

**Species Listing PROPOSAL Form:**  
**Listing Endangered, Threatened, and Special Concern Species in Massachusetts**

Scientific name: *Heterodon platirhinos*

Current Listed Status (if any): None

Common name: Eastern Hog-nosed Snake

Proposed Action:

☒ Add the species, with the status of: SC

☐ Remove the species

☐ Change the species' status to: \_\_\_\_\_

Change the scientific name to: \_\_\_\_\_

Change the common name to: \_\_\_\_\_

(Please justify proposed name change)

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Association, Institution or Business represented by proponent:

**Natural Heritage and Endangered Species Program, Massachusetts Division of Fisheries and Wildlife**

Proponent's Signature: 

Date Submitted: July 8, 2018

Please submit to: Natural Heritage & Endangered Species Program, Massachusetts Division of Fisheries & Wildlife, 1 Rabbit Hill Road, Westborough, MA 01581

**Justification**

**Justify the proposed change in legal status of the species by addressing each of the criteria below, as listed in the Massachusetts Endangered Species Act (MGL c. 131A) and its implementing regulations (321 CMR 10.00), and provide literature citations or other documentation wherever possible. Expand onto additional pages as needed but make sure you address all of the questions below. The burden of proof is on the proponent for a listing, delisting, or status change.**

**Brief introductory statement:** Whether or not *Heterodon platirhinos* warrants special protection in Massachusetts has been a subject of debate for at least 30 years (Michener and Lazell 1989; L. Erb, pers. comm.; T. French, pers. comm.; C. Buelow, pers. comm.; Tynning 2013; Mirick et al. 2016; NHESP 2018). The species has probably always been relatively uncommon, as well as difficult to find, in most areas of its natural occurrence Massachusetts, as it is limited in distribution to fire-maintained pine-oak communities on areas of deep sand deposits, such as glaciofluvial lake deltas, outwash plains, and postglacial deposits of eroded outwash coastal sediments. Both pitch-pine scrub oak barrens and open-canopy, early-successional habitats have been drastically declining throughout Massachusetts, in some regions <10% of historical pine barrens remain (Motzkin et al. 1999). It is possible that the decline of pine barrens and open habitats, resulting from wildlife control and lack of disturbance, allowed habitats to transition to closed canopy habitats with mesic soils and more leaf litter (Akresh, UMass, pers. comm.). Recent telemetry studies in Franklin and Barnstable Counties, and southern New Hampshire, have revealed that adult snakes use tens of hectares of upland habitat on average in a given year, providing additional insight into why the species appears to have been extirpated from large

areas of fragmented sandplain habitats in Hampden, Hampshire, Norfolk, and Barnstable Counties. Recent telemetry studies (Akresh et al. 2017) also found that individuals in open habitat have smaller annual home ranges. While it does not appear that the species is at immediate risk of extirpation from the entire State, and several potentially viable populations persist, there is evidence of a historical trend of range contraction in several counties and apparent extirpation of formerly documented occurrences, and clear biological links between population decline and habitat fragmentation. Recognizing the limitations of available trend data, it is still my judgment that the species warrants protection in Massachusetts as a Species of Special Concern. To prepare this assessment and proposal, I used all reported occurrences of *Heterodon platirhinos* from the Natural Heritage and Endangered Species Program (NHESP) databases, Massachusetts Herpetological Atlas (MHA), museum collections (Global Biodiversity Information Facility; vertnet); and expert surveys. Not all of the information gathered for this status assessment has been independently verified or confirmed by photograph or specimen. I would also note its overall status in New England: *Heterodon platirhinos* is not native to Maine or Vermont, is Endangered in New Hampshire, is a Species of Special Concern in Connecticut, and is of undetermined status in Rhode Island (S. Buchanan, RI DEM, pers. comm.). This proposal is based upon earlier efforts by NHESP scientists, especially Lori Erb, to document the status of this species in Massachusetts, and was greatly improved by technical review and contributions by Michael Akresh at the University of Massachusetts Amherst; Robert Cook with the National Park Service (retired); Scott Buchanan, Rhode Island State Herpetologist; and Tom Tynning from Berkshire Community College.

**(1) Taxonomic status. Is the species a valid taxonomic entity? Please cite scientific literature.**

The Eastern Hog-nosed Snake *Heterodon platirhinos* (Latreille 1801) is a well-supported, valid species within the widespread family Dipsadidae, subfamily Heterodontinae (formerly Colubridae; Figure 1). First described by Linnaeus in 1766 as *Coluber simus*, frequent changes in taxonomy between 1801 and 1948 have reflected taxonomic errors and misunderstandings rather than uncertainty regarding evolutionary distinctiveness (Platt 1985). Although the phylogenetic relationships of genus *Heterodon* to other Heterodontine genera (*Carphophis*, *Diadophis*, *Farancia*, and *Contia*) remain unclear, each genus is clearly monophyletic. Further, the three living species within *Heterodon*—*H. platirhinos* (Eastern Hog-nosed Snake), *H. simus* (Southern Hog-nosed Snake), and *H. nasicus* (Western Hog-nosed Snake)—are estimated to have diverged 11 million years before present (Zheng and Wiens 2016) and are generally well-supported (Ernst and Ernst 2003). Further, *Heterodon* is estimated to have diverged from the genus *Carphophis*, its closest living relative in Massachusetts, between 27.6 and 38.9 million years ago (Pook et al. 2009; Chen et al. 2014. Zootaxa 3881(6): 532–548; Zheng and Wiens 2016, *op. cit.*). In summary, *Heterodon platirhinos* is a relatively ancient (Miocene), conserved lineage without taxonomic or phylogenetic ambiguity.

**(2) Recentness of records. How recently has the species been conclusively documented within Massachusetts?**

As described in detail below, *Heterodon platirhinos* has been conclusively documented in Massachusetts this year (2018) from sites in Franklin and Barnstable Counties, and as recently as 2017 from sites in Montague (Franklin County), Townsend (Middlesex County), Plymouth (Plymouth County), and Bourne (Barnstable County). The species was observed as recently as 2016 in Bourne, Mashpee, and Provincetown (Barnstable County). There is no question or ambiguity that the species is conclusively extant in the Commonwealth at the time of the writing of this version of the listing proposal (i.e., July 2018; Table 1; Maps 1–3).

**(3) Native species status. Is the species indigenous to Massachusetts?**

The unambiguous native status *Heterodon platirhinos* to the Commonwealth of Massachusetts is corroborated by historical reports as well as clear, regional, biogeographic trends (Lazell 1976; Michener and Lazell 1989; Ernst and Ernst 2003). *Heterodon* was not among the species listed in Smith's (1835) first reptile catalogue from Hitchcock's *Report on the Geology, Mineralogy, Botany, and Zoology of Massachusetts*. Rather, it was first included in Storer's (1840) list of native reptiles, based on a specimen from Medfield in the possession of Dr. J.E. Holbrook, author of *North American Herpetology* (1842). The species is also unquestionably native to

several adjacent states including New Hampshire (Michener and Lazell 1989; LaGory et al. 2009), Connecticut (Klemens 1993), Rhode Island (Raithel 2015), and New York. Considering the larger biogeographic context, it appears indisputable that the species is native at least to the Connecticut, Blackstone, Taunton, Nashua, and Merrimack basins and the mainland coastal plain of Massachusetts. *H. platirhinos* is absent from suitable habitat on major offshore islands in New England (such as Nantucket, Martha's Vineyard, the Elizabeth Islands, etc.), suggesting the species colonized southern New England relatively late, and is not able to disperse long distances across seawater (see Lazell 1979). Several islands from which the species is known, such as Fire Island (NY) and Assateague Island (MD) (R. Cook, NPS, pers. comm.), and the Outer Banks (NC; Lazell 1979) were formerly spits of land connected to the mainland. I am not aware of fossil or subfossil remains of *Heterodon* in Massachusetts, which would more clearly substantiate the date of colonization in New England.

**(4) Habitat in Massachusetts. Is a population of the species supported by habitat within the state of Massachusetts?**

Extant populations are supported by the natural habitats of Massachusetts, including Pitch Pine-Scrub Oak (*Pinus rigida-Quercus ilicifolia*) associations, ericaceous scrub, and other forested and nonforested habitats of glacial lake deltas, glacial outwash plains, and eroded glacial sediments reorganized by longshore drift. The species is found naturally in both forested and nonforested habitats in Massachusetts and adjacent New Hampshire (Michener and Lazell 1989; LaGory et al. 2009; NHFG 2015; Mirick et al. 2016)(Figure 2, Figure 3). Wetlands are often a key habitat feature for *H. platirhinos* because they support populations of amphibian prey species, especially toads (R. Cook, NPS, pers. comm.).

**(5) Federal Endangered Species Act status. Is the species listed under the federal Endangered Species Act? If so, what is its federal status (Endangered or Threatened)**

*Heterodon platirhinos* is not listed at the federal level, nor has it been proposed for federal listing.

**(6) Rarity and geographic distribution.**

**(a) Does the species have a small number of occurrences (populations) and/or small size of populations in the state? Are there potentially undocumented occurrences in the state, and if so, is it possible to estimate the potential number of undocumented occurrences?**

*Heterodon platirhinos* is known from approximately 15 to 20 extant sites across the Commonwealth. It is possible that some currently extant sites are currently unknown, and some historic sites without recent reports are probably still extant. Only two sites, one in Montague (Franklin County) and one in the Province Lands of Barnstable County, have been intensively studied. Populations in the Province Lands (Provincetown and Truro), Wellfleet, and Montague appear to be large and relatively robust (Buchanan et al. 2013; Akresh et al. 2017; Cook, unpubl. data 2017; Buchanan et al. 2017). The population (or populations) in Camp Edwards Wildlife Management Area (WMA) in Bourne, Myles Standish State Forest and adjacent areas of Plymouth and Carver, and certain areas of Franklin County appear to be extensive and may be viable with appropriate habitat management. Most other occurrences are apparently small, and many are historic or nearly historic (i.e., not observed for more than 25 years, see Table 1; Maps 1–3).

It is not possible to estimate the number of undocumented occurrences without a statewide, systematic, and randomized sampling effort. Large patches of pitch pine-scrub oak barrens and/or sandy glacial outwash in Hampshire County could support unknown occurrences. However, most unmanaged patches of sandy soils are likely degraded and have mostly closed-canopy habitat. However, regarding standardized surveys, it should be noted that *H. platirhinos* is difficult to detect.

**(b) What is the extent of the species' entire geographic range, and where within this range are Massachusetts populations (center or edge of range, or peripherally isolated)? Is the species a state or regional endemic?**

*Heterodon platirhinos* has a large range in the eastern United States and southern Canada, ranging from southern New England to peninsular Florida, west to the Edwards Plateau of central Texas, and north along major river valleys to the upper Mississippi basin and possibly the southern Superior shore of Minnesota and Wisconsin. Therefore, Massachusetts populations (together with isolated and Endangered subpopulations in New Hampshire), encompass the northeasternmost extreme distribution of the genus. Documented areas of occurrence in Massachusetts tend to be discrete, clustered, and likely isolated from other areas of occurrence. Although historically, Massachusetts populations were likely contiguous with populations in New Hampshire, Connecticut, and Rhode Island, but now appear to be functionally isolated from the rest of the range by urbanization, development, and declining availability and degradation of pine barrens throughout the region. Several (if not most) remaining populations appear to be isolated from one another, and from the core of the species' range, which reaches to southern New England.

Within Massachusetts, *Heterodon platirhinos* is native to low-elevation (<300 m), sandplain habitats of the mainland east of Berkshire County and the Berkshire Plateau, including most of Cape Cod (*H. platirhinos* may have been native to most sandplain habitats on Cape Cod; R. Cook, NPS, pers. comm.). Confirmed or corroborated occurrences are known from Franklin, Hampshire, Hampden, Worcester, Middlesex, Norfolk, Bristol, Plymouth, and Barnstable Counties. There are no records from Dukes or Nantucket County, and in fact, *H. platirhinos* has not been recored from offshore islands in Massachusetts. Lazell (1976) suggested that Hog-nosed Snakes are absent from the outlying islands in Massachusetts and Rhode Island because they are poor dispersers across seawater and they arrived in New England after the major islands were isolated from the mainland by postglacial sea level rise. However, mirroring other patterns of amphibian and reptile biogeography (as seen in Eastern Mud Turtle and Eastern Tiger Salamander) *H. platirhinos* is native to Long Island (Robert Cook, NPS, pers. comm.), and the species appears to be relatively salt-tolerant and has even been observed in the surf at Assateague Island, MD (R. Cook, NPS, pers. comm.). There are no records from Essex County, although the species is well-documented in portions of the Merrimack and Nashua River Valleys in Middlesex County (Michener and Lazell 1989) and New Hampshire.

*Heterodon platirhinos* is not a Massachusetts endemic species.

## **(7) Trends.**

**(c) Is the species decreasing (or increasing) in state distribution, number of occurrences, and/or population size? What is the reproductive status of populations? Is reproductive capacity naturally low? Has any long-term trend in these factors been documented?**

The reproductive status and demography of *Heterodon platirhinos* has been quantitatively evaluated in Massachusetts only at the Province Lands (Buchanan et al. 2013). Also, the distribution of the species has not been studied using standardized sampling or randomized study design. However, *Heterodon* clearly appears to have declined across Massachusetts in recent decades, evidenced by aggregated and clustered areas of Hampden, Hampshire, Norfolk, Bristol, and Barnstable Counties where the species has not been reported for more than 25 years, and even larger areas where the species has not been observed in at least 20 years. In the following paragraphs, I outline the evidence for decline at the county level, roughly proceeding from west to east:

### *Berkshire County*

There are no valid reports of *Heterodon* from Berkshire County, although Klemens (1993) reported a current town record from Salisbury, Litchfield County, Connecticut, which borders Sheffield and Mount Washington, Berkshire County, Massachusetts.

### *Hampden County*

The earliest reports on Massachusetts reptiles (Smith 1835 in Hitchcock's *Report on the Geology, Mineralogy, Botany, and Zoology of Massachusetts*; Storer 1840) contained little or no information on *Heterodon*

*platirhinos*. But three decades later, writing in 1868 concerning the reptiles of the Springfield area, J.A. Allen provided a very different perspective on an animal confined to sand plains, but numerous in such habitats:

“*Heterodon platyrhinos* Latreille. Hog-nosed Snake. “Blowing Adder.” “Flat-head.” Common. Especially numerous on our dry sandy plains, where it is the most abundant species.... Dr. Storer states in his (1839) Report that he had never seen a specimen of this animal, but says he is assured by Dr. Holbrook that he (the latter) possessed a specimen captured at Medfield. It also occurs quite plentifully, as I have recently learned, in the sandy regions of Barnstable County. I was surprised to find, a few years since, that its existence in Massachusetts was generally doubted by the naturalist in the eastern part of the State (Allen 1868).”

Further substantiating Allen’s description are six *Heterodon platirhinos* specimens from Springfield in the MCZ collected by Allen in the 1860s (MCZ R2261; R2288; R153959; R177361–177364) and an additional specimen collected by Solomon Stebbins before 1929 (MCZ R5608). The last Springfield specimen that I am aware of was found in August 1970 in the North Branch area and brought to Al Richmond (T. Tynning, BCC, pers. comm.). Elsewhere in Hampden County, *Heterodon* was subsequently reported from West Springfield (Stull 1926); Wilbraham (A.M. Richmond report to MHA\* 1992); Hampden (J.T. Reynolds 1976; T. Tynning, BCC, pers. comm.); Westfield (Welch and Welch report to MHA 1993). According to A. Richmond (UMass Amherst), Hog-nosed Snakes were “fairly common” in Wilbraham in the 1950s–1970s but have subsequently become scarce in the areas along the Chicopee River. An individual was found at Laughing Brook Sanctuary in Hampden in May 1977 (T. Tynning, BCC, pers. comm.). Three records between 1996 and 2014 from Monson (Coughlin report to MHA 1996; Brown report to MHA 1996; NHESP A2808) indicate that the species is still extant in Hampden County (see Figure 1, Figure 2). However, the overall picture is of widespread decline associated with the urbanization of the Greater Springfield area and two of the three Monson records, from 1996, are within three years of becoming historic. Klemens (1993) provides a record from Hartland, Hartford County, Connecticut, approximately 2 km from Granville, Hampden County, Massachusetts.

#### *Hampshire County*

Historically, *Heterodon* was probably broadly distributed on sandy soils throughout Hampshire County, with historic records from Hadley, Williamsburg, and Northampton (Stull 1926) and more recent records from Northampton (Sanders, Morrison, and Hale reports to MHA 1994–1995); Southampton (Allen report to NHESP, 1999); Amherst (B.W. Compton, unpubl. data 1995); North Amherst (T. Tynning, BCC, pers. comm.), and multiple reports from Belchertown (Edward Nied, Jr. report to MHA 1997; J. Cardoza unpubl. data 2012; T.W. French unpubl. data 2015). Of the six towns with reported occurrences, only Belchertown has sightings more recently than the 1990s.

#### *Franklin County*

Franklin County clearly encompasses a portion of the northern range limit of the genus *Heterodon* in the Northeastern United States (Ernst and Ernst 2003). *Heterodon* has been documented in three Franklin County towns, with extant population known in two towns. The species was first reported from Sunderland (reported as “Mount Toby”) by Stull (1926), but has not been reported from this area since the 1920s. There is a widespread area of occurrence New Salem, represented by 11 reports by six observers between 1994 and 2011 (Milam and Hilton reports to MHA 1994–95; Jones, Koenen, Cooper and Small reports to the NHESP 2003–2011). This area of occurrence may be contiguous with reports from Petersham (discussed under Worcester County, below). A robust and presumably stable population is known from Montague (Jones report to NHESP 2006; King and Brooks report to NHESP 2008; Akresh et al 2017), the only large and well-documented occurrence in the three counties of the Connecticut River Valley.

#### *Worcester County*

*Heterodon* has been recently reported from six towns in Worcester County, including Petersham (Koenen and Cooper reports to NHESP, 2008–2009); Ware (Nichols report to NHESP, 2007); Warren (Packard report to NHESP, 1996); Northbridge (NHESP A2710, 2014); Uxbridge (NHESP, unpubl. data 2009); and Mendon (Candela, Jr. report NHESP 2007). Worcester County is noteworthy for being the only Massachusetts county in which all towns with reported occurrences have recent *Heterodon* sightings. Among the Worcester County

towns, Petersham is unique for having two historical reports represented by museum collections, from 1914 (MCZ R10948) and 1948 (USNM 129093).

#### *Middlesex County*

*Heterodon* has been reported from three towns in Middlesex County, being recently reported from Townsend (Pettit report to NHESP 2008; Gahagan report to NHESP 2017) and Townsend (Chaney report to NHESP, 2008). A single *Heterodon* specimen was historically collected from Lexington in 1977 (MCZ R-154767), the only report from southern Middlesex County.

#### *Essex County*

I am aware of no records, and thus no trend data, from Essex County. The absence of Hog-nosed Snakes from the sandy areas of the North Shore was inexplicable to Michener and Lazell (1989), although they note that the absence is consistent with the species' range in New Hampshire. The species' historical presence in Essex County is possible because of records in the Merrimack and Nashua basins in New Hampshire (J. Megyesy, NHFG, pers. comm.). Suitable habitat occurs on Plum Island, but the species has never been reported there and is unlikely to occur.

#### *Suffolk County*

I am aware of no reports from Boston or Suffolk County.

#### *Norfolk County*

Contrary to the trend observed in Worcester County, Norfolk County is represented only by historic records from Medfield in the 1830s (Storer 1840); Dover in 1946 (MCZ R-49094); Westwood in 1944 (MCZ R-46964); Cohasset in 1880 and 1883 (MCZ R26675; MCZ R-5062), and Holbrook in 1945 (MCZ R48786). The historical record appears to clearly establish the the hog-nosed snake was widespread in Norfolk County, but the most recent observation of 1946 suggests widespread extirpation.

#### *Bristol County*

In Bristol County, *Heterodon* is known only from a 1942 specimen (MCZ R46550). Suitable habitats appear to exist throughout Bristol County, and the species is known from much of adjacent Rhode Island, but there are no known corroborated or recent areas of occurrence.

#### *Plymouth County*

*Heterodon* was reported from Wompatuck State Park in Hingham in the 1980s and 1990s (R. Campbell, pers. comm. to T.W. French). The species was also known historically (1973) from Duxbury (J. Richard, report to NHESP). Multiple, widespread occurrences are known recently from Plymouth (NHESP unpubl. data; J. Crane, pers. comm.), Carver (NHESP unpubl. data), and Wareham (B. Windmiller, Zoo New England, pers. Comm.; R. Hopping, Trustees of Reservations, pers. comm.). Wareham is also represented by a large series of six snakes in the MCZ collected by Outram Bangs in 1913 and 1914. A single report from Kingston in 2012 (NHESP A7481) suggests that the species is still locally present in northern Plymouth County. Myles Standish State Forest and the relatively unfragmented areas bordering the MSSF pine barrens provide a stronghold for *Heterodon*, and the species was reported to occur on the Massasoit National Wildlife Refuge in 2017 (K. Bouley, USFWS, pers. comm.).

#### *Barnstable County*

It is clear from available evidence that the Hog-nosed Snake historically occurred throughout the mainland portion of Cape Cod (Table 1; Maps 1–3). Today, portions of unfragmented pine barrens and dune habitats on Cape Cod remain the species' apparent strongholds in the Commonwealth. In fact, only Harwich, Gosnold, and possibly Chatham do not have formally reported occurrences. Regarding Chatham: Lazell (1976) noted the apparent absence of *Heterodon* from Monomoy, though he suspected they may be present, and there have been recent but unconfirmed reports of the species from South Monomoy (S. Koch, USFWS Eastern Massachusetts National Wildlife Refuges, pers. Comm.; USFWS CCP 2015). The species appears to be relatively widespread in the Province Lands of Provincetown and Truro (Cook, unpubl. data; Buchanan et al. 2013; Buchanan et al.

2016; Buchanan et al. 2017) and the “Wellfleet Ponds” region of Wellfleet (Cook, unpubl. data) in the Cape Cod National Seashore. Although the species is widespread in parts of Provincetown, Truro, and Wellfleet, it is also absent from large areas of the three towns. For example, there is historic evidence of *Heterodon* on Great Island in Wellfleet in 1973 (P. Rich, pers. comm. to R. Cook), but no recent information anywhere west of Route 6. Further, *H. platirhinos* have not been observed at MassAudubon’s Wellfleet Bay Wildlife Sanctuary (R. Prescott and M. Faherty, MAS, pers. comm.), and in Eastham I am aware of only one reported occurrence, from a fragmented area in 1996 (R. Cook, unpubl. data). Available data from the Mid-Cape suggests decline and possible extirpation. Although there are records from Dennis, Yarmouth, Barnstable, and Falmouth, I am aware of no recent sightings (i.e., since 1994). Two sites are illustrative of this apparent decline, although they have not been quantitatively studied. At Sandy Neck in Barnstable, Michener and Lazell (1989) reported a “good population” with densities of approximately one snake per three hectares of land. The Sandy Neck site was also described by Lazell (1976). I am not aware of any recent sighting of *H. platirhinos* on the Sandy Neck peninsula despite considerable work with Eastern Spadefoots in the past three years (S. Kortis and N. Coleman, Town of Barnstable, pers. comm.; I. Ives, MassAudubon, pers. comm.). Further, Lazell (1976) noted multiple occurrences at Ashumet Holly in Falmouth. Again despite ongoing work with Spadefoots, including drift fencing, no *Heterodon* have been observed recently (I. Ives, MassAudubon, pers. comm.). *Heterodon* appears to be widespread and regularly encountered throughout unfragmented areas of Bourne, from the Upper Cape Technical School (J. Kelly, pers. comm. to I. Ives) throughout the Massachusetts Military Reserve/Camp Edwards WMA.

#### *Dukes County*

I am aware of no reports from Dukes County and the species does not appear to have occurred naturally on Martha’s Vineyard or the Elizabeth Islands.

#### *Nantucket County*

I am aware of no reports from Nantucket County and the species does not appear to have occurred naturally on Nantucket Island or its associated island (e.g., Tuckernuck).

### **(8) Threats and vulnerability.**

**(d) What factors are driving a decreasing trend, or threatening reproductive status in the state? Please identify and describe any of the following threats, if present: habitat loss or degradation; predators, parasites, or competitors; species-targeted taking of individual organisms or disruption of breeding activity.**

Individual mortality and survivorship rates have not been well-studied across Massachusetts, although Akresh et al. (2017) provided some data on adult survival. Plummer and Mills (2000) found adult survivorship to be approximately 50% for resident (not translocated) radio-tagged snakes during an activity season slightly longer than that of Akresh et al. (2017) (i.e., 184 days) in Arkansas. Similarly, Parker and Plummer (1987) obtained an annual survivorship rate of 47% from Platt’s (1969) mark-recapture data of *H. platirhinos* in Kansas. Buchanan (2012) had a higher apparent survival rate on Cape Cod, in which only 3 of 16 radio-tracked snakes died during a period of 3063 observation days. Lastly, Rouse et al. (2011) observed that 9 of 13 radio-tracked snakes died during a study in Ontario, with an average tracking period of 91 days per snake (survival data provided by M. Akresh, UMass). Combining these data across studies, it may appear that *H. platirhinos* has relatively low annual survivorship rates augmented by higher fecundity and more young produced annually compared to larger snakes (Platt 1969). *Heterodon platirhinos* appears to be susceptible to declines caused by habitat fragmentation and succession. The proximate cause of declines is likely habitat loss, roadkill, and depredation by small mammals and birds. The loss of essential habitats such as nesting sites may be particularly detrimental to some populations, as it has been shown that some individuals exhibit nest-site fidelity (Buchanan et al. 2013; Vanek et al. (2014). Population declines could also be related to the declines in reproductive success associated with increasing closed-canopy habitats. On Cape Cod, *H. platirhinos* are still killed by homeowners who think they are venomous and may be surprised by the snake’s startling anti-predator displays (R. Cook, NPS, pers. comm.), suggesting that habitat fragmentation not only increases rates of roadkill but also targeted and incidental killing by landowners. Further, some populations may have been negatively influenced by a declining

prey base (primarily toads), although this is purely conjectural. Dispersal capability is probably poor, given an aversion to crossing paved roads (Robson and Blouin-Demers 2013), high nest site fidelity (Vanek et al. 2014), and potential for roadkill and incidental killing.

Further compounding the likely negative response of *Heterodon platirhinos* to habitat fragmentation, the species exhibits relatively large home ranges, especially in forested landscapes. For example, Akresh et al (2017) reported average home range size (MCP) of 18.6 +/- 19.3 ha, and 95% fixed kernel home range size of 27.4 +/- 29.5 ha in Franklin County, and Buchanan et al. (2017) reported average home range size of 35.4 ha in the Province Lands. Daily movements in New Hampshire ranged from 5.7 to 99.8 m (mean = 35.3 m), and the 95 percentile of home range sizes (Minimum Convex Polygon) for a New Hampshire populations were 28.7–128.6 ha (mean=72.7 ha). The overlapping home range size over multiple year for 12 snakes tracked in one population in New Hampshire was 834 ha (Goulet, pers. comm. to Lori Erb, 2009). A multi-year study on Long Island, NY reported preliminary home ranges of 1.1 ha to 10.7 ha (Finn, 2005). Adult *Heterodon* in Ontario have home ranges of greater than 100 ha and daily movement of approximately 100 m (Cunnington 2004a). The mean range length for 10 individuals in Ontario was 2.7 km and the maximum range length was over 6 km (in Seburn 2009).

Furthermore, one of the most extensive populations known occurs on federally-managed land on the Cape Cod National Seashore. Because of the level of automobile, bicycle, and pedestrian traffic within known areas of occurrence, the species should be closely monitored in Wellfleet, Truro, and Provincetown and necessary management actions taken to minimize adult mortality. NPS policy (4.4.2.3 Management of Threatened or Endangered Plants and Animals) states: “The National Park Service will inventory, monitor, and manage state and locally listed species in a manner similar to its treatment of federally listed species to the greatest extent possible.”

**(e) Does the species have highly specialized habitat, resource needs, or other ecological requirements? Is dispersal ability poor?**

More than any other snake species in Massachusetts, *Heterodon platirhinos* is associated with sandplain communities on deep sand outwash and coastal dunes (Lagory et al. 2009; Buchanan et al. 2012; Vanek and Wasko 2017). *Heterodon platirhinos* relies upon sandy or sandy-loam soil (Seburn, 2009). They prefer areas with surface debris and rock cover within close proximity to both ponds and shrubs, lower canopy closure, greater solar radiative emissivity, and higher surface temperatures (Goulet et al. 2015; Buchanan et al. 2016). As noted by Buchanan (pers. comm.), one commonality amongst northeastern studies of habitat selection is a preference for edge habitat. *Heterodon platirhinos* is also an “extreme dietary specialist” (Cooper and Secor 2007; NHFG 2015; Mirick et al. 2016), primarily feeding on toads and other amphibians. The availability of an adequate amphibian prey base must be considered a critical limiting factor for populations of *H. platirhinos*.

**Conservation goals.**

**What specific conservation goals should be met in order to change the conservation status or to remove the species from the state list? Please address goals for any or all of the following:**

**(a) State distribution, number of occurrences (populations), population levels, and/or reproductive rates**

There are approximately 15 to 20 known extant occurrences, only approximately 10 of which have been corroborated by reports of multiple individuals within the past 25 years. Six general areas of occurrence are associated with large areas of protected land, favorable or neutral habitat management, and a baseline understanding of the species distribution. These areas are broadly distributed throughout the Commonwealth, correspondingly roughly to natural management areas: the Outer Cape; Upper Cape; Plymouth County; Quabbin Reservoir; and Montague Plain. No specific distribution goals have been developed, but a statewide conservation strategy should focus on protecting functional populations in representative areas of the Commonwealth and preventing further range contraction. If viable populations are documented in Hampshire,



Hampden, Middlesex, or Norfolk Counties, they should form the basis for new management focal areas. This species warrants a quantitative status assessment based upon standardized, long-term sampling at areas of known and expected occurrence. Reproductive rates of Cape Cod *H. platirhinos* were provided by Buchanan et al. (2013).

**(b) Amount of protected habitat and/or number of protected occurrences**

Known, confirmed extant populations are nominally protected on the Cape Cod National Seashore (Province Lands and Wellfleet Ponds); Camp Edwards WMA; Myles Standish State Forest; Quabbin Reservation; and Montague Plains Wildlife Management Area. However, protected status does not necessarily translate to population stability or security because of the range of complex ecological interactions and space requirements of *H. platirhinos*. For several of these six large areas, the management emphasis should be placed on continuing or implementing regular prescribed fire or surrogates for fire, such as mowing, tree canopy thinning, and forestry. However, in the Province Lands and possibly some other areas, other natural disturbance regimes may provide adequate habitat without regular fire (S. Buchanan, RI DEM, pers. comm.). In other areas where potentially viable occurrences may persist, protected cores should be established that permit the overlapping home ranges of multiple adult snakes, which likely requires unfragmented landscapes of suitable sandplain, glacial delta, outwash, and dune habitats exceeding several hundred hectares.

**(c) Management of protected habitat and/or occurrences**

No specific habitat management guidelines have been developed, and no specific habitat restoration has occurred specifically for *Heterodon* in Massachusetts. However, current habitat management activities on six major protected areas—including vegetation management, forestry, and prescribed fire—appear to be consistent with Hog-nosed Snake conservation (Akresh et al. 2017). In particular, pine barrens restoration by MassWildlife in Franklin County (Hawthorne 2017) will likely benefit *H. platirhinos*. Restoration of Pitch Pine-Scrub Oak communities with prescribed fire and forestry will likely improve habitat quality for the species at other locations. As noted by NHFG (2015), habitat management activities need further evaluation to confirm that they achieve population-level effects (demographic stability, increasing or stable population trend, connectivity between subpopulations). While Akresh et al. (2017) provide compelling information that *H. platirhinos* respond favorably to active habitat management in western Massachusetts, the long-term response of *Heterodon* populations to common habitat management practices in pine barrens communities is needed to further refine habitat management goals. Road mortality hotspots must be identified, mapped, and mitigated. A long-term quantitative monitoring should be implemented, and an assessment of population genetics is needed.

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Figure 1. Adult Eastern Hog-nosed Snake from Franklin County, Massachusetts. Mike Jones / MassWildlife.



Figure 2. Decumbent Pitch Pine (*Pinus rigida*), habitat of the Eastern Hog-nosed Snake near Truro, Barnstable County. Mike Jones / MassWildlife.

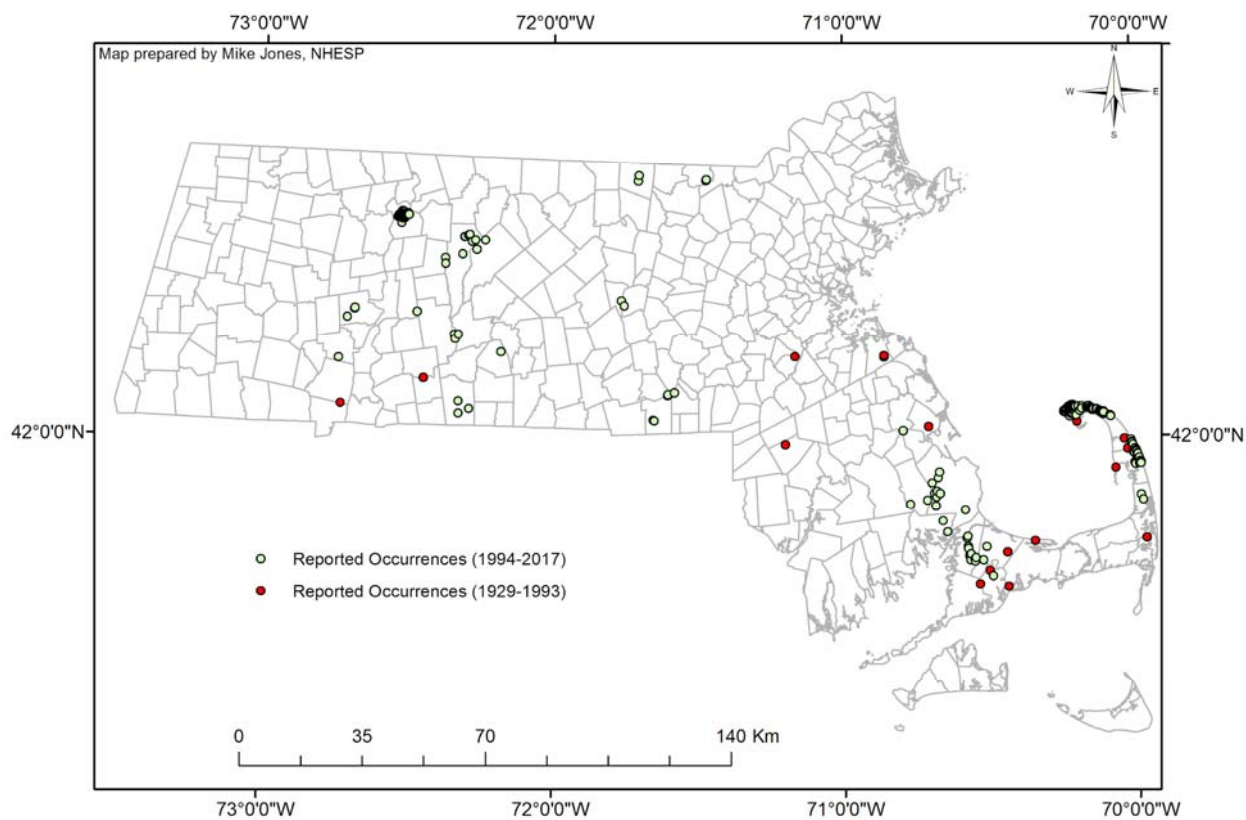




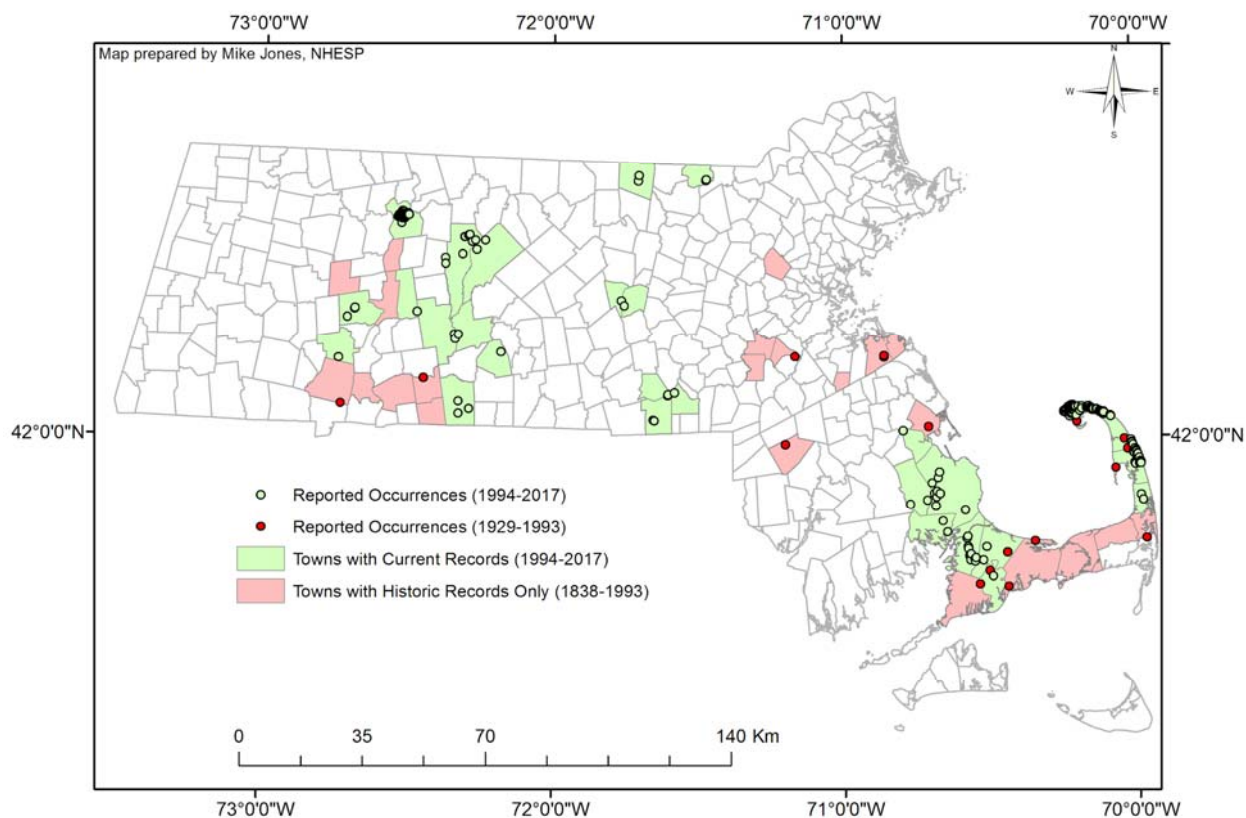
Figure 3. Pitch Pine-Scrub Oak community of glaciofluvial sand delta, habitat of the Eastern Hog-nosed Snake in Franklin County, Massachusetts. Mike Jones / MassWildlife.



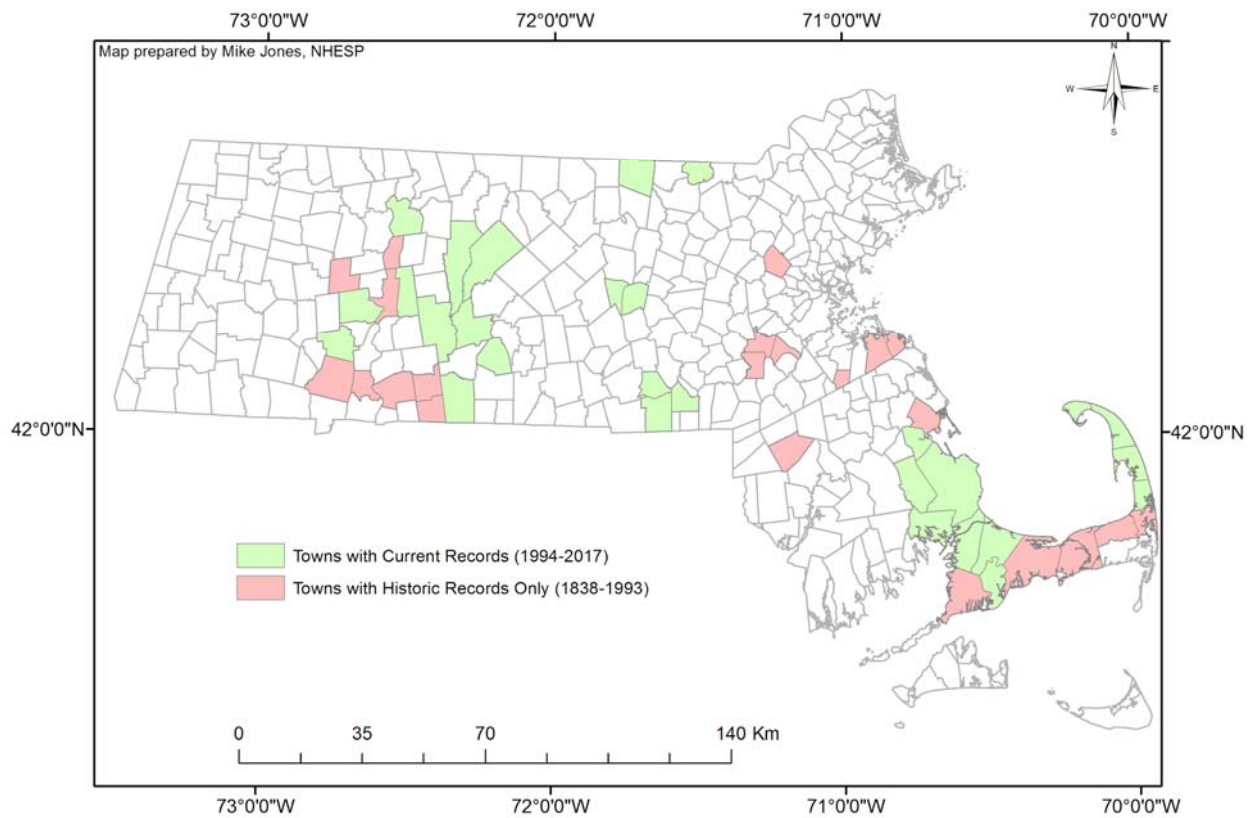
**Map 1. Reported site-level occurrence of *Heterodon platirhinos* in Massachusetts, 1929–2017. Only records with specific locality information are provided. Additional locations are discussed in the text, by county.**



**Map 2. Reported town- and site-level occurrence of *Heterodon platirhinos* in Massachusetts, 1838–2017, including town reports without site-level information.**



**Map 3. Town-level occurrence of *Heterodon platirhinos* in Massachusetts, 1839–2017. Additional locations are discussed in the text, organized by county.**



**Table 1. Occurrence of *Heterodon platirhinos* by Massachusetts town, with important references and museum collections, organized alphabetically by County and Town.**

Town	County	First Observation	Most Recent Observation	Key References
Barnstable (Cotuit)	Barnstable	1880	1973	MCZ
Barnstable (Marstons Mills)	Barnstable	1949	1949	MCZ
Barnstable (Sandy Neck)	Barnstable	c. 1988	c. 1988	Michener and Lazell (1989)
Bourne	Barnstable	1958	2017	A. Curtis (unpublished)
Cohasset	Barnstable	c. 1880	1883	MCZ
Dennis	Barnstable	1976	1976	MCZ
Eastham	Barnstable	1996	2015	R. Cook (unpublished); NHESP (unpublished)
Falmouth (East Falmouth)	Barnstable	1969	1969	Lazell 1976a; MCZ
Mashpee	Barnstable	c. 2014	c. 2014	J. Carlson (unpublished)
Orleans (South Orleans)	Barnstable	1929	1929	MCZ
Provincetown	Barnstable	1974	2016	MCZ; Lazell 1976a; R. Cook (unpublished); Buchanan (2012); NHESP (unpublished)
Sandwich	Barnstable	1954	1954	NHESP (unpublished)
Truro	Barnstable	1889	2013	USNM; R. Cook (unpublished); NHESP (unpublished)
Wellfleet	Barnstable	1973	2013	R. Cook (unpublished); NHESP (unpublished)
West Yarmouth	Barnstable	1858	1858	MCZ
Norton	Bristol	1942	1942	MCZ
Montague	Franklin	2006	2017	D. King and R. Brooks (unpublished); Lotterhand (2016); Akresh et al. (2017)
New Salem	Franklin	1994	2013	Milam (1997); K. Koenan (unpublished); NHESP (unpublished); D. Small (unpublished)
Sunderland	Franklin	1926	1926	Stull (1926)
Hampden	Hampden	1976	1976	MCZ
Ludlow	Hampden	1992	1992	Mass Herp Atlas; A.M. Richmond (unpublished)
Monson	Hampden	1996	2014	Mass Herp Atlas; NHESP (unpublished)
Springfield	Hampden	c. 1868	1929	Allen (1868); MCZ
West Springfield	Hampden	c. 1926	c. 1926	Stull (1926)
Westfield	Hampden	1993	1993	Mass Herp Atlas
Amherst	Hampshire	1995	1995	B.W. Compton (unpublished)
Belchertown	Hampshire	1997	2012	Mass Herp Atlas; J. Cardoza (unpublished)
Hadley	Hampshire	c. 1926	c. 1926	Stull (1926)
Northampton	Hampshire	1926	1995	Stull (1926); Mass Herp Atlas; L. Sanders and F. Morrison (unpublished); M. Hale (unpublished)
Southampton	Hampshire	1999	1999	NHESP (unpublished)
Williamsburg	Hampshire	c. 1926	c. 1926	Stull (1926)
Dunstable	Middlesex	2008	2008	NHESP (unpublished)
Lexington	Middlesex	1977	1977	MCZ
Townsend	Middlesex	2008	2017	NHESP (unpublished); J. Pettit (unpublished)
Dover	Norfolk	1946	1946	MCZ
Holbrook	Norfolk	1945	1945	MCZ
Medfield	Norfolk	c. 1838	c. 1838	Storer (1840)
Quincy	Norfolk	c. 1861	c. 1861	MCZ
Westwood	Norfolk	1993	1993	Mass Herp Atlas
Carver	Plymouth	1996	2016	NHESP (unpublished)
Duxbury	Plymouth	c. 1973	c. 1973	NHESP (unpublished)
Hingham	Plymouth	1990	1990	NHESP (unpublished)
Kingston	Plymouth	2012	2012	NHESP (unpublished)
Plymouth	Plymouth	2002	2016	NHESP (unpublished); J. Crane (unpublished); M. Nelson (unpublished); L. Harper (unpublished)
Wareham	Plymouth	1913	2008	MCZ; Mass Herp Atlas; O. Bangs (unpublished); R. Hopping (unpublished)
Mendon	Worcester	2007	2007	NHESP (unpublished)
Petersham	Worcester	1914	2009	MCZ; K. Koenen (unpublished); R. Cooper (unpublished)
Uxbridge	Worcester	2005	2009	T. Rawinski (unpublished); NHESP (unpublished)
Ware	Worcester	2007	2007	NHESP (unpublished)
Warren	Worcester	1996	1996	Mass Herp Atlas
West Boylston	Worcester	2000	2009	NHESP (unpublished)