
[22] David R. Smith *et al*., *Conservation Status of the American Horseshoe Crab (*Limulus Polyphemus*): a Regional Assessment*, REVS. IN FISH BIOLOGY & FISHERIES 135, 157 (2016).
[23] *Id*. at 159.

"breeding well below its intrinsic rate of growth."[24] This data demonstrates that Massachusetts' horseshoe crab populations have been dropping for decades and will continue to drop without legal protection.

Both the IUCN and NatureServe show concern over the population of New England horseshoe crabs. Because the MESA guidelines "draw upon other major systems used in the assessment of extinction risk, particularly the systems of NatureServe and the International Union on the Conservation of Nature," MassWildlife should give substantial weight to both these organization's determinations when listing the horseshoe crab.[25]

The IUCN Red List listed the horseshoe crab as threatened in 2016.[26] It found that the mid-Atlantic population of horseshoe crabs experienced "significant declines" with declines "highest in the New England area."[27] NatureServe has yet to determine the horseshoe crab's conservation status in Massachusetts, Maine, New Hampshire, or Rhode Island populations. However, New York's population is threatened, and nearby Connecticut's population is imperiled.[28] NatureServe defines imperiled as a "high risk of extinction or collapse[.]"[29]

ii. The Male-Biased Sex Ratio is a Demographic Proxy Suggesting Pressures on Population

The MESA Guidelines allow a downward population trend to be "extrapolated from mortality rate or other demographic data."[30] The high female to male ratio of horseshoe crabs in Massachusetts is "other demographic data" that suggests prolonged overharvesting of this species.

Females are preferred by both fishers and the biomedical industry because they are substantially larger, and therefore have more bait and blood than males. When females are preferentially selected out of the population, the ratio of males to females increases. The average sex ratio in unharvested populations is 1.5-2.4 males per female.[31] Populations in Massachusetts have an "extremely male-biased sex ratio," with surveys showing a 9:1 ratio in Pleasant Bay.[32] Highly biased sex ratios have negative consequences for populations. If there is a population of 100,000 crabs with an equal sex ratio, 50,000 females can spawn. If the overall population is the same,

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[24] J. Mattei *et al*., *The Power of Citizen Science: 20 Years of Horseshoe Crab Community Research, Merging Conservation, Education, and Management*, *in* INTERNATIONAL HORSESHOE CRAB CONSERVATION AND RESEARCH EFFORTS: 2007-2020 (J. T. Tanacredi et al., eds. 2022).
[25] MESA Listing Guidelines at 2 (internal citations omitted).
[26] *American Horseshoe Crab*, IUCN RED LIST, https://www.iucnredlist.org/species/11987/80159830#assessment-information.
[27] *Id*. at 2.
[28] Limulus Polyphemus, NATURESERVE EXPLORER, https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.111326/Limulus_polyphemus.
[29] *Statuses*, NATURESERVE EXPLORER, https://explorer.natureserve.org/AboutTheData/DataTypes/ConservationStatusCategories.
[30] MESA Listing Guidelines at 3.
[31] Smith, *supra* note 22, at 146.
[32] Mary-Jane James Pirri, *Seasonal Movement of the American Horseshoe Crab* Limulus Polyphemus *in a Semi-Enclosed Bay on Cape Cod, Massachusetts (USA) as Determined by Acoustic Telemetry*, 56 (5) CURRENT ZOOLOGY 575, 576 (2010).

yet there is a 9:1 sex ratio, only 10,000 females can spawn. This means 80% fewer eggs, which means far fewer horseshoe crab larvae and less food for animals that depend on those eggs.

Even though females comprise a small part of the overall population, 43.5% of the crabs bled by the biomedical industry in 2021 were females.[33]

Given the striking male-biased demographic data, the conservation status by the IUCN and Nature Serve, and the science demonstrating the vulnerability of New England's horseshoe crabs, there is plenty of evidence to show that the horseshoe crab has experienced a decades long downward population trend.

D. The Horseshoe Crab Exhibits Some Traits of Rarity, as Defined by MESA

The horseshoe crab is not rare *per se*. Yet under the MESA guidelines, the horseshoe crab exhibits some traits of rarity. MESA views the listing of a species by the IUCN, Nature Serve, or other states as informative to whether a species is rare in Massachusetts.[34] The MESA guidelines weigh in favor of listing when species is at the edge of its range in Massachusetts. [35] Massachusetts is the edge of a genetic subgroup of horseshoe crabs. Lastly, MESA does not require a species to be rare to get legal protection.

i. Listing Determinations by Other Entities Support Rarity Under MESA

MESA views listing determinations and conservation efforts in other states as informative to whether the species should be listed in Massachusetts.[36] The IUCN lists the horseshoe crab as threatened and Nature Serve lists it as imperiled in Connecticut and threatened in New York. Maine, New Hampshire, Rhode Island, Connecticut, Delaware, Maryland, and South Carolina have all classified the horseshoe crab as a Species of Greatest Conservation Need under their state wildlife plans. Connecticut listed the species as a species of special concern under that state's endangered species act. Just this month, the Connecticut legislature voted unanimously to ban nearly all harvest of horseshoe crabs.[37] New Jersey bans all harvest.[38] South Carolina bans all non-medical harvest. [39] Massachusetts should heed the warnings from the IUCN and Nature Serve and follow the leadership of other states by listing the horseshoe crab.

ii. Horseshoe Crabs Have a Limited Ability to Disperse

Evidence shows that horseshoe crabs have a limited ability to disperse to new habitats. For example, Chesapeake Bay and Delaware Bay are next door to one another with no significant barriers between them. Yet genetic analysis has shown the populations of horseshoe crabs in

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[33] REVIEW OF THE FISHERIES *supra* note 10, at 7.
[34] *Id*. at 10.
[35] Mesa Listing Guidelines at 9–10.
[36] *Id*. at 10.
[37] John Moritz, *Connecticut Lawmakers Pass Ban on Horseshoe Crab Harvest as Numbers Decline in Long Island Sound*, CT INSIDER (June 1, 2023) https://www.ctinsider.com/politics/article/ct-horseshoe-crabs-harvest-ban-long-island-sound-18129812.php?src=ctiartribbon,
[38] REVISION TO THE ADAPTIVE MANAGEMENT FRAMEWORK, *supra* note 7, at 17.
[39] S.C. CODE ANN. § 50-5-1330 (2019) (West 2023).

these two bays are almost isolated from one another, with few crabs moving from one population to the other.[40] When crabs do migrate from one area to another, they are more likely to be males.[41] Since females and larval crabs are unlikely to migrate far in their lifetimes, there is limited potential for horseshoe crabs to recolonize an area if they have been extirpated from it. Evidence suggests that Massachusetts' horseshoe crab populations may be similarly isolated from one another.[42]

Scientists have determined there are six genetically distinct subgroups of horseshoe crabs.[43] Massachusetts represents the northernmost edge of the Mid Atlantic genetic subgroup, which extends to the Carolinas.[44] Since Massachusetts is at the edge of the genetic subgroup, and since horseshoe crabs have a limited ability to disperse and recolonize areas, Massachusetts will lose invaluable and unique genetic adaptations if it allows populations of its horseshoe crabs to disappear from its coast.

While the horseshoe crab is not at the edge of its range in Massachusetts, being at the edge of the genetic subgroup along with limited dispersal ability should weighs in favor of rarity under MESA.

iii. Rarity is Not Required For Listing Under MESA

Even if MassWidlife does not find the horseshoe crab to be rare under MESA, MassWildlife should still list the horseshoe crab as a Species of Special Concern. A species need not be rare to be listed under MESA. The first sentence of MESA's guiding principles state that the "Massachusetts List of Endangered, Threatened, and Special Concern Species is more than simply a list of rare species."[45] The MESA guiding principles go on to say that "rarity is but one criterion" used for listing, and that "listing a species with many populations in the state may be reasonable when most of the populations are small, declining, or threatened."[46]

Other species of special concern in Massachusetts have a much wider global distribution than the horseshoe crab, including the peregrine falcon ("one of the most widely distributed birds in the world")[47] and the mountain alder ("a circumboreal species").[48] MassWildlife should not let the apparent commonness of the horseshoe crab preclude it from being listed as a species of special

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[40] J. C. Pierce et al., *Delaware Bay and Chesapeake Bay Populations of the Horseshoe Crab* Limulus Polyphemus *are Genetically Distinct*, 23 ESTUARIES 690 (2000).
[41] Tim L. King et al., *Regional Differentiation and Sex-Biased Dispersal Among Populations of the Horseshoe Crab*, 134 TRANSACTIONS OF THE AM. FISHERIES SOC'Y 441, 441 (2005).
[42] *See* Katherine Terkanian Johnson, *Population Genetic Analysis of Atlantic Horseshoe Crabs (*Limulus Polyphemus*) in Coastal Massachusetts*, UNIV. OF MASS. AMHERST (2016).
[43] King, *supra* note 41, at 449.
[44] *See* M. T. James-Pirri et al., *Spawning Densities, Egg Densities, Size Structure, and Movement Patterns of Spawning Horseshoe Crabs,* Limulus Polyphemus*, within Four Coastal Embayments on Cape Cod, Massachusetts*, 28 (2) ESTUARIES 296, 296 (2005); King, *supra* note 41, at 441.
[45] MESA Listing Guidelines at 3 (underline in original).
[46] *Id*. at 3.
[47] *Peregrine Falcon*, NATURAL HERITAGE & ENDANGERED SPECIES PROGRAM (2019), https://www.mass.gov/doc/peregrine-falcon-factsheet/download.
[48] *Mountain Alder*, NATURAL HERITAGE & ENDANGERED SPECIES PROGRAM (2015), https://www.mass.gov/doc/mountain-alder/download.

concern, especially considering the increasing threats, downward population trend, and substantial ecological importance of the species. The MESA guidelines allow listing of non-rare species.

II. Ecological Importance of the Horseshoe Crab

Beyond the inherent value of horseshoe crabs as a species, horseshoe crabs are vital to the health of Massachusetts' coastal ecosystems. They are a keystone species that sustains numerous listed species.

The eggs of horseshoe crabs are literally lifesaving for migratory shorebirds, like the federally threatened rufa red knot. The red knot has one of the longest migrations in the world, from the tip of South America to the Canadian Arctic.[49] They fly non-stop for nearly a week across the Atlantic Ocean from Brazil to the eastern seaboard of the U.S. The red knots time their migration to coincide with spawning horseshoe crabs. Under ideal circumstances, the red knots gorge themselves on hundreds of thousands of eggs during their stopover. They can double their body weight in two weeks.[50] This sustenance is essential to fuel the rest of their arduous migration to their arctic breeding ground. Red knots that do not eat enough horseshoe crab eggs either fail to finish the migration or are so emaciated upon arriving in the arctic they fail to reproduce.[51]

Massachusetts used to support thousands of spring migrating red knots.[52] Current spawning horseshoe crab densities in Massachusetts are too low to nourish migrating red knots. Short-billed shorebirds, like the red knot, require "'superabundant' prey densities" of horseshoe crabs to access enough nutritious eggs to sustain migrations.[53] Horseshoe crabs lay eggs deeper than four inches into the sand. Due to their short bills, red knots can only reach about one inch under the beach surface, leaving the eggs out of reach.[54] When the horseshoe crab population is sufficiently dense, the constant digging of egg-laying females tills already-laid clusters of eggs to the surface. This constant tilling makes previously inaccessible eggs accessible to the red knot and other shorebirds. Without dense populations of horseshoe crabs, migrating shorebirds like the red knot will continue to suffer. Semipalmated sandpipers, ruddy turnstones, short-billed dowitchers, whimbrels, and Hudsonian godwits are other species of rapidly decreasing shorebirds that also rely on horseshoe crab eggs.

The red knot and other migrating birds also rely on eating horseshoe crab larvae on their fall migration through Massachusetts. A 1912 account claimed that the population of south-bound

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[49] *The Red Knot*, NAT'L PARK SERV., https://www.nps.gov/caco/learn/nature/the-red-knot htm#:~:text=Historically%2C%20thousands%20of%20red%20knots,migration%20(July%2DSeptember).
[50] U.S. FISH & WILDLIFE SERV., SPECIES STATUS ASSESSMENT REPORT FOR THE RUFA RED KNOT (CALIDRIS CANUTUS RUFA) 54 (2020).
[51] *See* Sjoerd Duijns et al., *Body Condition Explains Migratory Performance of a Long-Distance Migrant*, 284 PROC. OF THE ROYAL SOC'Y B (2017).
[52] *The Red Knot*, NAT'L PARK SERV., https://www.nps.gov/caco/learn/nature/the-red-knot htm#:~:text=Historically%2C%20thousands%20of%20red%20knots,migration%20(July%2DSeptember).
[53] Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Rufa Red Knot (Calidris Canutus Rufa) 86 Fed. Reg. 37410, 37417 (July 15, 2021).
[54] Id. at at 37416.

red knots was "so large on Cape Cod that estimates were useless."[55] While south-bound knots still return to Massachusetts, they are do so in far fewer numbers than they did historically.[56]

When abundant, horseshoe crabs are the primary food of the loggerhead turtle, which is listed as threatened under MESA and the federal ESA. Fewer horseshoe crabs means fewer threatened loggerheads in Massachusetts.

Massachusetts should take the necessary step of giving legal protection to the horseshoe crab to restore its shorebird and turtle populations.

III. Conclusion

Horseshoe crabs easily qualify as a species of special concern under MESA. The numerous threats of increasing severity, decades-long downwards population trend, and Massachusetts' isolated population at the edge of the Mid Atlantic subgroup's range together demonstrate that the horseshoe crab has "suffered a decline that could threaten the species if allowed to continue unchecked."[57] As such, MassWidlife must list the species as a species of special concern under MESA.

Sincerely,

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[55] Brian A. Harrington et al., *Changing Use of Migration Staging Areas by Red Knots: An Historical Perspective from Massachusetts*, 33(2) WATERBIRDS: THE INT'L J. OF WATERBIRD BIOLOGY 188, 188 (2010).
[56] *Id*.
[57] 321 CODE OF MASS. REGS. § 10.03(6)(c) (West 2023).