

**Listing Proposal for the Timber Rattlesnake (*Crotalus horridus*)
in Nebraska**



Photo by Jon Farrar, NEBRASKALand

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Introduction

The Nebraska Game and Parks Commission (hereafter, Commission) is authorized under the Nebraska Nongame and Endangered Species Conservation Act (NESCA; Neb. Rev. Stat. § 37-801 to 37-811) to determine what species should be placed on the list of threatened or endangered species maintained under the act. Species that are listed as threatened or endangered federally are automatically placed on the state's list of threatened or endangered species; however, there are additional unlisted species whose continued existence within our state is at-risk and who are candidates for state listing. The Commission is obligated to conduct a review of species when monitoring data or emerging issues indicate concern. In 2017, Commission staff undertook a review of the state's wildlife and plants to determine whether any species warranted placement on the list or whether any species currently listed as threatened or endangered should be removed from the list. The last full review and revision of the list occurred in 2000. The purpose of the current statewide review is to maintain an accurate list of threatened and endangered species, based on the best information available, to help the Commission complete its mission of effectively conserving the wildlife resources of Nebraska. Over the last several months, Wildlife Division staff received input from species' experts, conducted extensive literature reviews, and coordinated with the Commission's Fisheries and Planning and Programming divisions to develop a list of species to consider for listing action. An in-house committee (Appendix 1) further refined the list based on multiple criteria of relevance, including but not limited to those described in Nebraska statute 37-806 (process and legal requirements; see Appendix 2). Of Nebraska's reptiles and amphibians, Commission staff concluded the Timber Rattlesnake (*Crotalus horridus*) has experienced significant, well documented declines in abundance in Nebraska and throughout much of its range, its population faces significant threats, and it should be placed on the state list.

Species Description:

Fogell (2010) and Panella (2010) describe Timber Rattlesnakes (*Crotalus horridus*) as ranging in color from yellow-brown or gray to black, with dark crossbands, often bordered with whitish scales. They may also be yellowish-, brownish- or pinkish-gray, with tan or reddish-brown dividing crossbands, which may not always connect on the ventral side of the snake. Timber Rattlesnakes have a rusty brown dorsal stripe, a triangular head, and vertical pupils. A golden colored stripe extends along the cheeks. They have a sensory pit in front of the eye. Tail is black with a lighter colored rattle. Timber Rattlesnakes are the largest of Nebraska's rattlesnakes and grow to an average size of 111.8–127 cm (44–50 in) long.

Distribution:

Timber Rattlesnakes have a wide distribution across most of the eastern half of the United States. NatureServe (2017) describes their range as extending south from the states of central New England to northern Florida, and west to southeastern Minnesota, southern and eastern Iowa, eastern Texas, central Oklahoma, eastern Kansas, and southeastern Nebraska.

Timber Rattlesnakes have a patchy distribution on the northern and western portions of their range, and they are believed to now be extinct in the state of Maine and Ontario, Canada (NatureServe 2017; Fig. 1).

In Nebraska, Timber Rattlesnakes live in the very southeast portion of the state (Fig. 2). They are found in the Sandstone Prairies, Southeast Prairies, Missouri River, Indian Cave Bluffs, and Rulo Bluffs Biologically Unique Landscapes, although records are scarce. Nebraska's population is at the western periphery of the species' range.

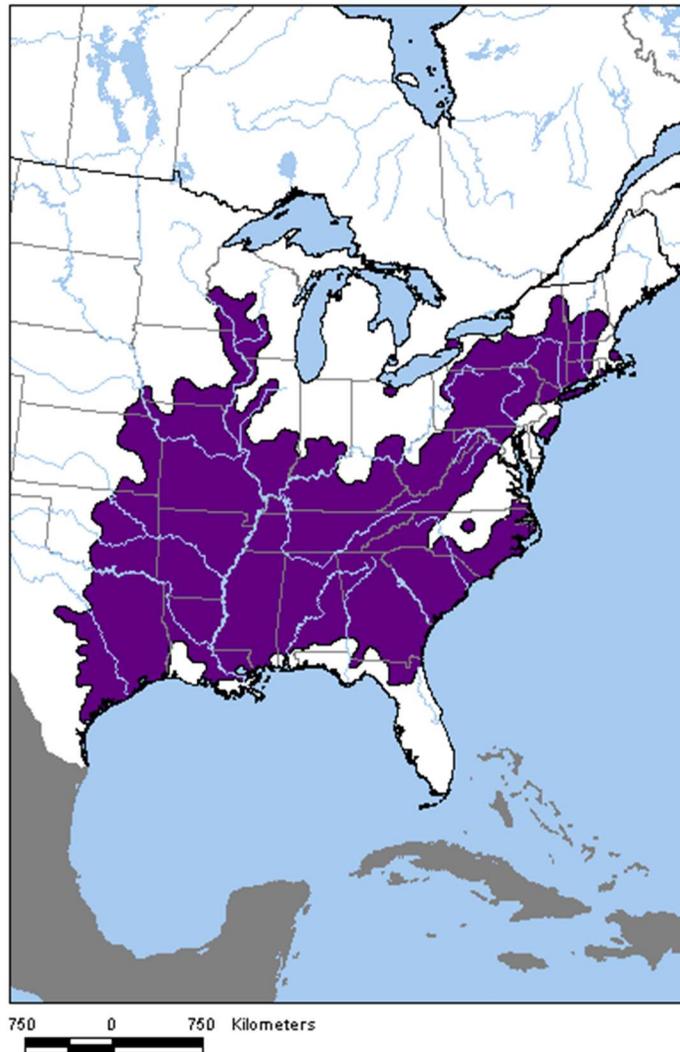


FIG. 1. Map illustrating the distributional range of the Timber Rattlesnake, *Crotalus horridus*. Map prepared by NatureServe.

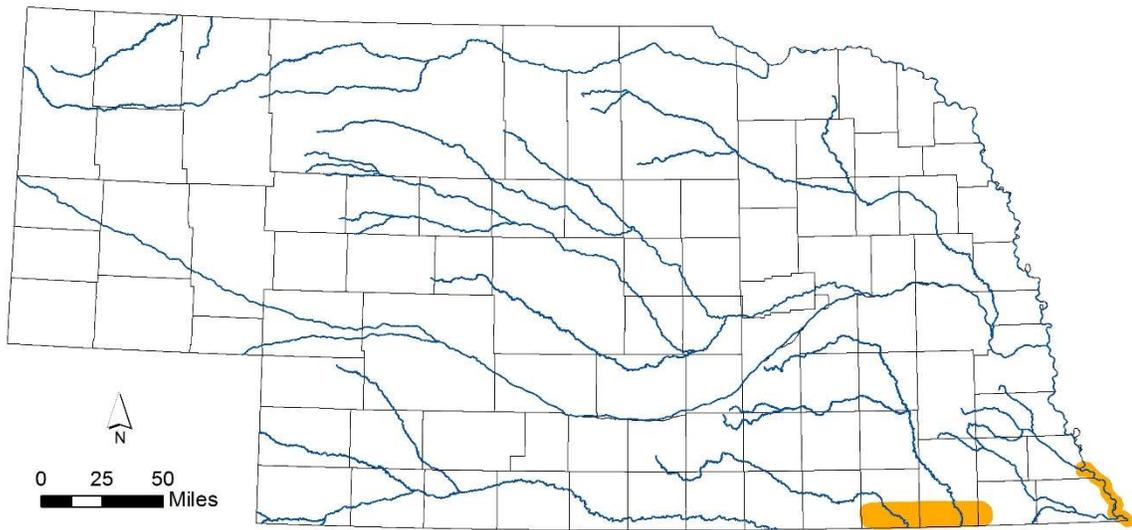


FIG. 2. Within the state of Nebraska, the current range of the Timber Rattlesnake, *Crotalus horridus*, is limited to the southeastern area of the state. Map prepared by the Nebraska Natural Heritage Program.

Habitat Requirements:

Fogell (2010) documents Timber Rattlesnakes using deciduous and riparian woodlands in conjunction with rock outcrops or talus slopes that provide winter denning hibernacula. Woodlands that Timber Rattlesnakes inhabit often are associated with prairie uplands. Grasslands, and sometimes agricultural fields, provide the snakes with a migratory corridor between woodlots. During their migration, they are known to use houses of Eastern Woodrats (*Neotoma floridana*) for cover (Fogell 2010).

The foraging ecology of Timber Rattlesnakes can vary geographically, and they will hunt a variety of prey (Reinert et al. 2011). Clark (2002) synthesized the feeding ecology of Timber Rattlesnakes with published records and information about stomach contents from museum specimens. Their diet consists primarily of small mammals (>90%) such as mice, chipmunks, ground squirrels, and voles (Clark 2002). Occasionally, they will eat birds, amphibians, or reptiles (Clark 2002). Gravid females may fast or feed less, relying on their fat reserves, because they must spend more time basking and seeking warmth of rocks to support development of their young (Keenlyne 1972).

Reproduction:

Timber Rattlesnakes are a slow-growing and long-lived species. Sexual maturity is not reached until males are ~5 years old (New York State Department of Environmental Conservation 2018), and females are 5–11 years old (i.e., most females are 7–10 years at first reproduction; Brown 1991, Martin 1993). The females ovulate 4–6 weeks after their spring emergence from their hibernacula (Martin 1993). A female may migrate ~3.2 km (2 mi) in search of a mate (Fogell 2010). Anderson (2010) and Mohr (2012) found that males traveled farther

than females in search of mates. Females give birth to live young in late summer (Aug–Sept) (Martin 1993, Fogell 2010). Litter sizes range from 4–15 (ave. ~9) (Center for Reptile and Amphibian Conservation and Management 2003, New York State Department of Environmental Conservation 2018).

Lifespan is 16–22 years (max ~30 years, New York State Department of Environmental Conservation 2018). Females reproduce at 2–4-year intervals (Brown 1991, Martin 1993), so they may only produce 3–4 litters before they die. The largest females can be expected to have the greatest overall fecundity (i.e., number and size of neonates) (Martin 1993). Frequency of reproduction and litter size can vary based on environmental conditions and food availability (Martin 1993).

The young remain close to their mother for at least the first week of life (Cobb et al. 2005). Snake mortality during the first year of life is high, estimated at 75–90% because of predation on neonates, not enough small prey, lack of suitable dens (Greene 1997), and risks during dispersal (Bonnet 1999).

Abundance and Status:

Approximately half the states in the U.S. consider the Timber Rattlesnake to be a species of greatest conservation need (U.S. Geological Survey 2017). Of these states, Timber Rattlesnakes are listed as threatened in Texas, Minnesota, Illinois, and New York and endangered in Indiana, Ohio, New Jersey, Vermont, Massachusetts, Connecticut, and New Hampshire. Two populations remain in Vermont, but only one persists in New Hampshire. In Massachusetts, there are five known viable population clusters. In New York, 26% of known historic den sites are now extirpated, another 5% are nearly extirpated, and the state's entire population is estimated to have declined by 50–75% since colonial settlement. Timber Rattlesnakes are considered extirpated from Maine and Rhode Island. Populations are also extinct in Canada (NatureServe 2017).

Precise data on distribution decline at the global level are not readily available; however, the consensus among researchers is that the distribution of Timber Rattlesnakes is shrinking everywhere they occur. The most notable distribution declines are in the New England states, New York, New Jersey, Minnesota, Wisconsin, and Indiana. There is no place where their distributions are increasing, though in several Appalachian states they are somewhat stable.

The only known extant occurrences of Timber Rattlesnakes in Nebraska are in southern Gage County where multiple small den sites collectively form a single population in which gene flow can regularly occur, and in northeastern Richardson County in the Barada Hills where only a single den site is known, but evidence supports at least 1–2 additional den sites that collectively compose a single, interbreeding population. Additional den sites may occur in southeastern Richardson County; however, presently there are no known sites. A specimen from Jefferson County was collected by Marvin Stover in 1992 (Catalog #15110; University of Nebraska State Museum 2018), and there is another record of one killed in Pawnee County (Fogell 2011) in 1989 (EO #6201; Nebraska Natural Heritage Program 2018), but extant populations have never

been identified for those locales. Populations in Cass County were extirpated by the end of the 1970s, and it is believed that any Otoe and Nemaha county populations also perished during that time. Population studies and surveys have been ongoing in Gage County since 1997, and evidence strongly shows a decline in both number and distribution in Gage County. In Richardson County where Timber Rattlesnakes were once reported to be fairly common, <20 individuals have been sighted within the past 40 years, and seven of those were within the last 3 years as a result of intense survey efforts.

Two of the largest den site populations in Nebraska have <100 Timber Rattlesnakes each based on a long-term mark and recapture study from Gage County. Fogell (2000) estimated the population size using the Lincoln-Petersen index (Blower et al. 1981). Given that there are 10–12 known den sites in Gage County and one in Richardson County, the total number of Timber Rattlesnakes in the state is estimated to be <1,000. Declining population densities reduce the probability of encounters with other Timber Rattlesnakes, and therefore reduce the probability for mating, reproduction, and recruitment. This exacerbates the continued decline of populations.

Den site re-establishment studies at locations within the population core have all failed because of the strong, nearly 100% den site fidelity exhibited by this species. In Nebraska, den site fidelity was the norm but was not 100%, thus re-establishing den sites here could be more successful than at the core of the species' distribution. This would require restoration of habitat around denning sites and establishing and maintaining travel corridors. However, the natural history of Timber Rattlesnakes will not afford for a successful recovery within just 10 years. Additionally, habitat connectivity in both Gage and (especially) Richardson counties is so poor that natural recolonization of extirpated den sites would take substantially >10 years.

While Nebraska's population represents a significantly small proportion of the global population, its placement in distribution is notable and significant in terms of the species' biogeography, global genetic diversity, and most importantly – conservation value. Several studies have shown that as species become rare and start to decline in population size and distribution, they do not collapse at the periphery of their range but rather at the center, and the peripheral populations remain intact (Crowley 2011, Channell and Lomolino 2000). In a review of numerous studies, more than 90% of declining distributions remained intact at the western periphery of their global distribution – which is precisely where Nebraska's Timber Rattlesnakes reside. One reason for this is the more diverse set of adaptability “tools” present within these populations. Individuals at peripheries are more prone to adapt and survive under suboptimal conditions, thus those “survival” alleles become prevalent in peripheral populations. Those at the core of the range are rarely presented with the extreme conditions present at the periphery, thus those same “survival” alleles are not nearly as prevalent (Lesica and Allendorf 1995). From a conservation genetics standpoint, Timber Rattlesnakes at their extreme periphery contain valuable genetic diversity that will allow both for survival in an already extreme environment and the potential to provide founding stock for reintroduction efforts elsewhere in the range as populations begin to collapse and become extirpated. While Nebraska's Timber Rattlesnakes are an extreme peripheral population, the Richardson County population is also disjunct from the

rest of the distribution, with the nearest known population occurring ~45 mi to the southeast near Atchison, Kansas. Populations in Gage County are somewhat continuous with populations in Kansas to the south.

Factors Affecting the Species:

Section 37-806 (2) of the Nongame and Endangered Species Conservation Act states that the Nebraska Game and Parks Commission shall determine whether any species of wildlife or wild plants normally occurring within this state is an endangered or threatened species as a result of any of the five factors described therein. These factors and their application to the Timber Rattlesnake are as follows:

(A) The present or threatened destruction, modification, or curtailment of its habitat or range.

While Timber Rattlesnakes have been known to use grassland and agricultural habitats during their active seasons, they are predominantly a woodland species that is adapted to forested and savanna-like environments. Woodlands are rare and scarce in Nebraska, and woodlands associated with suitable hibernation habitat are even rarer. It is doubtful that – if their habitat features in Nebraska were to become severely altered – Timber Rattlesnakes would be able to survive.

The need for rocky outcrops with very specific characteristics limits the likelihood that Timber Rattlesnakes will survive extreme winter conditions in Nebraska. While Timber Rattlesnakes in more southern regions of their range can survive by hibernating in tree root systems and mammal burrows, extended time periods with sub-freezing temperatures preclude this behavior in Nebraska.

In Nebraska, Timber Rattlesnakes once occurred from Plattsmouth to Rulo along the Missouri River's limestone bluffs; however, channelization construction quarried these bluffs for stabilization rock, which ultimately reduced their distribution to a small part of Richardson County near the town of Barada. The distribution of Timber Rattlesnakes in Gage County has been reduced as a result of quarrying and land conversion for agriculture, but several stronghold den sites still persist.

The spread of invasive eastern redcedars (*Juniperus virginiana*) has caused significant “shading over” of den sites, which depend on solar exposure during winter months. Many of these den sites have been abandoned over the past 30-40 years (per landowner discussions). In the species' range, rock outcroppings in some locations are being quarried for rock. Some old quarries with denning sites are once again being mined, thus destroying denning sites.

(B) Over-utilization from commercial, sporting, educational, or other purposes.

Timber Rattlesnakes have been victims of illegal collecting and pet trade in some states such as Connecticut (Connecticut Department of Energy and Environmental Protection 2016), New York (New York State Department of Environmental Conservation 2018), and

New Jersey (Conserve Wildlife Foundation for New Jersey 2018). It is unknown if this is a significant contributing factor to the species' decline in Nebraska.

(C) Disease or predation.

A new and potentially devastating mortality factor is a disease known as *Ophiodiomyces ophiodiicola*, also known as Snake Fungal Disease (SFD). Preliminary evidence of this disease in Nebraska's Timber Rattlesnakes has been recorded as far back as 1998. Other than several observational notes in the past 20 years, its prevalence, mortality rate, and continued presence in Nebraska are currently unknown.

Isolated populations of Timber Rattlesnakes may be the most at risk of mortality attributable to SFD (Lorch et al. 2016). An isolated population in New Hampshire suffered high mortality (>50%) after skin infections with clinical signs consistent with SFD, but those snakes may have been unusually susceptible because of lack of genetic diversity following a population bottleneck (Clark et al. 2011). Stengle (2018) found that wild Timber Rattlesnakes in Massachusetts fared better, showing healing of lesions and recovery, than in reports of SFD mortality from other states, but she also stated that peripheral and isolated populations are more susceptible (McBride et al. 2015) and can benefit from assisted gene flow (i.e., introduction of genetically diverse individuals) to support disease resistance and population persistence. Several other states have reported occurrences of SFD – in Timber Rattlesnakes and other species – but without any observable population declines (U.S. Geological Survey 2016). Because Nebraska's Timber Rattlesnakes are a peripheral population, there are potential population level impacts of SFD to consider as a threat.

(D) Inadequacy of existing regulatory mechanisms.

While take of Timber Rattlesnakes is prohibited under Title 163, Chapter 4, 010.02, state laws and regulations do not protect against habitat loss and alteration that threaten Timber Rattlesnakes. The Nongame and Endangered Species Conservation Act could offer the possibility for protection of this species on state and private lands through Section 37-807 involving conservation programs and state agency consultation.

The greatest contribution to mortality of Timber Rattlesnakes in Nebraska has been the result of human interactions. In the past 20–25 years an estimated average of 6–8 large adult Timber Rattlesnakes each year have been reported by residents of Gage County to have been killed on roads – either accidentally by traffic or maliciously. Additionally in the past 5 years, a total of at least six have been killed either by car traffic or maliciously on roads in Richardson County. Additional malicious killings of Timber Rattlesnakes have also occurred at locations other than roads, such as directly on den sites or at sites where they were randomly encountered.

(E) Other natural or human-induced factors affecting its continued existence.

Because Timber Rattlesnakes in Nebraska also frequently occupy grasslands such as pastures and hay fields, several are killed annually during hay cutting and baling activities. With the recent conversion of railroad lines to bicycling/hiking trails along the Big Blue River in Gage County, trail users will pass directly in front of den sites where Timber Rattlesnakes hibernate communally and which were previously protected by railroad “no trespassing” regulations; therefore, interactions with Timber Rattlesnakes are likely to increase, and these almost never end well for the snakes. The small size of the remaining populations increases the possibility of loss of the remaining populations as a result of any natural catastrophic or human induced events.

Proposal:

Based on population declines, habitat loss, and the threats described therein, we believe the species’ continued existence in the state of Nebraska is uncertain. Therefore, we recommend the Timber Rattlesnake for listing as Threatened under the Nebraska Nongame and Endangered Species Conservation Act (37-801 to 37-811) and will follow all legal requirements (Appendix 2) in pursuit of this status change for the species. Timber Rattlesnakes may be treated similarly in state regulations to the currently listed Massasauga (*Sistrurus catenatus*) as threatened.

Acknowledgments

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APPENDIX 1.

Nebraska Game and Parks Commission staff members formed the Listing Action Committee to evaluate information for all species being considered for listing action during this review.

Committee Member	Division
Melissa Panella (Chair)	Wildlife
Carey Grell	Planning and Programming
Rick Holland	Fisheries
Michelle Koch	Planning and Programming
Rick Schneider	Wildlife
Kristal Stoner	Wildlife

APPENDIX 2.

Nebraska Statute 37-806 outlines the legal requirements of endangered or threatened listing action.

37-806. Endangered or threatened species; how determined; commission; powers and duties; unlawful acts; exceptions; local law, regulation, or ordinance; effect.

- (1) Any species of wildlife or wild plants determined to be an endangered species pursuant to the Endangered Species Act shall be an endangered species under the Nongame and Endangered Species Conservation Act, and any species of wildlife or wild plants determined to be a threatened species pursuant to the Endangered Species Act shall be a threatened species under the Nongame and Endangered Species Conservation Act. The commission may determine that any such threatened species is an endangered species throughout all or any portion of the range of such species within this state.
- (2) In addition to the species determined to be endangered or threatened pursuant to the Endangered Species Act, the commission shall by regulation determine whether any species of wildlife or wild plants normally occurring within this state is an endangered or threatened species as a result of any of the following factors:
 - (a) The present or threatened destruction, modification, or curtailment of its habitat or range;
 - (b) Overutilization for commercial, sporting, scientific, educational, or other purposes;
 - (c) Disease or predation;
 - (d) The inadequacy of existing regulatory mechanisms; or
 - (e) Other natural or manmade factors affecting its continued existence within this state.
- (3)(a) The commission shall make determinations required by subsection (2) of this section on the basis of the best scientific, commercial, and other data available to the commission.
- (b) Except with respect to species of wildlife or wild plants determined to be endangered or threatened species under subsection (1) of this section, the commission may not add a species to nor remove a species from any list published pursuant to subsection (5) of this section unless the commission has first:
 - (i) Provided public notice of such proposed action by publication in a newspaper of general circulation in each county in that portion of the subject species' range in which it is endangered or threatened or, if the subject species' range extends over more than five counties, in a newspaper of statewide circulation distributed in the county;

- (ii) Provided notice of such proposed action to and allowed comment from the Department of Agriculture, the Department of Environmental Quality, and the Department of Natural Resources;
- (iii) Provided notice of such proposed action to and allowed comment from each natural resources district and public power district located in that portion of the subject species' range in which it is endangered or threatened;
- (iv) Notified the Governor of any state sharing a common border with this state, in which the subject species is known to occur, that such action is being proposed;
- (v) Allowed at least sixty days following publication for comment from the public and other interested parties;
- (vi) Held at least one public hearing on such proposed action in each game and parks commissioner district of the subject species' range in which it is endangered or threatened;
- (vii) Submitted the scientific, commercial, and other data which is the basis of the proposed action to scientists or experts outside and independent of the commission for peer review of the data and conclusions. If the commission submits the data to a state or federal fish and wildlife agency for peer review, the commission shall also submit the data to scientists or experts not affiliated with such an agency for review. For purposes of this section, state fish and wildlife agency does not include a postsecondary educational institution; and
- (viii) For species proposed to be added under this subsection but not for species proposed to be removed under this subsection, developed an outline of the potential impacts, requirements, or regulations that may be placed on private landowners, or other persons who hold state-recognized property rights on behalf of themselves or others, as a result of the listing of the species or the development of a proposed program for the conservation of the species as required in subsection (1) of section 37-807.

The inadvertent failure to provide notice as required by subdivision (3)(b) of this section shall not prohibit the listing of a species and shall not be deemed to be a violation of the Administrative Procedure Act or the Nongame and Endangered Species Conservation Act.

- (c) When the commission is proposing to add or remove a species under this subsection, public notice under subdivision (3)(b)(i) of this section shall include, but not be limited to, (i) the species proposed to be listed and a description of that portion of its range in which the species is endangered or threatened, (ii) a declaration that the commission submitted the data which is the basis for the listing for peer review and developed an outline if required

under subdivision (b)(viii) of this subsection, and (iii) a declaration of the availability of the peer review, including an explanation of any changes or modifications the commission has made to its proposal as a result of the peer review, and the outline required under subdivision (b)(viii) of this subsection, if applicable, for public examination.

- (d) In cases when the commission determines that an emergency situation exists involving the continued existence of such species as a viable component of the wild fauna or flora of the state, the commission may add species to such lists after having first published a public notice that such an emergency situation exists together with a summary of facts which support such determination.
- (4) In determining whether any species of wildlife or wild plants is an endangered or threatened species, the commission shall take into consideration those actions being carried out by the federal government, by other states, by other agencies of this state or political subdivisions thereof, or by any other person which may affect the species under consideration.
- (5) The commission shall issue regulations containing a list of all species of wildlife and wild plants normally occurring within this state which it determines, in accordance with subsections (1) through (4) of this section, to be endangered or threatened species and a list of all such species. Each list shall refer to the species contained therein by scientific and common name or names, if any, and shall specify with respect to each such species over what portion of its range it is endangered or threatened.
- (6) Except with respect to species of wildlife or wild plants determined to be endangered or threatened pursuant to the Endangered Species Act, the commission shall, upon the petition of an interested person, conduct a review of any listed or unlisted species proposed to be removed from or added to the lists published pursuant to subsection (5) of this section, but only if the commission publishes a public notice that such person has presented substantial evidence which warrants such a review.
- (7) Whenever any species of wildlife or wild plants is listed as a threatened species pursuant to subsection (5) of this section, the commission shall issue such regulations as are necessary to provide for the conservation of such species. The commission may prohibit, with respect to any threatened species of wildlife or wild plants, any act prohibited under subsection (8) or (9) of this section.
- (8) With respect to any endangered species of wildlife, it shall be unlawful, except as provided in subsection (7) of this section, for any person subject to the jurisdiction of this state to:
 - (a) Export any such species from this state;

- (b) Take any such species within this state;
 - (c) Possess, process, sell or offer for sale, deliver, carry, transport, or ship, by any means whatsoever except as a common or contract motor carrier under the jurisdiction of the Public Service Commission or the Interstate Commerce Commission, any such species; or
 - (d) Violate any regulation pertaining to the conservation of such species or to any threatened species of wildlife listed pursuant to this section and promulgated by the commission pursuant to the Nongame and Endangered Species Conservation Act.
- (9) With respect to any endangered species of wild plants, it shall be unlawful, except as provided in subsection (7) of this section, for any person subject to the jurisdiction of this state to:
- (a) Export any such species from this state;
 - (b) Possess, process, sell or offer for sale, deliver, carry, transport, or ship, by any means whatsoever, any such species; or
 - (c) Violate any regulation pertaining to such species or to any threatened species of wild plants listed pursuant to this section and promulgated by the commission pursuant to the act.
- (10) Any endangered species of wildlife or wild plants which enters this state from another state or from a point outside the territorial limits of the United States and which is being transported to a point within or beyond this state may be so entered and transported without restriction in accordance with the terms of any federal permit or permit issued under the laws or regulations of another state.
- (11) The commission may permit any act otherwise prohibited by subsection (8) of this section for scientific purposes or to enhance the propagation or survival of the affected species.
- (12) Any law, regulation, or ordinance of any political subdivision of this state which applies with respect to the taking, importation, exportation, possession, sale or offer for sale, processing, delivery, carrying, transportation other than under the jurisdiction of the Public Service Commission, or shipment of species determined to be endangered or threatened species pursuant to the Nongame and Endangered Species Conservation Act shall be void to the extent that it may effectively (a) permit that which is prohibited by the act or by any regulation which implements the act or (b) prohibit that which is authorized pursuant to an exemption or permit provided for in the act or in any regulation which implements the act. The Nongame and Endangered Species Conservation Act shall not otherwise be construed to void any law, regulation, or ordinance of any political subdivision of this state which is intended to conserve wildlife or wild plants.

Source:Laws 1975, LB 145, § 5; R.S.1943, (1993), § 37-434; Laws 1998, LB 922, § 356; Laws 2002, LB 1003, § 33.

Cross References Administrative Procedure Act, see section 84-920.