

Terrestrial Wildlife Crossing Structure Types (By Function)

This table is for terminology only and is not intended to be used for structure design. It can be used for generalized discussions early in planning process. It is not intended to be prescriptive since each site requires site-specific planning by qualified biologists and engineers.

Note: Structures are viewed from animal's perspective. Some structures constructed for transportation purposes alone may be retrofitted to meet these functional classes. Generally, species that use small structures will use larger structures if appropriate cover and other features are provided, but most species can not use smaller classes.

| Crossing Structure Class | Function | Approximate Dimension Range (Span x Rise) | Structure Examples | Species Examples | Wildlife Behavioral Attributes |
|---|---|--|--|--|--|
| Class 0: No structure or non-functional structure | No useable structure available where one is needed. | No structure or small drainage pipes. | Fill slope blocking a drainage where there is no structure present or a structure with an aquatic component only. | Determined by target species. | N/A |
| Class 1: Small Underpass | Provides enclosed protection for small animals that require cover. | Metal pipe culverts or small box culverts 1.5 m (5') span or less | Small bridges, dry culverts, and ephemerally flooded drainage culverts. Continually flooded drainage structures have limited functionality for terrestrial species but may function for some aquatics. | Amphibians, reptiles, small mammals and some medium-sized mammals (badger, fox, bobcat). Aquatic species include fish, aquatic amphibians, and invertebrates. | Small animals that prefer cover or do not mind confinement. |
| Class 2: Medium Underpass | Provides some cover yet more openness than Class 1 structures for animals smaller than deer. If water is conveyed, allows for stream simulation including unwetted natural banks. | Underpasses larger than 1.5 m (5') span, to 2.4 m (8') span x 2.4 m (8') rise | Box culverts, arch pipes and other culvert shapes, small bridges. | Coyote, bobcat, ocelot, lynx and some large carnivores (black bear, puma); alligator. | Medium sized mammals that require some cover and some openness to see through passage. |
| Class 3: Large Underpass | Provides an approximate minimum for ungulates, especially deer, and other species that require visibility, maneuverability, and moderated noise. May allow some natural processes including vegetation growth and stream processes. | Underpasses with minimum dimensions: 6.1 m (20') span x 2.4 m (8') rise, or 3.1 m (10') span x 3.1 m (10') rise, and open span bridges | Box culverts, large arch pipes, bridges including open span bridges. Multiple chambered structures are considered as individual units. | Ungulates use structures in approximate proportion to their size (ie, deer can use smaller structures than elk or moose) although pronghorn require larger structures (minimum 18.3 m span x 5.5 m rise). Large carnivores (wolf, grizzly bear, black bear, puma). | Larger mammals that require structures of a minimum size for passage. |

| Crossing Structure Class | Function | Approximate Dimension Range (Span x Rise) | Structure Examples | Species Examples | Wildlife Behavioral Attributes |
|---|--|---|--|--|---|
| Class 4: Extensive Bridge (includes Viaducts) | Allows ecosystem processes to permeate highway such as wetland water flow, vegetation growth, and entire floodplains. Provides excellent horizontal visibility for animals requiring openness. | Bridge extending over several spans. Designed for each site so dimensions vary. May allow more sunlight under structure than other types. | Viaducts are long bridges elevated over the landscape in a series of smaller spans, often connecting points of equal height. Typically over wetlands, steep terrain. | Most species including wetland species, birds, pronghorn. | Viaducts are particularly good for wary species including carnivores that may not approach other structures, or low mobility species such as mollusks that require vegetation throughout the structure. |
| Class 5: Wildlife Overpass | Provides an open top and expansive visibility of the horizon for animals preferring unenclosed spaces. Allows full sunlight and precipitation for vegetation growth. May allow small, sunlit water features. | Overpass structure for wildlife to pass over roadway, as small as 6.7 m (22') wide, but preferably ≥ 50 m (164') wide. Large highway traffic tunnels can be very long and provide vast amounts of undisturbed habitat. | Overpasses with soil and plant growth. A tunnel for highway traffic under intact bedrock, soil and vegetation would function as a wildlife overpass regardless of the original objective of the structure. | All ungulates (pronghorn not proven yet), carnivores (bear, puma, forest carnivores). Songbirds and insects including butterflies. | Any species that requires natural habitat, sunlight or ambient conditions for movement. |
| Class 6: Specialized Culvert | Allows outside environmental conditions to occur within the entire structure, including light, temperature and moisture. | Current designs are small culverts less than .5 m (24") span but could be larger structures. | Trench drains and slotted culverts. | Reptiles and amphibians | Reptiles and amphibians that require ambient outside conditions to survive and disperse, or to orientate during movements. |
| Class 7: Aerial Bridge | Provides an aerial passage for animals that typically do not descend below tree canopy to ground. | Adequate to cross all traffic lanes. May be connected to trees in the median. | Treetop rope bridges, or modified wire or metal structures. Towers may function the same way for some species (such as flying squirrels). | Squirrels, arboreal rodents, opossum, monkeys. Potential for insects and plants. | Species that move through the canopy rather than on the ground surface. |
| Wildlife Fence | Functions to barrier access to the roadway and to divert the animals towards a suitable crossing location. | Dimensions vary by target species from small concrete or polymer curved structures a few centimeters in height, to 2 m page wire mesh for high-jumping mammals. | Types vary greatly but can be distinguished from standard right-of-way fencing which is primarily only effective for livestock. Concave or lipped concrete walls; buried small mesh wire; 2 m page wire. | All animals, including some birds, can be effectively barriered from the roadway with fencing designed to match their physical and behavioral characteristics. | Wildlife tend to have 4 types of fence avoidance behaviors: Pushing, digging, climbing, or jumping. |

May 28, 2010 version-- Innovative Approaches to Wildlife and Highway Interactions. Table modified from NCHRP 25-27 "Evaluating the Use and Effectiveness of Wildlife Crossing Structures"

The term 'wildlife underpasses' connotes many different structures from the smallest culverts that may pass a salamander, to the space under a highway viaduct, 27.4 m (90 feet) above the landscape. We propose a definitive set of conditions for four different underpasses, the overpass, and two unusual designs for passages. The critical dimensions for breaks among the four classes are based on heights and widths of structures, which are dictated by engineering design constraints and wildlife characteristics that define individual species willingness to move through a structure. We support the above classifications with the information below.

Small

We based this categorization on the engineering constraints that make this size of 1.5 meters (5') the typically largest a prefabricated culvert can be made without specific site limitations. Small passages are typically (but not always) preferred by smaller mammals, and amphibians and reptiles which do not hesitate to enter confined spaces and may need cover and other conditions such as moisture that are more typically found in smaller spaces than in larger passages. Aquatic passages which are designed to only convey water typically fall into this category. We strongly recommend that even these smaller structures be designed to allow some terrestrial movement to the sides of the aquatic passages.

Medium

The minimum size of medium passages are just above the upper limit for small passages (1.5 m, 5') height limit. We use height as the definitive at this level because the majority of existing passages in this size class are culverts where the height is equivalent or similar to the width (width as animal approaches, or length as autos travel overhead). We decided to make the upper limit of medium sized passages based on the constraints of deer use. We want large passages to be defined in part as the passages that will pass deer (both mule and white tailed). Deer have typically been the definitive species for passages. This is changing with time, but minimum dimensions for deer passage is a frequently asked question by practitioners. We decided to make the 8' by 8' standard box culvert (2.4 m by 2.4 m) as the upper limit of the medium passage, since deer have typically not preferred these passages, fully understanding that in some instances deer will use these. A very important different crossing structure that is also 2.4 m high is a bridge, which is much wider than a 2.4 culvert, thus having a lot more visible openness than a 2.4 box culvert. The most popular example of a bridge that is 2.4 m high and 13.1 m wide which has documented proof of deer movement is the 24 underpasses in Florida built under I-75 for Florida panther and the suite of species in the ecosystem (Foster and Humphrey 1975). This size structure or slightly smaller (2.4 m high and over 10 m wide) is to be classified as Large (Class 3). The break between 2.4 m (8 feet) high and 3.1 m (10 feet) high is also based on a definitive break in the grouping of existing passages. See Figure 1 below for a graph of number of passages in each size category, and a break in the data.

Large

The minimum dimensions for large passages are based largely on the minimum sizes mule deer and white tailed deer have been documented using and prefer to use. There are 5 bridges and 22 culverts ranging from 2.5 m to 3.1 m high that have been constructed at least in part for deer, and some of these have been documented as working (see below). In our list of over 140 passages where we have the documented dimensions, the smallest passage that has been monitored and verified used by deer is the 10 by 10 foot (3.1 m by 3.1 m) culvert in Dowd Junction Colorado (Reed et al. 1975). Donaldson (2005,2006) documented limited use of a smaller culvert (10 ft by 6 ft), but recommends passage height be at least 12 feet (3.7 m). Gordon and Anderson (2003) recommend the minimum dimensions for a deer passage in their study area in Wyoming be at least 8 feet (2.4 m) high and 20 feet (6.1 m) wide. We used the Gordon and Anderson recommendation and the Reed et al. results as the minimum sizes for a 'large' passage, either a 2.4 m h by 6.1 m wide (8' h x 20'w) culvert or 3.1 m by 3.1 m (10' x 10') culvert, or a bridge of a minimum of 2.4 m high and 10 m wide (which is similar to the 2.4 m high x 13.1 m wide bridges under Florida's I-75, which are used by white tailed deer). Bridges are typically over 13 m wide (43 ft), (which is the span the autos travel over). The added width provides greater openness to a passage.

Viaduct

These passages are areas where the roadbed is elevated over the landscape for such large distances and heights that most wildlife and processes in the area will use the passage beneath.

Overpass

There are only 8 overpasses for wildlife in North America. The minimum dimensions are taken from the first wildlife overpass in North America, built in 1975 for mule deer in Utah. Deer do use this rather narrow, 6.7 m passage. The best studied, largest (50 m across) and certainly the most used passages are in Banff National Park and have been documented passing almost every large

and meso mammal species in the Park, from grizzly bear and elk to lynx (Clevenger and Waltho 2000, 2005, Clevenger et al. 2001). Wildlife use has been found to be dependent on the ability of an animal to see across the passage to where it connects to, vegetative cover, lack of human use, and fencing to guide the animals to the passage. Overpasses have also been used over above ground pipelines, with anecdotal evidence of caribou, moose, black bear and coyote use.

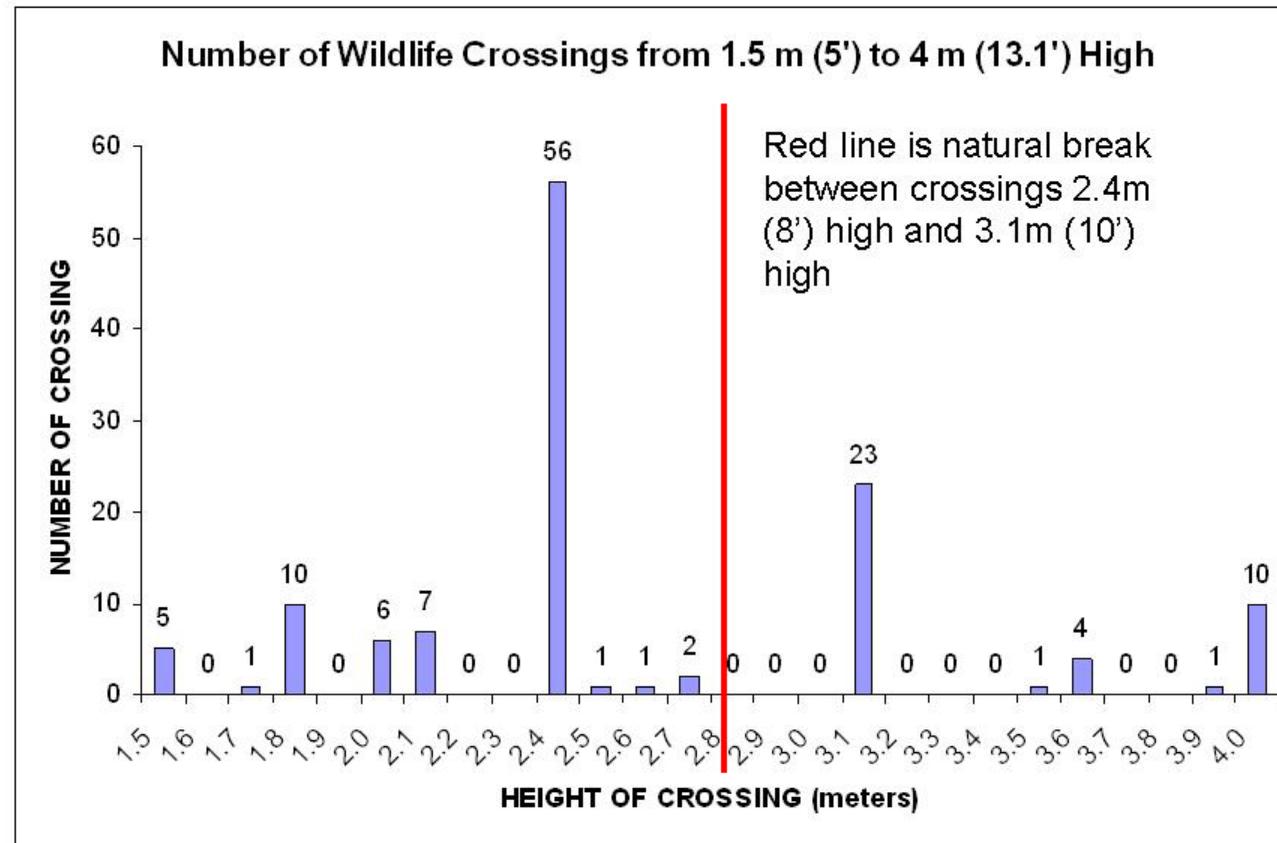


Figure 1. Number of wildlife crossings within each one/tenth of a meter height class.