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I-89 and U.S. Route 2 over Sharkyville Brook: Wildlife Crossing Structure Design and Monitoring

The following is a supplemental memorandum addressing the justification for the selection of wildlife monitoring surveys and related wildlife design components into the crossing structure design recommended by Hoyle Tanner.

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Introduction

Nation-wide, wildlife-vehicle collisions (WVCs) have been estimated to cost Americans approximately $8 billion dollars annually (Huijser *et al*. 2008). The Vermont Agency of Transportation (VTrans) places high emphasis on understanding and mitigating impacts of wildlife-vehicle collisions and habitat fragmentation on wildlife species ecology as well as public safety and the economy (Hardy et al. 2003). As is detailed in the grant application VTrans submitted to the U.S. Department of Transportation, Federal Highway Administration Wildlife Crossings Pilot Program[1,2]; placing a wildlife crossing structure across U.S. Highway Route 2 and U.S. Highway Interstate-89 near the Sharkyville Brook in Waterbury, Vermont (Project)"...is perhaps the single most important wildlife measure related to Vermont's transportation system, because it would reconnect large and valuable habitat blocks in the Green Mountains that are separated by only the I-89 corridor..."

The prior wildlife connectivity study of the project corridor completed by McFarland Johnson (McFarland Johnson 2016) detailed broad objectives that collectively facilitated the selection of the present crossing location at Sharkyville Brook. These study results documented several species using the selected project area which emphasizes its importance as a significant corridor for wildlife movements. In addition, documentation of these species in the project area highlights the need to incorporate species-specific design components into the wildlife crossing structure to encourage its use. Hereafter, a more targeted approach to the habitat design and monitoring of wildlife use of the selected crossing structure location will be employed by Hoyle Tanner. Incorporating design components into the habitat surrounding and within the selected crossing structure will ensure the highest probability of success.

[1] https://highways.dot.gov/federal-lands/wildlife-crossings/pilot-program
[2] https://www.mjinc.com/mjweb/projects/public/waterbury

Wildlife Habitat Design

Arch-style underpass crossing structures, like what is proposed for this project, have been shown to be effective at facilitating movements of large mammals across a highway barrier (Andis *et al*. 2016). However, research has shown that to ensure success, the incorporation of species-specific habitat components into design of any crossing structure is crucial (Clevenger and Waltho 2005). To incorporate wildlife species-specific habitat requirements into the design of the crossing structure, Hoyle Tanner will primarily adhere to recommendations listed in the Wildlife Crossing Structure Handbook, Design and Evaluation in North America (Clevenger and Huijser 2001) as well as the recommendations of VTrans and VT ANR Fish and Wildlife Biologists. Although the siting location and structure size will be used to primarily accommodate American black bear (*Ursus americanus*), white-tailed deer (*Odocoileus virginianus*) and moose (*Alces alces*), Hoyle Tanner will utilize additional design components to meet the movement needs of the widest possible range of species that are native to the area (Clevenger and Huijser 2001).

Crossing Structure Design

Human Disturbance

Human activity near a crossing has been shown to negatively impact wildlife use of that structure (Clevenger and Waltho 2000). Hoyle Tanner understands that a project such as this may invite curiosity and interest from the public. However, given the importance of maintaining an ideal environment to encourage use of the crossing structure by area wildlife, Hoyle Tanner will explore options for signage or other passive deterrents that would discourage human visitation to the area.

Wildlife Fencing

When designed based on the requirements of target species, properly implemented and maintained crossing structures that include wildlife fencing can reduce vehicle collisions with large mammals by 80-97%. However, to be most effective, fencing needs to be placed along mitigated road sections >5 km long (Huijser *et al.* 2016). Therefore, Hoyle Tanner will investigate alternatives to incorporate wildlife fencing with the planned wildlife crossing structure in a way that is the most effective as well as aesthetically and practically feasible. It has been noted in our observations of the site that there are natural topographic features (bedrock cliffs to the east and west of the project site) that may be suitable limits to the fencing associated with this crossing project.

Species-specific Design

White-tailed Deer and Moose

As prey species, research has shown that wildlife such as deer and moose prefer crossing underpasses with a high openness index (Donaldson 2005, Olsson 2007), suggesting they are less inclined to cross in areas where they can't readily see the other side (Hoyle Tanner recognizes that openness index is a parameter that should be considered with caution). In addition, both deer and moose have been documented to prefer crossing structures with adequate distance from thick forest cover, likely due to factors associated with visibility and predation avoidance (Clevenger and Waltho 2005, Olsson 2007). Given the fact that moose, and especially white-tailed deer are highly prevalent in the project area and thus pose the greatest risk to motorist safety, Hoyle Tanner will prioritize high visibility and openness index into final crossing structure design components. Hoyle Tanner understands there is already a well-worn wildlife trail in the vicinity of the chosen crossing location which suggests that species in the area such as deer are already accustomed to the prevailing habitat conditions so they should be maintained.

Black Bear and Mid-sized Carnivores

In the eastern United States, black bear use of wildlife underpasses is not well understood, and reports from previous studies have been conflicting (Donaldson 2005). Clevenger and Waltho (2005) documented black bear use of crossing structures to be negatively correlated with relative openness, while other studies found structure dimensions to be minimally correlated with use (Clevenger and Waltho 2000) and proximity to herbaceous vegetation as a stronger predictor (Donaldson 2005). Hoyle Tanner will consider implementing native plantings on either side of the crossing that offer preferred seasonal food items for black bears such as soft mast and herbaceous vegetation.

For mid-sized carnivores such as coyote, bobcat, and lynx, studies suggest that availability of prey-species and habitat surrounding the structure as opposed to structure dimensions may more strongly predict crossing (Clevenger and Waltho 2005, Caldwell and Klip 2020). While maintaining relative openness in the crossing structure should be a priority for deer and moose, Hoyle Tanner will call for utilization of salvage materials from project construction such as logs, root wads, rocks, or brush along the walls of the wildlife crossing to encourage use by bears and mid-sized carnivores (Clevenger and Huijser 2011). Hoyle Tanner may also consider providing small culverts or pipes within the crossing structure to be used as additional cover for these species, and/or by potential prey.

Small to Mid-sized Mammals and Semi-arboreal Mammals

The Wildlife Crossing Structure Handbook similarly recommends salvage materials to be used within wildlife crossing structures to encourage use by small to mid-sized mammals as well as semi-arboreal mammals, in addition to culverts or pipes for species such as fisher or marten (Clevenger and Huijser 2011).

Semi-aquatic Mammals

To continue to encourage use by semi-aquatic mammals such as river otter, muskrat or mink in the riparian buffers along the portion of Sharkyville Brook that will run through the crossing structure, Hoyle Tanner will maintain riparian vegetation through the crossing (Clevenger and Huijser 2011).

Herpetofauna

Though the crossing is not likely to be used significantly by herpetofauna unless during dispersal, Hoyle Tanner will optimize riparian vegetation, soil moisture, and natural light conditions through the structure for these species (Clevenger and Huijser 2011).

Aquatic Organism Passage

This project inherently improves aquatic organism passage with the replacement of a long pipe culvert with natural open stream bottom. Our team will work with VTrans Hydraulics to create a channel shape that closely matches the upstream and downstream sections, is scour resistant with properly sized e-stone, is supplemented with native soils with nutrients that provide suitable habitat through the crossing and meets the bank-full width and hydraulic standards.

Wildlife Monitoring Studies

Hoyle Tanner understands that the primary purpose of wildlife monitoring surveys surrounding the crossing location is to assess the efficacy of the crossing structure in facilitating more successful movements of wildlife through the roadway bisecting the corridor. Hoyle Tanner will oversee the design and execution of a science-based monitoring study to assess wildlife use of the project area. This study will be designed to satisfy Federal grant requirements and provide VTrans with data for public and internal dissemination.

Thermal Video Cameras

According to Ford et al. (2009), utilizing track-count surveys and motion-sensor cameras to monitor wildlife use at crossing structures can result in variable detection rates of species which aligns with the results reported by McFarland Johnson. McFarland Johnson reported higher detections of large mammals such as black bear and moose using motion-sensor cameras, whereas small to midsized mammals were more reliably detected using track-count surveys. The use of thermal cameras to detect more cryptic or nocturnal wildlife species is becoming more commonly used in scientific research in part because it has been shown to be more effective in certain conditions than other monitoring methods and can support attaining unique results (Brawata *et al*. 2013, Cilulko *et al*. 2013, Gray *et al*. 2023). Partnering with Wildlife Imaging Systems[3] to utilize thermal imaging to monitor wildlife use of the project area would bring a higher level of innovation and precision to this project.

Thermal imaging cameras measure body surface temperature and have been documented to be effective in detecting warm-blooded animals as small as mice and as large as moose (Cilulko *et al*. 2013). The specific cameras used by Wildlife Imaging Systems would also provide monitoring through live-action video, which in addition to detecting various species, would allow for the study of animal behavior including ideally detecting crossing attempts (Hardy *et al*. 2003). Cilulko *et al*. (2013) details potential limitations associated with this technology and of those included, the main factors for consideration to ensure for success with this project include weather conditions, distance between the object and the camera, field of view, and vegetation density of the surveyed area. Although no survey method comes without error, Hoyle Tanner believes that by collaborating with Wildlife Imaging Systems on proper camera placement and designing a robust monitoring schedule, these limitations can be minimized. Hoyle Tanner would also work with

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[3] https://www.wildlifeimagingsystems.com/

Wildlife Imaging Systems to adjust and troubleshoot camera monitoring methods based on review of captured footage, if an issue were discovered.

Incorporating this technology into planned surveys of the project area would also present a unique opportunity to compare the data these cameras collect against data that we understand is being collected from a motion-senor camera currently deployed by VTrans in the project area. If this camera continues to be deployed throughout the duration of the project, then a true analytical comparison between these two survey methods could be made which to our knowledge has never been done before. The results of this comparison could have strong implications for not just future projects by VTrans and other transportation agencies nationwide, but also for researchers looking to utilize this technology for future wildlife monitoring studies. If VTrans is amenable to this objective, Hoyle Tanner will facilitate information sharing by providing a SharePoint site for motion-sensor camera photos to be placed on and used for analysis.

Roadkill Surveys

Assessing the "direct" effects of a travel corridor on wildlife by documenting mortality events on the roads can provide a wealth of information in addition to simply quantifying mortality numbers of different species (Schwartz *et al*. 2020). Trends in species populations, distribution, and behavioral patterns can also be evaluated by collecting wildlife roadkill data. The Vermont Agency of Natural Resources provides citizen-science opportunities for the public to submit observations of wildlife roadkill incidences in Vermont[4]. However, given the variability in reporting rates and detection rates, a more targeted and methodical approach at surveying the project area for roadkill would result in more reliable and useful data, especially for species whose carcasses may be found by scavengers and removed, or decompose much sooner than large mammals. In its proposal, Hoyle Tanner has incorporated training VTrans District staff on proper methods of wildlife species identification and data collection to be used while carrying out surveys. This will ensure more accurate reporting during the collection and disposal of carcasses within the project limits.

Additional Studies Considered

The following is a summary of additional wildlife monitoring studies that were considered during the preparation of the Hoyle Tanner proposal, with the above detailed studies ultimately being selected based on funding agency requirements and project needs. Throughout collaboration on this project, if VTrans has a desire to conduct additional studies aside from the selected and scoped thermal camera and roadkill surveys, the three-year pre-construction window would allow for the initiation of additional research. A separate scope and fee would be developed for VTrans consideration.

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[4] https://anr.vermont.gov/content/vt-roads-and-wildlife#Intro

GPS Tracking Collars

If desired, Hoyle Tanner has the expertise to facilitate the deployment of GPS tracking collars on wildlife within the vicinity of the project corridor. This would be a unique and definitive approach to documenting use of the wildlife crossing area and would allow for the detection of movement changes relative to the newly connected landscape provided by the wildlife crossing (Hardy *et al*. 2003). In addition, it would likely garner significant public interest and excitement given the accurate, fine-scale data that would be collected and readily available, and how projects such as this are rare in Vermont. However, studies such as this also need to be methodically planned given their potential to become cost-prohibitive and specific requirements for permitting, field equipment and personnel experienced with wildlife capture and handling techniques. In addition, thoughtful planning for ideal sample size and GPS collar programming would need to be done given the anticipated collar battery life compared to the estimated timeline of monitoring. There is also a high probability that some captured individuals will not survive the project's duration, requiring those collars to be redeployed.

The focal species in this project being black bear, white-tailed deer, and moose, it is logical to assume that it would be most prudent to project results and reporting to place tracking collars on one of these species. Although all three species have been documented to be using the project area, considering the behavioral ecology of each species, it would be most reasonable to deploy collars on white-tailed deer. Of the three, deer are the most densely populated in the project area and likely cause the highest amount of damage from WVCs; they have the smallest home ranges (± 1 square mile) and individuals using the area are likely to continue using it so collared individuals in the area would have a high probability to use the crossing structure once completed; and they are the easiest to capture so would have the most efficient catch-per-unit effort. Hoyle Tanner is not aware of any known research in recent years that placed GPS collars on white-tailed deer in Vermont. GPS collars placed on deer in the project area (which when programmed accordingly could hold a battery life of <10 years) could provide significant insight into space-use and resource selection of individuals within the wildlife corridor, which would have significant applications for VTrans and other transportation agencies.

DNA Monitoring

Wide-ranging, large-bodied apex consumers such as black bears can be particularly susceptible to road-caused population fragmentation due in part to their reproductive rates and large home-ranges (Sawaya *et al*. 2013), which has already been anecdotally documented in the project area (J. Hilke, *Personal Communication*). This illustrates the importance of not only documenting black bear use of the project area, but also understanding individual, sex, and age-specific use of the crossing structure area which DNA monitoring could reliably provide. Utilizing hair-snares, Hoyle Tanner can collect DNA data in the project area which would be consistent with previous methodology employed by McFarland Johnson.

Motion-sensor Trail Camera and Track-count Surveys

As mentioned, motion-sensor camera and track-count surveys were previously completed in the project area which allowed for ultimate selection of the current site for wildlife crossing structure placement. If desired by VTrans, Hoyle

Tanner has the ability and expertise to continue with these surveys using comparable methods with the selected crossing location as a focal area.

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