

CHANJ

Connecting Habitat Across New Jersey

Guidance Document Version 1.0 - 2019



New Jersey Department of Environmental Protection • Division of Fish and Wildlife



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Version 1.0

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CHANJ Working Group



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Thank you, Core Team members!

NJDEP Partners:

Office of the Commissioner; Air Quality, Energy, and Sustainability; Land Use Management; Natural and Historic Resources

Outside NJDEP Partners:

Conserve Wildlife Foundation of New Jersey, Delaware Valley Regional Planning Commission, Drexel University, Mercer County College, Montclair State University, Natural Resources Conservation Service, New Jersey Audubon Society, New Jersey Conservation Foundation, New Jersey Department of Transportation, New Jersey Highlands Council, The Nature Conservancy – New Jersey Chapter, North Jersey Transportation Planning Authority, Open Space Institute, Rutgers University, U.S. Fish and Wildlife Service – New Jersey Field Office

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POLICY AND REGULATIONS

Please note that the CHANJ Mapping and Guidance Document are tools for prioritizing habitat conservation in New Jersey and do not supersede or replace any regulatory requirements implemented by agencies with local, state, or federal jurisdiction for any activities, nor the requirement for permits or approvals under any such jurisdiction(s). For specific information concerning potential State jurisdiction under regulations implemented by the NJ DEP Division of Land Use Regulation, please visit <http://www.nj.gov/dep/landuse/> or contact the NJ DEP Division of Land Use Regulation at (609) 777-0454.

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CHANJ MISSION STATEMENT

To envision and guide a landscape strategy that preserves, restores, and maintains habitat connectivity for terrestrial wildlife across New Jersey, helping to ensure that healthy populations can persist long into the future

EXECUTIVE SUMMARY

Animals need to be able to move through the landscape to find food, shelter, mates, and other resources. Without that ability to move, healthy populations simply cannot persist over the long term. Here in New Jersey, wildlife are up against steady urbanization, a dense network of roads, and now a changing climate, all of which put the connectedness of our habitats and wildlife populations in jeopardy.

CHANJ is an effort to make our landscape more permeable for terrestrial wildlife by identifying key areas and actions needed to preserve and restore habitat connectivity across the state. This initiative is designed to help 1) prioritize land protection, 2) inform habitat restoration and management, and 3) guide mitigation of barrier effects on wildlife and habitats. CHANJ offers tools and resources to guide these goals forward in a strategic way and help target local, regional, and state planning efforts. The tools also help land-use, conservation, and transportation planners to be more proactive and collaborative, which reduces conflict and saves time and money. The success of CHANJ depends on partnerships like these to implement its guidance.

Drawing from the collective knowledge and experience of other states – at least half of which have habitat connectivity plans of their own – we formed a multi-partner, multi-disciplinary working group to inform this project’s development. The CHANJ Working Group helped research and design the connectivity mapping analyses, assisted in validating the mapping, and suggested implementation actions that end-users can take to apply CHANJ on the landscape.





Connecting Habitat Across New Jersey



Chapter 1. An Introduction to CHANJ

Whether they're small like a salamander or big and wide-roaming like a bear, wildlife need to be able to move through the landscape to find food, shelter and mates—all the things they need in life. Their movements can vary by season or by the need to go somewhere new, like a wood frog's spring migration to her breeding pond, or a young bobcat's journey to find a territory of his own. Without that ability to move, healthy populations simply cannot persist over the long term. Here in New Jersey, wildlife are up against steady urbanization, a dense network of roads, and now a changing climate, all of which put the connectedness of our habitats and wildlife populations in jeopardy.

Connecting Habitat Across New Jersey (CHANJ) is an effort to make our landscape more permeable for terrestrial wildlife by identifying key areas and actions needed to achieve habitat connectivity across the state. This initiative is designed to help 1) prioritize land protection, 2) inform habitat restoration and management, and 3) guide mitigation of road barrier effects on wildlife and their habitats.

CHANJ offers tools and resources to guide these goals forward in a strategic way. Whether on the local or statewide scale, the tools can help land managers, transportation planners, conservation groups, and the general public to visualize their place in New Jersey's habitat connectivity puzzle and to be more proactive and collaborative in their planning efforts. The ability to predict connectivity-related issues and opportunities can also reduce conflict and save time and money. The success of CHANJ depends on a variety of user groups and partnerships implementing its guidance.

New Jersey has a good foundation for achieving measurable success in habitat connectivity. Our state has done an outstanding job protecting open space for people and nature. More than one-third of the state's land mass (over 1.5 million acres) is now permanently preserved, thanks to proactive local governments and land trusts, the state Green Acres program, Farmland Preservation, and our citizens, who have consistently voted in favor of open space funding. But to maximize this investment for wildlife and ecosystems, we need to make sure that preserved lands aren't isolated; that they are instead are part of a functionally connected network of habitats. We need to be strategic about our future acquisitions – considering how each piece of land fits into the broader landscape context – as well as cognizant of how roads may be fragmenting or limiting wildlife access to even the best of our protected lands.

The challenge is great: New Jersey is the most densely populated state in the country (United States Census Bureau 2010), with the densest network of roads (National Research Council 2005). These realities make it

Chapter 1. Introduction to CHANJ

increasingly difficult for wildlife to safely move through the landscape to find the resources they need to survive and thrive. Climate change and sea level rise will only exacerbate our fragmentation problems, as the ability for wildlife to move and adapt has never been more crucial.

The actions we take now will determine what New Jersey's final landscape looks like and how much room is left for wildlife to roam. CHANJ offers a strategy to make sure those actions consider habitat connectivity.



NEW JERSEY LAND USE CHANGE AND HABITAT FRAGMENTATION

Habitat fragmentation is a “landscape-scale process involving both habitat loss and the breaking apart of habitat” (Fahrig 2003). Globally, habitat loss and fragmentation are worsening as a result of urbanization, the growth of industrial agriculture, expanding road networks, and a changing climate. A recent study of the contiguous United States found that just 41% of our natural land area – and less than 2% of natural land in the eastern U.S. – is connected enough for plants and animals to be able to move to maintain “climate parity” as temperatures warm (McGuire et al. 2016).

Here in New Jersey, the conversion of open space to urban land has only increased in recent years, with more than 323,000 acres entering the urban land class between 1986 and 2007 (Hasse and Lathrop 2010). As of 2012, more than 30% of our land area is considered “urbanized,” and fewer than a million buildable acres remain with development potential, foreshadowing that New Jersey’s final landscape will essentially be decided over the next few decades (Lathrop and Hasse 2016). The patterns of urbanization are also important. New Jersey is situated between the two major U.S. cities of Philadelphia and New York City, resulting in dense urbanization across the centerline of our state. This supports the movement of people and goods but severely fragments the habitats of central New Jersey and all but blocks wildlife connectivity between the north and south.

From a regional perspective, New Jersey also has an important role to play in habitat connectivity beyond our borders. Wildlife do not recognize jurisdictional boundaries. The Nature Conservancy has identified the Appalachians, extending from northern Alabama into Canada, as an extremely important region for wildlife movement and adaptation to a changing climate (E. Olsen, personal communication, February 1, 2019) based on

their **Resilient and Connected Landscapes mapping** of Eastern North America (Anderson et al., 2016), and New Jersey is a critical piece of that puzzle (Fig. 1.1). **The Staying Connected Initiative** is one organization that crosses state and national boundaries to advance regional connectivity in the northeast. Knowing that our efforts to restore and maintain connectivity in New Jersey will also benefit our region only strengthens the point of taking action now.

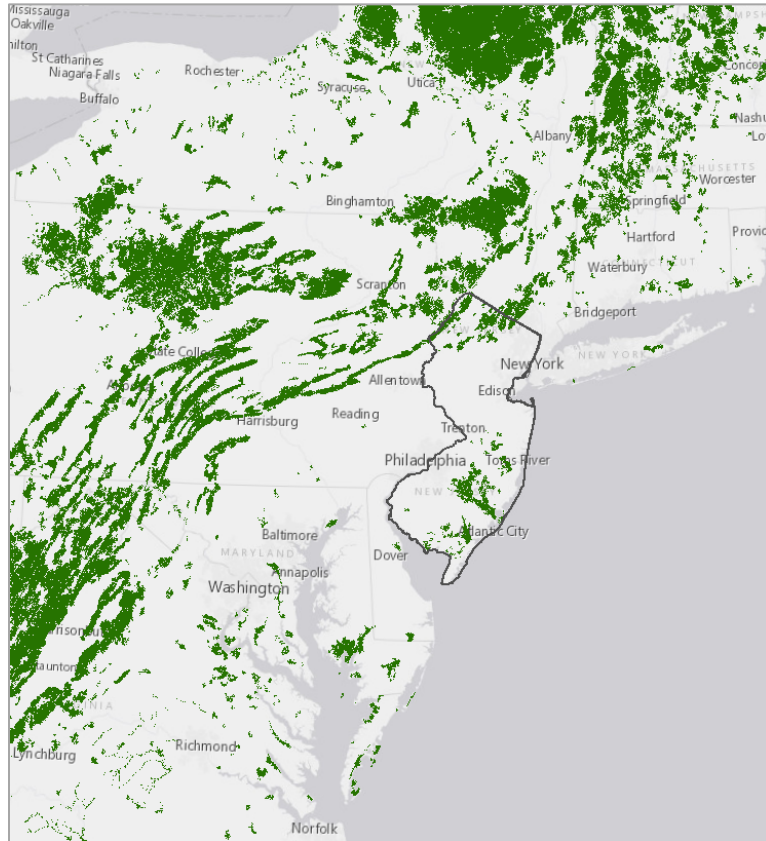


Figure 1.1 Map of New Jersey (black border) and the northeast states with The Nature Conservancy's Resilient and Connected Landscapes for Terrestrial Conservation "anthropogenic resistance" modeling. The dark green areas are predicted to see concentrated flow, channeling or accumulation of species as the climate changes.

IMPACTS OF ROADS ON NEW JERSEY'S WILDLIFE

Increased urbanization typically leads to expanded transportation networks or increased traffic on existing roadways. Roads impact wildlife populations in multiple ways, from direct mortality of vehicle-struck individuals to barrier effects on wildlife movement (Fig. 1.2). Millions of animals die outright every year trying to cross roads in the U.S. and worldwide (Forman and Alexander 1998). The negative effects of roads on wildlife and ecosystems are of great (and growing) conservation concern as humans continue our sprawl into previously uninhabited areas. These effects may lead to significant population declines for many wildlife species, including those already facing extinction (Reh and Seitz 1990; Langen et al. 2009). Animals with large home ranges are especially vulnerable to population declines as a result of increased road traffic conflicts and habitat loss (Pope et al. 2000; Steen et al. 2006).

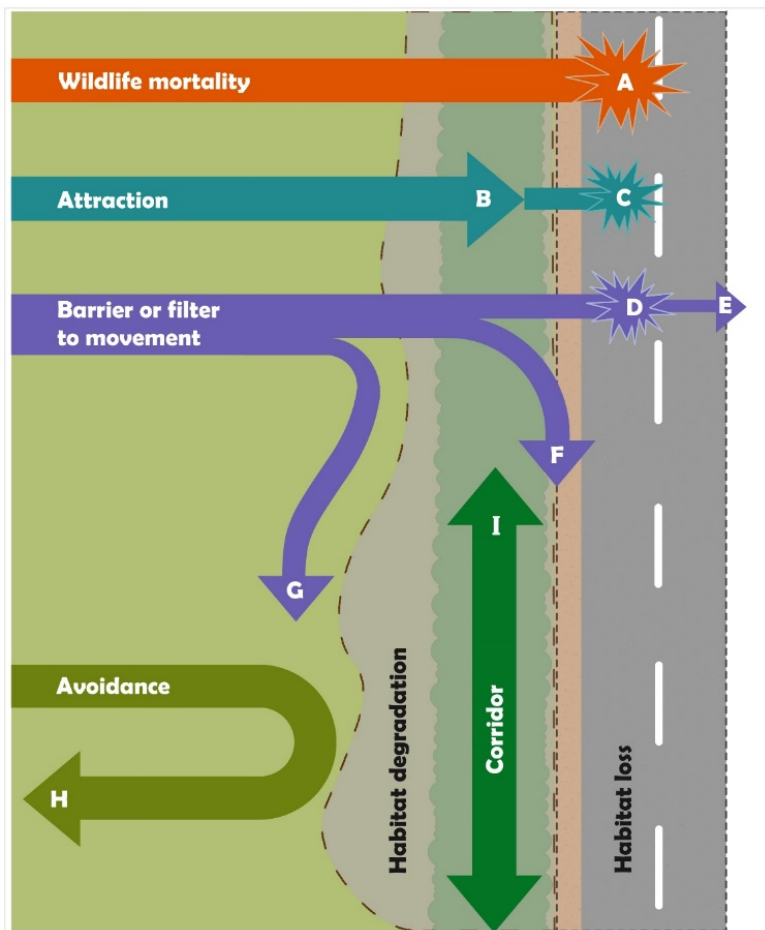


Figure 1.2 Impacts of roads on individual wildlife, populations and ecosystems. Habitat is lost to build the road and habitat adjacent to the road is degraded. The most obvious impact of roads and traffic on wildlife is mortality due to wildlife-vehicle collisions (A). Some species are attracted to resources (e.g., carrion, spilled grain or heat for basking) on the road or roadside (B) which, depending on the animal's ability to avoid traffic, may result in death due to vehicle collision (C). The barrier or filter effect reduces the movement of animals across the road and a proportion of individuals that attempt to cross are killed (D) and some make it across (E), while others are deterred by the road (F) or degraded roadside habitat (G). Other species actively avoid the road or degraded habitat (H). By contrast, some species use the roadside vegetation as habitat and/or as a corridor for movement (I). (Reprinted from the *Handbook of Road Ecology* (van der Ree et al. 2015) with permission from R. van der Ree.)

The degree to which a road network impacts wildlife movement depends largely on the density of the road network and on traffic volumes (Seiler 2003; van der Ree et al. 2015). In New Jersey, not only do we have the densest roadway network in the U.S., but many high-volume roads (used by more than 10,000 vehicles per day) criss-cross the state as well (Fig. 1.3). The National Insurance Crime Bureau reported that between 2014 and

2017, New Jersey had the 12th highest number of "animal loss claims" in the nation, citing more than 59,000 wildlife-vehicle incidents (Fenning 2018). The same report showed a 6% national increase in these claims from 2014 to 2017, showing that wildlife-related collisions are trending upwards. Most vehicle collisions reported in the northeast states are with white-tailed deer, while vehicle strikes involving smaller animals generally go unreported because they result in minor to no damage to the vehicle and no harm to the driver or passengers. Accidents caused by a driver swerving to avoid an animal on the road certainly occur as well, but these are typically reported as collisions with roadside objects, other vehicles, etc., and as such are not included in wildlife collision statistics (van der Ree et al. 2015).

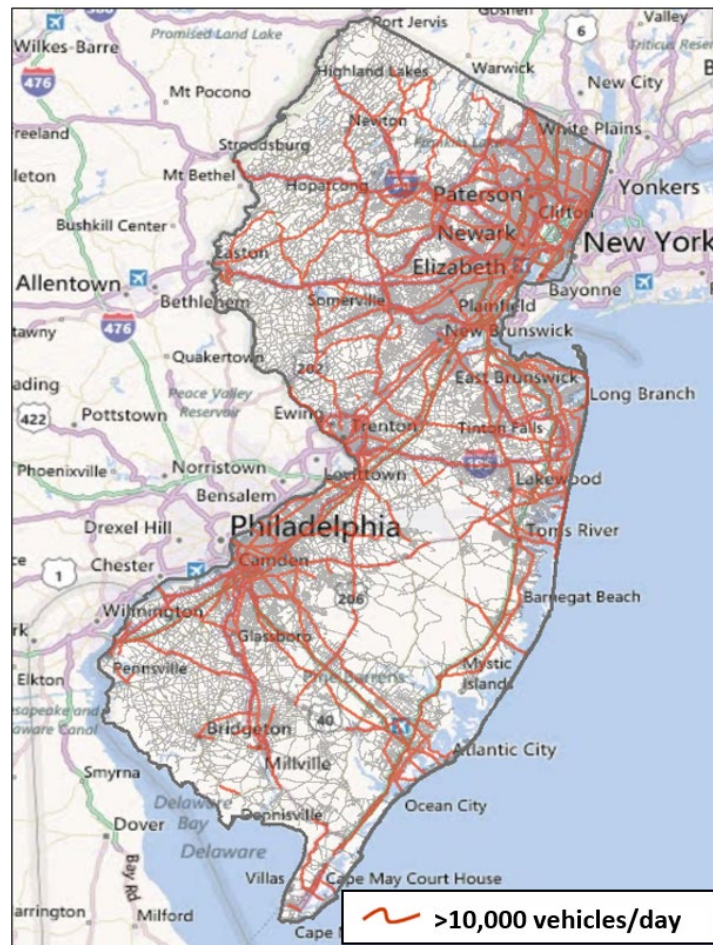


Figure 1.3 New Jersey’s extensive road network, with high-volume roads highlighted as red lines.

The New Jersey Division of Fish and Wildlife’s Endangered & Nongame Species Program (ENSP) Biotics database contains over 500 opportunistic observations of threatened and endangered wildlife on roadways over the past several years. A few species, including two snakes, have been studied to better understand the effects of roads on their populations. An assessment of the Northern Pine Snake (a state threatened species) found that major roads through their historic and present ranges are likely serving as barriers to movement and are dividing these animals into at least three discrete populations (New Jersey Division of Fish and Wildlife 2009). Similarly, researchers from Arcadia University and the College of New Jersey have found that paved roads are acting to isolate populations of the Timber Rattlesnake (state endangered) in the New Jersey Pine Barrens (Bushar et al. 2015). This isolation effect is not unique to slow-moving animals; it’s happening with more mobile species with larger home ranges as well. The movements of eleven Bobcats fitted with satellite or GPS collars by the ENSP

distinctly demonstrate the barrier effect caused by roads, particularly those with high traffic volumes (Fig. 1.4).

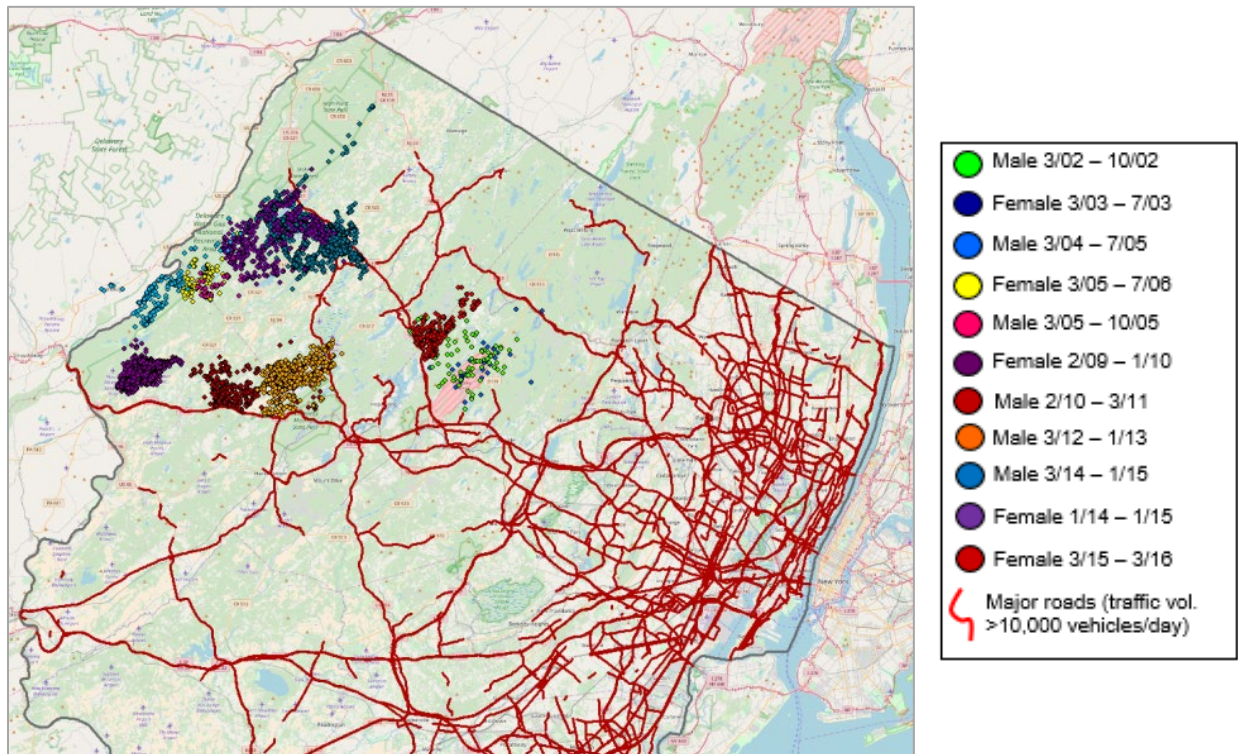


Figure 1.4 The movements of eleven collared Bobcats between 2002 and 2016 were distinctly bounded by roads, particularly high-volume roads.

Habitat fragmentation – due to a combination of urbanization and roads – is a leading threat to New Jersey’s terrestrial Species of Greatest Conservation Need and undermines our best efforts to maintain and restore wildlife populations. Consequently, habitat connectivity-related threats and actions are featured prominently in [New Jersey’s Wildlife Action Plan](#) (New Jersey Division of Fish and Wildlife 2018). In fact, the statement that “Habitat Loss or Modification is the Greatest Threat to New Jersey’s Wildlife” is the first of seven key considerations that permeate all aspects of the Plan. CHANJ is explicitly described as a tool to help address habitat fragmentation and connectivity issues.

SIGNIFICANCE OF HABITAT CONNECTIVITY

The challenge to reverse decades-long trends in habitat change and road impacts is daunting, but even making incremental progress with implementing the CHANJ guidance across our key connectivity areas can result in positive outcomes toward:

- Wildlife population recovery and sustainability
- Maximizing New Jersey’s open space investments
- Increased permit efficiency and cost savings for transportation projects
- Improved driver safety by keeping wildlife off roads

Chapter 1. Introduction to CHANJ

The need to restore and maintain landscape connectedness has become a priority for wildlife conservation, to allow gene flow between wildlife populations (Beier and Noss 1998, Soule´ and Orians 2001; Hilty et al. 2006). A well-connected landscape is also a key climate change adaptation strategy, allowing for species to move as necessary to follow their preferred climates (Beier et al. 2008, Heller and Zavaleta 2009, Lawler 2009, Keeley et al. 2018).



Certain habitat features are especially important to the long-term persistence of wildlife populations and can facilitate their dispersal and range expansion; these include large protected areas connected by corridors, smaller live-in “stepping stone” habitats between large protected areas, and riparian areas (Seavy et al. 2009, Beier 2012, Fremier et al. 2015, Saura et al. 2014, Keeley et al. 2018, Krosby et al. 2018). All of these features are represented in the CHANJ Mapping tools, described in the next chapter, which help us to think strategically about how to secure New Jersey’s remaining undeveloped land for habitat connectivity while taking advantage of what’s already been protected. Together, the CHANJ tools promote transparency by identifying valuable habitats for terrestrial wildlife and priority areas for mitigation efforts, along with guidance on how to implement actions. Knowing upfront where roads are most detrimental to connectivity, for example, can help with more proactive, wildlife-friendly transportation planning and design. Reducing the number of big and small animals that enter a roadway is safer for drivers and wildlife alike.

Because New Jersey is now joining a long list of other U.S. states and countries engaged in habitat connectivity efforts, we have the added advantage of knowing that pro-connectivity actions actually work. In Wyoming, for example, a focused, multi-partner effort to safeguard the “Path of the Pronghorn” has resulted in thousands of acres of land being preserved within the animals’ critical migration corridor ([The Conservation Fund](#), accessed April 11, 2019) There are also a number of studies that highlight the effectiveness of well-designed, well-constructed road mitigation projects at reducing wildlife-vehicle collisions and benefiting species’ populations (van der Ree et al. 2015).

Our vision for CHANJ aligns with New Jersey Department of Environmental Protection (DEP) priorities to reduce and respond to climate change and to manage and promote thriving natural and historic resources. It advances the mission of the New Jersey Division of Fish and Wildlife to protect and manage the State's fish and wildlife to maximize their long-term biological, recreational and economic values for all New Jerseyans.



At least 127 of New Jersey’s terrestrial wildlife species stand to benefit from the connected landscape envisioned by CHANJ. They include a variety of game and nongame species, some of which are rare and others that are common. Eighty-two of these animals (65%) are recognized as Species of Greatest Conservation Need in [New Jersey’s Wildlife Action Plan](#), like the Bobcat, Blue-spotted Salamander, and Northern Diamond-backed Terrapin, due to their low or declining populations and need for conservation.

CHANJ WORKING GROUP

Development of the CHANJ products is credited to the CHANJ Working Group, which has included representatives from natural resource management groups, transportation planning agencies, conservation organizations, and universities and institutes. Individuals from these different groups possess the combined skills and expertise from their respective fields that were needed to foster sound product development as well as on-the-ground implementation of the CHANJ guidance.

The role of the Working Group has been mainly to provide input to three Core Teams and to contribute to consensus-based decisions about the CHANJ products. The Core Teams (Mapping, Guidance Document, and Communications) are subsets of the Working Group and are the backbone of the project. Since late 2012, the three teams have met as often as every other month, with email, phone conversations, and assignments in between. During product development, the Core Teams updated and sought feedback from the full Working Group quarterly to annually. A separate group – primarily Core Team members from the DEP and New Jersey Department of Transportation – also met regularly as a Roads & Wildlife Working Group, specifically to work together on habitat connectivity topics related to roads. Table 1.1 lists the number of meetings/webinars held by each group during the development of CHANJ.

Table 1.1 Meetings/webinars held by the CHANJ Working Group, Core Teams, and Roads and Wildlife Working Group during the development of CHANJ.

CHANJ Working Group Meetings	
Working Group/Core Team	# of Meetings/Webinars
Full CHANJ Working Group	5
Core Team – Mapping	23
Core Team – Guidance Document	23
Core Team – Communications	16
Roads & Wildlife Working Group	28

Products developed by the Core Teams are designed to inform and guide a variety of implementable conservation actions to enhance New Jersey’s habitat connectivity. After the release of CHANJ, ongoing mapping validation, monitoring of on-the-ground actions, and further research will continue to inform the CHANJ products, making them more effective, user-friendly, and applicable over time (Fig. 1.5).

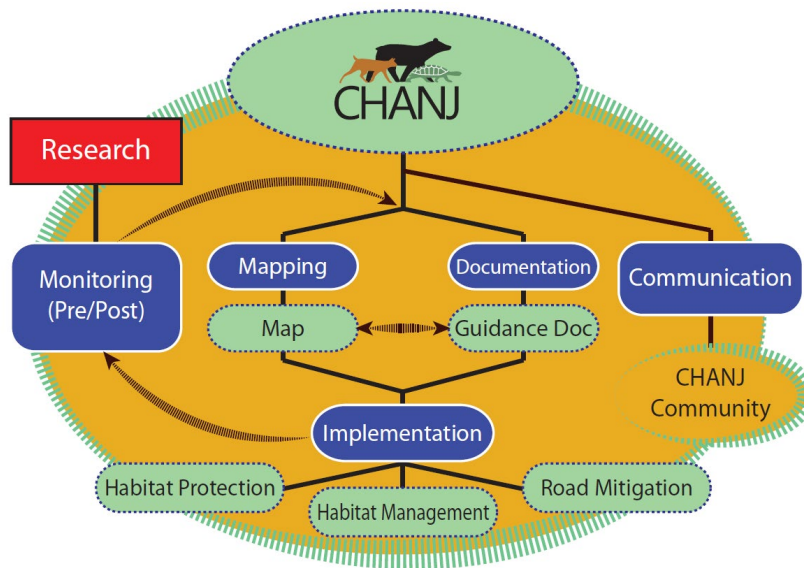


Figure 1.5 Flow chart of CHANJ, showing the various elements used in product development. These feedback loops will continue to inform and improve the CHANJ products over time.

HOW TO USE THIS DOCUMENT

The primary end-users of CHANJ and its products include land use planners, habitat managers, transportation agencies, and land trusts. The public also have an important role to play, both in managing private lands in a manner that supports nature and biodiversity, and in advocating for conservation in their communities. CHANJ can help focus these efforts on key areas at the local level which can benefit wildlife persistence and connectivity more broadly.

What follows in this CHANJ Guidance Document are information and resources to guide a landscape strategy that preserves and maintains habitat connectivity for terrestrial wildlife across New Jersey, helping to ensure that healthy populations can persist long into the future.

Here's what you will find in the remaining chapters:

- Chapter 2. CHANJ Mapping Tools – The CHANJ Mapping highlights our state’s remaining core terrestrial wildlife habitats and the corridors connecting them, as these Cores and Corridors are critical for the long-term viability of terrestrial wildlife populations. The Mapping also identifies road segments that intersect habitats and are likely to pose barriers to wildlife movement. This chapter describes the goals of the CHANJ Mapping, the methodology used to create it, and where it can be accessed.
- Chapter 3. Connectivity Assessments – The CHANJ Mapping not only provides a common vision for working toward a more connected landscape; it also gives us a basis to evaluate landscape connectivity trends over time from statewide, regional, and local scales. This chapter describes the current state of connectivity across New Jersey and its separate landscape regions and details the various metrics CHANJ will use to assess connectivity-related patterns (and hopefully, progress) over time.

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- Chapter 4. Guidance for CHANJ Cores and Corridors – The Cores, Corridors, and Road Segments depicted in the CHANJ Mapping Tools are meant to highlight the most advantageous places to implement conservation actions for wildlife connectivity, as they represent New Jersey’s most contiguous remaining habitat areas and the best opportunities to keep those areas functionally linked. This chapter provides ideas, contacts, and specifications related to habitat protection, habitat restoration and management, and mitigation of road barrier effects.



- Chapter 5. CHANJ Action Teams – Because the various connectivity actions fall under the scopes of different agencies, organizations, and landowners, partnerships are critical for successful implementation. We have organized CHANJ Action Teams as a way of bringing implementers together to advance connectivity across New Jersey.

CHANJ implementers may also be interested in [New Jersey’s Wildlife Action Plan](#). This Plan is a blueprint for conserving the state’s wildlife resources and their habitats, including our 656 Species of Greatest Conservation Need (SGCN). Many components of the Plan are useful to private property owners, whether they manage a small backyard or a significantly larger property, a farm, a forest, or anything in between. The Plan can also be applied by the managers who steward the state’s many public and nonprofit-owned parcels.

REFERENCES

- Anderson, M.G., Barnett, A., Clark, M., Prince, J., Olivero Sheldon, A. and Vickery B. (2016). Resilient and Connected Landscapes for Terrestrial Conservation. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, MA.
- Beier, P. & Noss, R.F. (1998). Do Habitat Corridors Provide Connectivity? Conservation Biology 12(6).
- Beier, P., Majka, D.R., Spencer W.D. (2008). Forks in the Road: Choices in Procedures for Designing Wildland

Chapter 1. Introduction to CHANJ

Linkages. *Conservation Biology* 22(4).

Beier, P. (2012). Conceptualizing and Designing Corridors for Climate Change. *Ecological Restoration* 30(4).

Beier P., Capon S.J., Chambers L.E., Mac Nally R., Naiman R.J., Davies P., Marshall N., et al. (2013). Riparian Ecosystems in the 21st century: Hotspots for Climate Change Adaptation? *Ecosystems* 16.

Bushar, L.M., Bhatt, N., Dunlop, M.C., Schocklin, C., Malloy, M.A., Reinert, H.K. (2015). Population Isolation and Genetic Subdivision of Timber Rattlesnakes (*Crotalus horridus*) in the New Jersey Pine Barrens. *Herpetologica*. 71(3).

Fenning, D. (2018). 2014-2017 United States Animal Loss Claims. National Insurance Crime Bureau. <https://www.nicb.org/media/527/download>

Forman, R.T.T & Alexander, L.E. (1998). Roads and their Major Ecological Effects. *Annual Review of Ecological Systems* 29.

Fremier AK, Kiparsky M, Gmur S, Aycrigg J, Craig RK, Svancara LK. A riparian conservation network for ecological resilience. *Biological Conservation*. 2015;191: 29–37.

Golden, D.M., Winkler, P., Woerner, P., Fowles, G., Pitts, W., & Jenkins, D. (2009). Status Assessment of the Northern Pine Snake (*Pituophis m. melanoleucus*) in New Jersey: An Evaluation of Trends and Threats. New Jersey Department of Environmental Protection, Trenton, NJ. 53pp.

Hasse, J.E. & Lathrop, R.G. (2010). Changing Landscapes in the Garden State: Urban Growth and Open Space Loss in NJ 1986 thru 2007 (PDF). Geospatial Research Lab, Rowan University, Glassboro, NJ; Center for Remote Sensing and Spatial Analysis, Rutgers University, New Brunswick, NJ. Accessed from <https://www.njmap2.com/land-change/changinglandscapes2010.pdf>.

Heller, N.E. & Zavaleta, E.S. (2009). Biodiversity Management in the Face of Climate Change: A Review of 22 years of Recommendations. *Biological Conservation*, 142.

Hilty, J., Merenlender, A. & Lidicker Jr, W. (2006). Corridor Ecology: The Science and Practice of Linking Landscapes for Biodiversity Conservation. Island Press. Washington, D.C., pp. 1-345.

Keeley, A.T.H., Ackerly, D.D., Cameron, D.R., Heller, N.E., Huber, P.R., Schloss, C.A., Thorne, J.H., & Merenlender, A.M. (2018). New Concepts, Models, and Assessments of Climate-wise Connectivity. *Environmental Research Letters* 13(7).

Krosby M., Theobald D.M., Norheim R., &McRae B.H. (2018) Identifying riparian climate corridors to inform climate adaptation planning. *PLoS ONE* 13(11): e0205156. <https://doi.org/10.1371/journal.pone.0205156>

Langen, T.A., Ogden, K.M., Schwarting, L.L. (2008). Predicting Hot Spots of Herpetofauna Road Mortality Along Highway Networks. *Journal of Wildlife Management* 73(1).

Lathrop, R.G., Bogner, J., & Hasse, J.E. (2016). Changing Landscapes in the Garden State: Land Use Change in NJ 1986 thru 2012. Center for Remote Sensing and Spatial Analysis, Rutgers University, New Brunswick, NJ; Geospatial Research Lab, Rowan University, Glassboro, NJ. Accessed from

[https://crssa.rutgers.edu/projects/lc/download/NJ Urb Growth III executive summary 2012 LathropHasse.pdf](https://crssa.rutgers.edu/projects/lc/download/NJ_Urb_Growth_III_executive_summary_2012_LathropHasse.pdf).

Lawler, J.J. (2009). Climate Change Adaptation Strategies for Resource Management and Conservation Planning Annals of the New York Academy of Sciences, 1162(1).

McGuire, J.L., Lawler, J.J., McRae, B.H., Nuñez, T.A., Theobald, D.M. (2016). Achieving Climate Connectivity in a Fragmented Landscape. Proceedings of the National Academy of Sciences, 113(26).

National Research Council. The National Academies of Sciences, Engineering, and Medicine. (2005). Assessing and Managing the Ecological Impacts of Paved Roads. The National Academies Press, Washington, DC.

New Jersey Division of Fish and Wildlife. (2018). New Jersey's Wildlife Action Plan. Accessed from https://www.state.nj.us/dep/fgw/ensp/wap/pdf/wap_plan18.pdf.

Pope, S. E., Fahrig, L., & Merriam, N.G. (2000). Landscape Complementarity and Metapopulation Effects on Leopard Frog Populations. Ecology 81.

Reh, W., & Seitz, A. (1990). The Influence of Land Use on the Genetic Structure of Populations of the Common Frog *Rana temporaria*. Biological Conservation 54.

Saura, S., Bodin, Ö. & Fortin, M. (2014). Stepping Stones are Crucial for Species' Long-distance Dispersal and Range Expansion Through Habitat Networks. Journal of Applied Ecology. 51.

Seavy N.E., Gardali T., Golet G.H., Griggs F.T., Howell C.A., Kelsey R, et al. (2009). Why climate change makes riparian restoration more important than ever: recommendations for practice and research. Ecological Restoration. 27.

Seiler A. (2003). The toll of the automobile: Wildlife and roads in Sweden. Dissertation, Swedish University of Agricultural Sciences, Uppsala, Sweden.

Soule', M.E. & Orians, G. (2001). Conservation Biology: Research Priorities for the Next Decade. Island Press.

Steen, D.A., Aresco, M.J., Beilke, S.G., Compton, B.W., Condon, E.P. et al., (2006). Relative Vulnerability of Female Turtles to Road Mortality. Animal Conservation 9.

van der Ree, R., Smith, D., & Grilo, C. (2015). Handbook of Road Ecology. First Edition. Oxford: John Wiley & Sons, Ltd.

United States Census Bureau. (2010). QuickFacts: New Jersey. Accessed from <https://www.census.gov/quickfacts/geo/chart/nj/POP060210>.



Chapter 2. CHANJ Mapping Tools

The CHANJ Mapping was created to give land managers, transportation planners, conservation groups, and the general public a way to visualize New Jersey's habitat connectivity puzzle and their place within it, in order to catalyze actions that will make our landscape and roadways more permeable to wildlife movement. Fundamentally, the Mapping highlights our state's remaining core terrestrial wildlife habitats and the corridors connecting them, as these Cores and Corridors are critical for the long-term viability of terrestrial wildlife populations. The Mapping also identifies road segments that intersect habitats and are likely to pose barriers to wildlife movement. From a "glass half full" perspective, these road segments can be viewed as mitigation opportunities.

The Core and Corridor areas mapped by CHANJ can:

- Provide live-in and move-through habitat for a broad suite of wildlife
- Enable animals to meet basic daily and seasonal biological requirements (e.g., finding food, mates, cover)
- Provide for dispersal and recolonization of populations
- Enable populations to redistribute in response to climatic, environmental, and population level changes
- Facilitate genetic exchange among populations

The target species for the CHANJ mapping are 127 terrestrial wildlife species native to New Jersey for which lack of habitat connectivity or isolation of habitat may jeopardize the long-term viability of the species (Table 2.1). In some cases, species were included based on their need for terrestrial habitat connectivity during certain periods of their life cycle (such as the flightless young of some avian species that disperse long distances on the ground). In other cases, species not included on the list may benefit from habitat connectivity mapping and guidance. For example, habitat breaks are not a significant impediment to the necessary movement of Indiana bats, but the restoration/management guidance provided for core areas throughout the state will benefit the species.

Table 2.1. The 127 terrestrial wildlife species native to New Jersey that are target species for the CHANJ mapping.

Low Mobility Terrestrial Wildlife	
Mammals	
Allegheny Woodrat * (E)	Short-tailed-shrew
Eastern Chipmunk	Smoky Shrew *
Eastern Mole	Southern Bog Lemming *
Hairy-tailed Mole *	Southern Red-backed Vole
Least Shrew *	Star-nosed Mole *
Long-tailed Shrew *	Tuckahoe Masked Shrew *
Masked Shrew	Water Shrew *
Meadow Jumping Mouse *	White-footed Mouse
Meadow Vole	Woodland Jumping Mouse *
Pygmy Shrew *	Woodland Vole
Reptiles	
Bog Turtle * (E)	Little Brown Skink *
Common Five-lined Skink *	Northern Diamond-backed Terrapin *
Common Gartersnake	Northern Ring-necked Snake *
Dekay's Brownsnake *	Northern Scarletsnake *
Eastern Box Turtle * (SC)	Queensnake * (E)
Eastern Fence Lizard *	Red-bellied Snake
Eastern Mud Turtle *	Rough Greensnake *
Eastern Musk Turtle	Smooth Earthsnake *
Eastern Painted Turtle *	Smooth Greensnake *
Eastern Ribbonsnake *	Spotted Turtle * (SC)
Eastern Wormsnake *	Wood Turtle * (T)
Amphibians	
Allegheny Mountain Dusky Salamander *	Green Frog
American Bullfrog	Jefferson Salamander * (SC)
American Toad	Marbled Salamander * (SC)
Atlantic Coast Leopard Frog *	New Jersey Chorus Frog *
Blue-spotted Salamander * (E)	Northern Dusky Salamander *
Carpenter Frog * (SC)	Northern Red Salamander *
Cope's Gray Treefrog * (E)	Northern Slimy Salamander *
Eastern Cricket Frog *	Northern Spring Salamander *
Eastern Long-tailed Salamander * (T)	Northern Two-lined Salamander *
Eastern Mud Salamander * (T)	Pickrel Frog
Eastern Red-backed Salamander	Pine Barrens Treefrog * (T)
Eastern Spadefoot *	Red-spotted Newt
Eastern Tiger Salamander * (E)	Southern Leopard Frog *
Four-toed Salamander *	Spotted Salamander *
Fowler's Toad * (SC)	Spring Peeper
Gray Treefrog	Wood Frog

(Continued on next page) E – State Endangered; T – State Threatened; SC – State Special Concern; * – Species of Greatest Conservation Need (SGCN; [New Jersey’s Wildlife Action Plan](#))

Moderate Mobility Terrestrial Wildlife		
Birds	Mammals	Reptiles
American Bittern * (E)	American Beaver	Eastern Hog-nosed Snake *
American Black Duck *	Common Raccoon	Eastern Kingsnake * (SC)
American Woodcock *	Eastern Cottontail	Eastern Milksnake
Black Rail * (E)	Eastern Gray Squirrel	Eastern Ratsnake *
Clapper Rail *	Ermine	Northern Black Racer *
King Rail *	Long-tailed Weasel	Northern Copperhead * (SC)
Least Bittern * (SC)	Marsh Rice Rat *	Northern Pinesnake * (T)
Northern Bobwhite *	Mink	Northern Red-bellied Cooter *
Ruffed Grouse *	Muskrat	Northern Watersnake
Virginia Rail *	Northern Flying Squirrel *	Red Cornsnake * (E)
Whip-poor-will * (SC)	Porcupine	Snapping Turtle
Wild Turkey	Red Squirrel	Timber Rattlesnake * (E)
	Southern Flying Squirrel	
	Striped Skunk	
	Virginia Opossum	
	Woodchuck	

High Mobility Terrestrial Wildlife
Mammals
Black Bear
Bobcat * (E)
Common Gray Fox
Coyote
Fisher *
Northern River Otter
Red Fox

(Continued from previous page) E – State Endangered; T – State Threatened; SC – State Special Concern; * – Species of Greatest Conservation Need (SGCN; [New Jersey’s Wildlife Action Plan](#))

In addition to improving conditions for vulnerable wildlife, we included other species that present potentially significant safety hazards for people. For example, there are a few species, like white-tailed deer, for which lack of habitat connectivity is likely not going to jeopardize their long-term viability (at least in the foreseeable future), but they are important for us to consider in the guidance document, for instance, where we recommend certain road mitigation strategies.

The CHANJ mapping of Cores and Corridors is based on a naturalness index approach (Spencer et al. 2010, Theobald et al. 2012) wherein areas are ranked based on their degree of human modification, following the assumption that species will have more success living in and dispersing through areas that are less modified by humans. The benefits of the approach, compared to modeling several different focal species connectivity networks, is that is more analytically efficient, yields a single connectivity network thereby avoiding confusion and simplifying interpretation, and can be updated efficiently over time. In the case of the CHANJ mapping, the main (though not only) base layer component for the Core and Corridor modeling is the [NJDEP 2012 Land use/Land cover Update](#). These land use/land cover layers have been updated by the New Jersey Department of Environmental Protection at regular, approximately 5-year intervals since 1986 with plans to continue to do so.

As noted by Krosby et al. (2015), a potential downside of utilizing a naturalness-based approach is that the models may better represent the needs of larger, more mobile species because of the large analysis area (moving window) size that is often used. However, the incorporation of a range of minimum patch sizes is a way to

Chapter 2. CHANJ Mapping Tools

capture the needs of less mobile, more locally-dispersing species, which we have done by also creating a [Stepping Stones layer](#) that uses a smaller moving window size and minimum patch size requirement.

In developing the mapping, we utilized the core and corridor delineation GIS toolsets, Core Mapper and Linkage Mapper (www.circuitscape.org). The benefits to using those toolsets are they are open access, they can use customized inputs, and the tools are updated and tested on a regular basis. In addition, active tool development will enable us to assist with prioritization efforts and more explicitly incorporate climate change considerations into the modeling in future iterations (<https://circuitscape.org/linkagemapper/linkage-mapper-tools/>).

Terrestrial species location data were used to inform model parameters and for validation. The Mapping was developed using raster data (10m and 20m grid cell sizes for the Cores and Corridors, respectively), and then converted to polygons for the final product. Within the Mapping, each Core, Corridor, and Road Segment element links to a corresponding section of Chapter 4 to give recommendations and resources for restoring and maintaining key areas for wildlife connectivity through strategic Habitat Protection, Habitat Restoration and Management, or Road Mitigation.

CHANJ MAPPING METHODOLOGY

Modeling Tools Used

We utilized the core and corridor delineation ArcGIS toolsets, Core Mapper (Shirk and McRae 2013) and Linkage Mapper (McRae and Kavanagh 2011) (www.circuitscape.org), developed and made available by the [Washington Wildlife Habitat Connectivity Working Group](#). These toolsets are comprised of python scripts packaged as ArcGIS Toolboxes. Their input parameters and processing steps were found to be user-friendly and flexible.

Statewide Mapping Extent

This assessment used the NJDEP 2012 Land use/Land cover Update¹(2012 LULC). It excluded any non-inland polygons, such as the Atlantic Ocean (LU12 = 5430), Open Tidal Bays (LU12 = 5411), and any Estuaries or Stream/River (FCODE_DESCRIPTION, NHD_FCODE = 49300 and 46006) that were not inland bays, streams, rivers, or mud flats. In some cases, it was necessary to split 2012 LULC polygons to separate the inland components; where possible, those polygons were split using the Counties of New Jersey² layer. The final polygons from the 2012 LULC layer were dissolved to create a single polygon, which then served as the mapping extent for all analyses.

CHANJ Cores

Definition: CHANJ Cores are areas of contiguous natural land cover (land and water) of at least 78.5 ha. This size represents the 75th percentile of the 127 target CHANJ species' home range sizes, and thus meets the habitat needs (foraging/prey, cover, reproduction) of most terrestrial wildlife, especially if functionally linked to other Cores.

Base habitat layer development: A raster base habitat layer (10m grid size) was created with habitat values (HV) ranging from 0 (Non-Habitat) to 1 (Habitat). The base habitat layer is composed of:

1. 2012 LULC¹ classes coded as Habitat (HV 1), Marginal Habitat (HV 0.5), and Non-Habitat (HV 0) (Habitat Value in Table 2.II);
2. Wetlands/Riparian Habitat (HV 1) characterized by i, ii, iii, and iv, and excluding v as follows:
 - i. Landscape Project 3.3 Riparian Corridor³ (HV 1)
 - ii. Flood Prone areas^{4, 5} (HV 1) (⁴Selected 1 USGS Documented Flood-prone Area, 8 Water; ⁵ Selected A, AE, AH, AO, Open Water, VE)
 - iii. Hydric soils⁶ (HV 1);
 - iv. 2012 LULC¹ Wetlands (HV 1) (Wetlands = 'X' in Table 2.II);
 - v. 2012 LULC¹ Urban (HV 0) (Urban = 'X' in Table 2.II)
3. Railroads^{7,8} (HV 0) (Note: Abandoned railroad lines that have been converted to trails⁹ were removed from the Railroads layer)
4. Roads¹⁰ (HV 0)

First, layers 1. and 2. were combined into a single layer by applying the maximum value to coincident cells. The resulting layer was combined with layers 3. and 4., wherein layers 3. and 4. were removed by applying the minimum cell value.

Core area development: Core Mapper V. 0.1.8 (in the [Gnarly Landscape Utilities ArcGIS toolbox](#)) was used to model and delineate Core areas. The inputs for the modeling included:

1. Base habitat layer;
2. A moving window radius of 500m, which represents the 75th percentile of average home range sizes of all 127 target CHANJ species;
3. A minimum average habitat value of 0.69, which was informed by analyses of species location data¹¹ and their average base habitat layer values;
4. Roads¹⁰ – County, Highways, Interstates (symboltype ≥ 100 , < 700), which divide Core areas;
5. A minimum Core threshold size of 78.5 ha, which represents the 75th percentile of average home range sizes of all 127 target CHANJ species.

Core area refinement: Further refinement included removing Core areas that did not meet the minimum threshold size after subtracting areas of the 2012 LULC¹ coded as Marginal Habitat or Water Bodies (Habitat Value = 0.5; Water Body = 'X' in Table 2.II).

Validation: 77.4% (1065/1375) of Endangered, Threatened, and Special Concern species locations¹¹ observed between 2009 and 2015 (to best relate to 2012 LULC) fall within Cores.

Table 2.II. 2012 Land Use/Land Cover Classes and their applicability to the CHANJ Mapping.

2012 Land Use/Land Cover Class Ratings							
LU12	LULC LABEL	TYPE	Habitat Value	Urban	Wetlands	Water Body	Urban Road Adj.
1110	RESIDENTIAL, HIGH DENSITY OR MULTIPLE DWELLING	URBAN	0	X	-	-	X
1120	RESIDENTIAL, SINGLE UNIT, MEDIUM DENSITY	URBAN	0	X	-	-	X
1130	RESIDENTIAL, SINGLE UNIT, LOW DENSITY	URBAN	0	X	-	-	X
1140	RESIDENTIAL, RURAL, SINGLE UNIT	URBAN	0	X	-	-	X
1150	MIXED RESIDENTIAL	URBAN	0	X	-	-	X
1200	COMMERCIAL/SERVICES	URBAN	0	X	-	-	X
1211	MILITARY INSTALLATIONS	URBAN	0	X	-	-	X
1214	NO LONGER MILITARY	URBAN	0	X	-	-	X
1300	INDUSTRIAL	URBAN	0	X	-	-	X
1400	TRANSPORTATION/COMMUNICATION/UTILITIES	URBAN	0	X	-	-	X
1410	MAJOR ROADWAY	URBAN	0	X	-	-	-
1411	MIXED TRANSPORTATION CORRIDOR OVERLAP AREA	URBAN	0	X	-	-	X
1419	BRIDGE OVER WATER	WATER	0	X	-	-	-
1420	RAILROADS	URBAN	0	X	-	-	X
1440	AIRPORT FACILITIES	URBAN	0	X	-	-	X
1461	WETLAND RIGHTS-OF-WAY	WETLANDS	1	-	X	-	-
1462	UPLAND RIGHTS-OF-WAY DEVELOPED	URBAN	0	X	-	-	X
1463	UPLAND RIGHTS-OF-WAY UNDEVELOPED	URBAN	1	-	-	-	-
1499	STORMWATER BASIN	URBAN	0	X	-	-	X
1500	INDUSTRIAL AND COMMERCIAL COMPLEXES	URBAN	0	X	-	-	X
1600	MIXED URBAN OR BUILT-UP LAND	URBAN	0	X	-	-	X
1700	OTHER URBAN OR BUILT-UP LAND	URBAN	0	X	-	-	-
1710	CEMETERY	URBAN	0	X	-	-	X
1711	CEMETERY ON WETLAND	WETLANDS	0	X	X	-	X
1741	PHRAGMITES DOMINATE URBAN AREA	WETLANDS	0	X	X	-	-
1750	MANAGED WETLAND IN MAINTAINED LAWN GREENSPACE	WETLANDS	0.5	-	X	-	-
1800	RECREATIONAL LAND	URBAN	0	X	-	-	X
1804	ATHLETIC FIELDS (SCHOOLS)	URBAN	0	X	-	-	X
1810	STADIUM, THEATERS, CULTURAL CENTERS AND ZOOS	URBAN	0	X	-	-	X
1850	MANAGED WETLAND IN BUILT-UP MAINTAINED REC AREA	WETLANDS	0	X	X	-	X
2100	CROPLAND AND PASTURELAND	AGRICULTURE	0.5	-	-	-	-
2140	AGRICULTURAL WETLANDS (MODIFIED)	WETLANDS	0.5	-	X	-	-
2150	FORMER AGRICULTURAL WETLAND (BECOMING SHRUBBY, NOT BUILT-UP)	WETLANDS	1	-	X	-	-
2200	ORCHARDS/VINEYARDS/NURSERIES/HORTICULTURAL AREAS	AGRICULTURE	0.5	-	-	-	-
2300	CONFINED FEEDING OPERATIONS	AGRICULTURE	0.5	-	-	-	-
2400	OTHER AGRICULTURE	AGRICULTURE	0.5	-	-	-	-
4110	DECIDUOUS FOREST (10-50% CROWN CLOSURE)	FOREST	1	-	-	-	-

2012 Land Use/Land Cover Class Ratings								
LU12	LULC LABEL	TYPE	Habitat Value	Urban	Wetlands	Water Body	Urban Adj.	Road Adj.
4120	DECIDUOUS FOREST (>50% CROWN CLOSURE)	FOREST	1	-	-	-	-	-
4210	CONIFEROUS FOREST (10-50% CROWN CLOSURE)	FOREST	1	-	-	-	-	-
4220	CONIFEROUS FOREST (>50% CROWN CLOSURE)	FOREST	1	-	-	-	-	-
4230	PLANTATION	FOREST	1	-	-	-	-	-
4311	MIXED FOREST (>50% CONIFEROUS WITH 10-50% CROWN CLOSURE)	FOREST	1	-	-	-	-	-
4312	MIXED FOREST (>50% CONIFEROUS WITH >50% CROWN CLOSURE)	FOREST	1	-	-	-	-	-
4321	MIXED FOREST (>50% DECIDUOUS WITH 10-50% CROWN CLOSURE)	FOREST	1	-	-	-	-	-
4322	MIXED FOREST (>50% DECIDUOUS WITH >50% CROWN CLOSURE)	FOREST	1	-	-	-	-	-
4410	OLD FIELD (< 25% BRUSH COVERED)	FOREST	1	-	-	-	-	-
4411	PHRAGMITES DOMINATE OLD FIELD	FOREST	1	-	-	-	-	-
4420	DECIDUOUS BRUSH/SHRUBLAND	FOREST	1	-	-	-	-	-
4430	CONIFEROUS BRUSH/SHRUBLAND	FOREST	1	-	-	-	-	-
4440	MIXED DECIDUOUS/CONIFEROUS BRUSH/SHRUBLAND	FOREST	1	-	-	-	-	-
4500	SEVERE BURNED UPLAND VEGETATION	FOREST	1	-	-	-	-	-
5100	STREAMS AND CANALS	WATER	1	-	-	-	-	-
5190	EXPOSED FLATS	WATER	1	-	-	-	-	-
5200	NATURAL LAKES	WATER	1	-	-	X	-	-
5300	ARTIFICIAL LAKES	WATER	1	-	-	X	-	-
5410	TIDAL RIVERS, INLAND BAYS, AND OTHER TIDAL WATERS	WATER	1	-	-	X	-	-
5411	OPEN TIDAL BAYS	WATER	1	-	-	-	-	-
5412	TIDAL MUD FLAT	WATER	1	-	-	-	-	-
5420	DREDGED LAGOON	WATER	1	-	-	X	-	-
5430	ATLANTIC OCEAN	WATER	1	-	-	-	-	-
6111	SALINE MARSH (LOW MARSH)	WETLANDS	1	-	X	-	-	-
6112	SALINE MARSH (HIGH MARSH)	WETLANDS	1	-	X	-	-	-
6120	FRESHWATER TIDAL MARSHES	WETLANDS	1	-	X	-	-	-
6130	VEGETATED DUNE COMMUNITIES	WETLANDS	1	-	X	-	-	-
6141	PHRAGMITES DOMINATE COASTAL WETLANDS	WETLANDS	1	-	X	-	-	-
6210	DECIDUOUS WOODED WETLANDS	WETLANDS	1	-	X	-	-	-
6220	CONIFEROUS WOODED WETLANDS	WETLANDS	1	-	X	-	-	-
6221	ATLANTIC WHITE CEDAR WETLANDS	WETLANDS	1	-	X	-	-	-
6231	DECIDUOUS SCRUB/SHRUB WETLANDS	WETLANDS	1	-	X	-	-	-
6232	CONIFEROUS SCRUB/SHRUB WETLANDS	WETLANDS	1	-	X	-	-	-
6233	MIXED SCRUB/SHRUB WETLANDS (DECIDUOUS DOM.)	WETLANDS	1	-	X	-	-	-
6234	MIXED SCRUB/SHRUB WETLANDS (CONIFEROUS DOM.)	WETLANDS	1	-	X	-	-	-
6240	HERBACEOUS WETLANDS	WETLANDS	1	-	X	-	-	-
6241	PHRAGMITES DOMINATE INTERIOR WETLANDS	WETLANDS	1	-	X	-	-	-
6251	MIXED WOODED WETLANDS (DECIDUOUS DOM.)	WETLANDS	1	-	X	-	-	-
6252	MIXED WOODED WETLANDS (CONIFEROUS DOM.)	WETLANDS	1	-	X	-	-	-
6290	UNVEGETATED FLATS	WETLANDS	1	-	X	-	-	-
6500	SEVERE BURNED WETLAND VEGETATION	WETLANDS	1	-	X	-	-	-

2012 Land Use/Land Cover Class Ratings								
LU12	LULC LABEL	TYPE	Habitat Value	Urban	Wetlands	Water Body	Urban	Road Adj.
7100	BEACHES	BARREN LAND	0.5	-	-	-	-	-
7200	BARE EXPOSED ROCK, ROCK SLIDES, ETC	BARREN LAND	0.5	-	-	-	-	-
7300	EXTRACTIVE MINING	BARREN LAND	0	X	-	-	X	-
7400	ALTERED LANDS	BARREN LAND	0	X	-	-	X	-
7430	DISTURBED WETLANDS (MODIFIED)	WETLANDS	1	-	X	-	-	-
7440	DISTURBED TIDAL WETLANDS	WETLANDS	1	-	X	-	-	-
7500	TRANSITIONAL AREAS	BARREN LAND	0	X	-	-	X	-
7600	UNDIFFERENTIATED BARREN LANDS	BARREN LAND	0	X	-	-	-	-

CHANJ Corridors

Definition: CHANJ Corridors are continuous swaths of habitat representing the most efficient movement routes between Cores. Corridors are expected to provide functional linkages between Cores based on empirical evidence of known or assumed species behavioral response to landscape elements.

Habitat resistance layer development: A habitat resistance layer (20m grid size) was created with resistance values (RV) from 1 (low resistance; easier to move through) to 100 (high resistance; harder to move through). To accomplish this, a moving window analysis was first run on the base habitat layer used for the Core area development. This resulted in a raster layer representing the average habitat value ([avehabgrid]) within a 100m radius window, with values 0 - 1. The values were then converted such that areas of high average habitat value became low resistance values and areas with low average habitat value became high resistance values by applying the following equation:

$99 * (1 - [\text{avehabgrid}]) + 1$. We made additional modifications to account for landscape features, like roads and water bodies, that represent high resistance to movement but were not yet adequately reflected in the resistance grid. The following features and values were applied to the resistance layer:

1. Roads¹⁰ - Local (RV 25) (symboltype >700);
2. Roads¹⁰ - County (RV 50) (symboltype >500, <700);
3. Roads¹⁰ - Highways, Interstates (RV 50) (symboltype >100, <500);
4. Roads¹² - High Average Daily Traffic Volume (>10,000 AADT) (RV 75) (¹² linked to AADT_flow table provided by DOT);
5. 2012 LULC¹ Water Bodies (RV 100) (Water Body = 'X' in Table 2.II)

Corridor development: [Linkage Mapper ArcGIS toolbox](#) was used to model and delineate cost-weighted distance and least cost corridors. The inputs for the modeling included:

1. Cores;

2. Habitat resistance layer;

A 20km bounding circle buffer distance was applied around “source” and “target” Core area pairs, and a maximum cost-weighted corridor length of 305km was applied to reduce processing time (see [LinkageMapper User Guide](#)). The resultant corridors were clipped using a 16.76km cost-weighted distance cut-off value, which seemed to strike the best balance between a simple single cell least-cost path and including areas of such high resistance that they may not function as corridors. Several biologists weighed in on incremental cut-off values and agreed on the value chosen.

Corridor refinement: Further refinement included removing resultant corridor mapping that overlapped with Core areas or with small (<78.5km²) “holes” within Cores areas. We then classified the corridor mapping into five equal interval bins to create gradients representing more optimal to marginal move-through habitats.

Validation: 93% (1278/1375) of Endangered, Threatened, and Special Concern species locations¹¹ observed between 2009 and 2015 (to best relate to 2012 LULC) fall within Cores and Corridors. The Core and Corridor mapping was also reviewed by species experts, and all concurred that the mapping captured critical connectivity areas for E/T/SC species, including habitat specialists.

CHANJ Road Segments

Definition: CHANJ Road Segments are segments of roads within CHANJ Cores and Corridors, not adjacent to urbanization on either side, that serve as starting points for targeting road wildlife mitigation efforts.

Road Segment layer development: Roads^{10,12} were coded into three categories: 1) Local, 2) County, Highways, Interstates with <10,000 vehicles/day and 3) County, Highways, Interstates with >10,000 vehicles/day. Road Segments that did not intersect with Core or Corridor areas were removed. Areas of the Road Segments adjacent to 2012 LULC¹ Urban areas (Urban Road Adj = ‘X’ in Table 2.II) on one or both sides were removed. The remaining layer includes Road Segments within Cores and Corridors that serve as targets for mitigation efforts.



OVERVIEW OF CHANJ MAPPING TOOLS

In addition to the fundamental mapping product: CHANJ Mapping (Cores, Corridors, and Road Segments), there are several other supplemental mapping tools available (see next section in this Chapter or [Tools of CHANJ](#) for details) that can be used to help inform decision-making. They include:

CHANJ: (Fig. 2.1) This layer package is the fundamental CHANJ mapping product, consisting of habitat Cores, Corridors, and Road Segments. Click on any of these elements in the mapping to view details like core size, the severity of a road barrier, and element IDs, and to link to a guidance document that provides recommendations and resources for restoring and maintaining those key areas for wildlife connectivity.

- **Cores:** Patches of contiguous natural land cover (land and water) at least 78.5 ha in size, which are likely to meet the habitat needs (shelter, forage/prey, reproduction) of most terrestrial wildlife species, especially if functionally linked to other Cores.
- **Corridors Gradients:** Continuous swaths of habitat representing the most efficient movement routes between Cores. The Corridors are displayed in color gradients (1-5) based on a cost-weighted distance analysis. Gradient 1 (lightest color) represents the most optimal move-through habitat, whereas gradient 5 (darkest color) is the most marginal.
- **Road Segments:** Segments of roads within Cores and Corridors, not adjacent to urbanization. This layer serves as starting points for targeting road/wildlife mitigation efforts.

CHANJ Stepping Stones: (Fig. 2.1) Contiguous areas of natural land cover at least 12.56 ha in size that occur within CHANJ Corridors and may provide “live-in” habitat for smaller, less mobile species.

Chapter 2. CHANJ Mapping Tools

(Note, the same methodology was used to produce CHANJ Stepping Stones as was used to produce CHANJ Cores (described earlier in this chapter), except that a 100m moving window radius was applied, a minimum average habitat value of 0.88 was used, and a minimum core threshold size of 12.56ha was applied.)

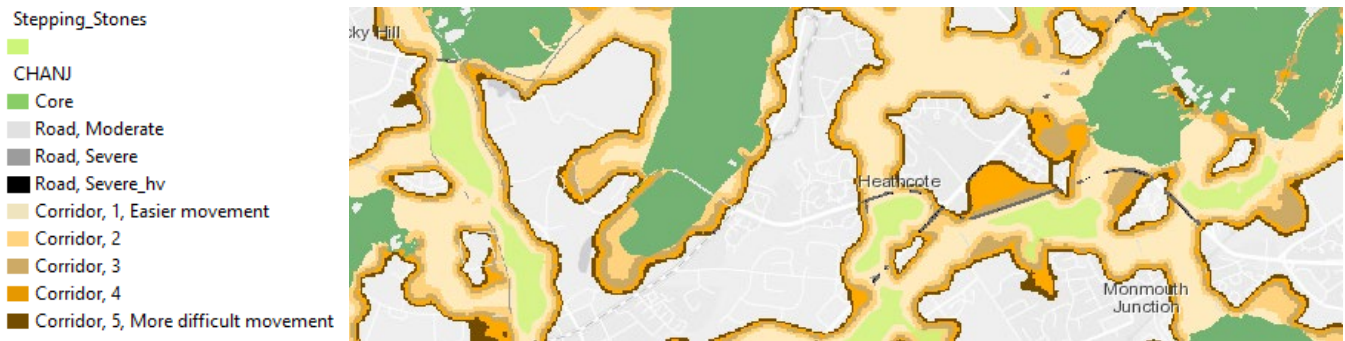


Figure 2.1. CHANJ Mapping (Cores, Corridor Gradients, and Road Segments) and Stepping Stones.

CHANJ Action Regions: The three Regions within which our CHANJ Action Teams (comprised of wildlife experts, transportation planners, habitat managers, and land acquisition professionals) coordinate work on habitat connectivity (see Chapter 5 of Guidance Document for more information).

NAACC Culvert Inventory: (Fig. 2.2) The NJ portion of [North Atlantic Aquatic Connectivity Collaborative](#) database, which identifies road/stream crossing structures across the state and inventories the results of those that have been surveyed for wildlife passability using the NAACC survey protocol. *Note:* Currently the scores depict aquatic wildlife passability. COMING SOON, terrestrial wildlife passability scores will be integrated into the database and depicted as well.



Figure 2.2. CHANJ Mapping (Cores, Corridor Gradients, and Road Segments) and NAACC Culvert Inventory.

Road Wildlife Mitigation Projects: (*coming soon*) Constructed and In Progress projects, such as underpasses, overpasses, and culvert modifications, that are designed to provide safe passage for terrestrial wildlife across roadways.



Terrestrial Wildlife Habitat Preserved Land: (Fig. 2.3) Permanently protected lands that have terrestrial wildlife habitat value now, and that have a high likelihood of being managed for wildlife conservation. *Note:* This layer was developed by applying a selective filter to the Preserved Lands layers (New Jersey Open Space and USA Protected Areas).

- **Terrestrial Wildlife Habitat Preserved Land – New Jersey Open Space (filtered):** Select Primary Use Types ('Conservation Area', 'Estuary or Marsh', 'Forest', 'Natural Area', 'Park', 'Recreation Area', 'Trail', 'Water Body', 'Wildlife Management Area', 'Wildlife Refuge', 'Wooded Lot', 'Fire Facility', 'Reservoir') and not including Green Acres "Unencumbered"
- **Terrestrial Wildlife Habitat Preserved Land – USA Protected Areas (filtered):** Select Manager Names ('U.S. Fish & Wildlife Service', 'National Park Service', 'Regional Water Districts').

Preserved Land: (Fig. 2.3) Protected lands under local, state, federal, and private land trust ownership. These layers include parcels with terrestrial habitat value (from which the Terrestrial Wildlife Habitat Preserved Lands layer was derived) as well as non-habitat parcels. *Note:* The USA Protected Areas layer was filtered to remove overlap with the New Jersey Open Space and Farmland Preservation Program layers.

Chapter 2. CHANJ Mapping Tools

- **Preserved Land – New Jersey Open Space**
- **Preserved Land – Farmland Preservation Program**
- **Preserved Land – USA Protected Areas (filtered)**: Do not include GIS Source ‘NJDEP, Green Acres Program’, ‘New Jersey Department of Environmental Protection’, and does not include Unit Name that contains ‘Farm’ or ‘Highlands Preservation’.

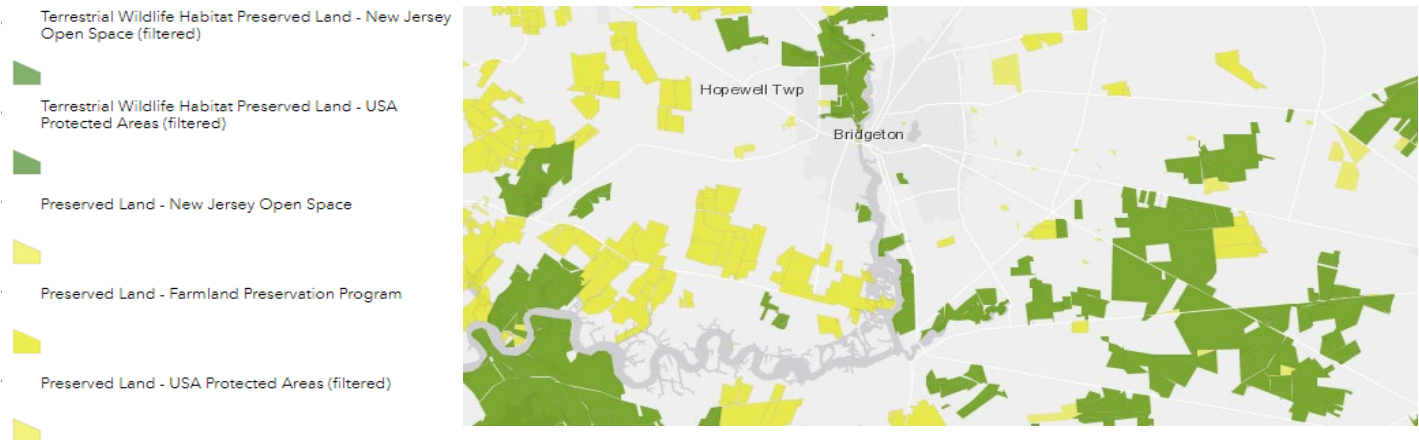


Figure 2.3. Terrestrial Wildlife Habitat Preserve Land and Preserved Land as represented in the [CHANJ Web Viewer](#).

WHERE TO FIND THE CHANJ MAPPING

The CHANJ Mapping Tools are accessible in a few different ways:

Option #1: Online Interactive Map

The [CHANJ Web Viewer](#) is easy to use from any computer or mobile device and is pre-loaded with the CHANJ layers and a variety of supplemental layers, such as municipal and county boundaries, watershed boundaries, water bodies, preserved lands, and several aerial imagery and basemap options. We recommend bookmarking the page or adding it to your device’s Home Screen for ready access in the field. A detailed User Guide and a *Quick Guide* are available in the Web Viewer’s “About” section.

Option #2: Download the Layers

The CHANJ Cores and Corridors, Stepping Stones, CHANJ Action Regions, and New Jersey’s NAACC Culvert Inventory data layers are available for download through the [NJDEP Bureau of GIS Open Data Site CHANJ menu](#).

Option #3: As Feature Services


From ArcMap Desktop, choose ‘Add Data from ArcGIS Online’ (under File menu, or using the Add Data button () and search for the name of the layer or its ArcGIS Online Item ID. For more information about each layer and other viewing options, click the associated link in Table 2.II.

Table 2.II. CHANJ Mapping tools available as feature services via ArcGIS Online.

Feature Services		
Data Layer	ArcGIS Online Item ID	Link
NAACC Culvert Inventory of New Jersey ¹	eebe82c4a7dc4400b900a7bfbf9e4b25	https://njdep.maps.arcgis.com/home/item.html?id=eebe82c4a7dc4400b900a7bfbf9e4b25
Connecting Habitat Across New Jersey (CHANJ) Action Regions for New Jersey ²	369fd5940c614c23bfc0db57be80a21b	https://njdep.maps.arcgis.com/home/item.html?id=369fd5940c614c23bfc0db57be80a21b
Terrestrial Wildlife Habitat Cores and Corridors in New Jersey, Connecting Habitat Across New Jersey (CHANJ) ³	bee8b65301514b67a3750afbad9dfeca	https://njdep.maps.arcgis.com/home/item.html?id=bee8b65301514b67a3750afbad9dfeca
Terrestrial Wildlife Habitat Stepping Stones in New Jersey ³	25c349f2ebb44772b0357c45ee615dc5	https://njdep.maps.arcgis.com/home/item.html?id=25c349f2ebb44772b0357c45ee615dc5
Road Wildlife Mitigation Projects	<i>(coming soon)</i>	<i>(coming soon)</i>
Terrestrial Wildlife Habitat Preserved Lands	New Jersey Open Space*: 4a1f9d3075a04cd792a14f78b9697df3	https://njdep.maps.arcgis.com/home/item.html?id=4a1f9d3075a04cd792a14f78b9697df3
	USA Protected Areas*: 6ef455dc13b84deba6b098d5efcad984	https://njdep.maps.arcgis.com/home/item.html?id=6ef455dc13b84deba6b098d5efcad984
Preserved Lands	New Jersey Open Space: 4a1f9d3075a04cd792a14f78b9697df3	https://njdep.maps.arcgis.com/home/item.html?id=4a1f9d3075a04cd792a14f78b9697df3
	Farmland Preservation Program: f40dd40ad3c44821a0ed97503c35f007	https://njdep.maps.arcgis.com/home/item.html?id=f40dd40ad3c44821a0ed97503c35f007
	USA Protected Areas*: 6ef455dc13b84deba6b098d5efcad984	https://njdep.maps.arcgis.com/home/item.html?id=6ef455dc13b84deba6b098d5efcad984

¹ See Chapter 3 of Guidance Document for more detail.

² See Chapter 5 of Guidance Document for more detail.

³ See Chapter 2 of the Guidance Document for more detail.

*These datasets were filtered as described in previous section ('Overview of CHANJ Mapping Tools') of this Chapter.

GIS DATA SOURCES

Numbering of the following sources corresponds with superscripts used in the CHANJ Mapping Methodology section of this chapter:

1. NJ Department of Environmental Protection (NJDEP), Office of Information Resources Management (OIRM), Bureau of Geographic Information Systems (BGIS). 2015. NJDEP 2012 Land use/Land cover Update.

Online Linkage: <http://www.nj.gov/dep/gis/lulc12.html>
2. New Jersey Office of Information Technology (OIT), Office of GIS (OGIS). 2015. Counties of New Jersey.

Online Linkage: https://njgin.state.nj.us/NJ_NJGINExplorer/DataDownloads.jsp
3. State of New Jersey Department of Environmental Protection (NJDEP), Division of Fish and Wildlife (DFW), Endangered and Nongame Species Program (ENSP). 2015. Landscape Project Version 3.3 Riparian Corridor. (https://www.state.nj.us/dep/fgw/ensp/landscape/lp_report_3_3.pdf)

Online Linkage: Unpublished
4. New Jersey Department of Environmental Protection (NJDEP). 2015. New Jersey Integrated Terrain Unit Maps (ITUM) Flood Prone Areas.
5. United States Department of Homeland Security, Federal Emergency Management Agency (FEMA), Flood Map Service Center. 2015.

Online Linkage: <https://msc.fema.gov/portal>
6. Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Soil Survey Geographic (SSURGO) Database. Accessed [06/01/2015].

Online Linkage: <https://sdmdataaccess.sc.egov.usda.gov>
7. New Jersey Department of Transportation (DOT), Geographic Information Systems. 2016. NJDOT State Railroad Lines: Abandoned and Freight.

Online Linkage: <http://www.state.nj.us/transportation/gis/map.shtm>
8. New Jersey Office of Information Technology (OIT), Office of GIS (OGIS). 2016. NJ Transit, NJ Passenger Rail.

Online Linkage: https://njin.state.nj.us/NJ_NJGINExplorer/DataDownloads.jsp

9. New York-New Jersey Trail Conference. 2014. NYNJTC_NJ-LongDistanceTrails.

Online Linkage: Unpublished

10. New Jersey Office of Information Technology (OIT), Office of GIS (OGIS). 2015. Tran_road_centerline_NJ.

Online Linkage: https://njin.state.nj.us/NJ_NJGINExplorer/jviewer.jsp?pg=ROADS

11. New Jersey Department of Environmental Protection (NJDEP), Division of Fish and Wildlife (DFW), Bureau of Wildlife Management, and Endangered and Nongame Species Program (ENSP). 2016. Terrestrial wildlife species location data.

Online Linkage: Unpublished.

12. New Jersey Department of Transportation (DOT), Geographic Information Systems. 2014. NJ Road Network.

Online Linkage: <https://www.state.nj.us/transportation/gis/data.shtm>

ARCGIS TOOLSETS

McRae, B.H. and D.M. Kavanagh. 2011. Linkage Mapper Connectivity Analysis Software. The Nature Conservancy, Seattle WA. Available at: <http://www.circuitscape.org/linkagemapper>.

Shirk, A.J., and B.H. McRae. 2013. Gnarly Landscape Utilities: Core Mapper User Guide. The Nature Conservancy, Fort Collins, CO. Available at: <http://www.circuitscape.org/gnarly-landscape-utilities>.

REFERENCES

Krosby, M., Breckheimer, I., Pierce, D.J., Singleton P., Hall, S.A., Halupka, K., Gaines, W., Long, R., McRae, B., Cosentino, B.L., Schuett-Hames, J. (2015). Focal species and landscape “naturalness” corridor models offer complementary approaches for connectivity conservation planning. *Landscape Ecology*, 30. 10.1007/s10980-015-0235-z.

Nuñez, T.A., Lawler, J.J., McRae, B.H., Pierce, D.J., Krosby, M.B., Kavanagh, D.M., et al. (2013). Connectivity planning to address climate change. *Conservation Biology* 27, 407-416.

Spencer W.D., Beier P., Penrod K., Winters K., Paulman C., Rustigian-Romsos H., Strittholt J., Parisi M., Pettler A.

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(2010). California essential habitat connectivity project: a strategy for conserving a connected California. Prepared for California Department of Transportation, California Department of Fish and Game, and Federal Highways Administration. Statewide Analysis. Washington Departments of Fish and Wildlife, and Transportation, Olympia.

Theobald D.M., Reed S.E., Fields K., Soule' M. (2012). Connecting natural landscapes using a landscape permeability model to prioritize conservation activities in the United States. Conservation Letters 5:123–133.



Chapter 3. Connectivity Assessments

Identifying the connectivity network across the state using the CHANJ Mapping not only provides a common vision for those interested in working toward a connected landscape, but also enables us to evaluate statewide, regional, and local patterns of landscape connectivity and movement corridors.

Spatially explicit connectivity data allows us to quantify connectivity metrics to assess our progress toward achieving a more functionally connected landscape. The mapping also helps us target areas to collect animal movement data, such as from roadkill surveys, remotely triggered cameras, telemetry studies and genetic studies. All of which help us evaluate functional connectivity at local, regional, and statewide scales. To those ends, we have developed a set of metrics for statewide and state regional levels to serve as a baseline of New Jersey's current connectedness. We will reproduce the metrics annually to evaluate progress in achieving improved connectivity and to help us set goals for future efforts (see CHANJ Action Teams in Chapter 5). CHANJ partners are actively engaged in monitoring studies at local scales, collecting animal movement data and evaluating the potential for safe wildlife crossings at roadways, and we present standardized protocols related to those studies.

CONNECTIVITY METRICS

The connectivity metrics we developed are based on habitat and road variables that relate to landscape connectivity status at statewide and regional scales. We defined the regions as Skylands, Piedmont, Delaware Bay, Atlantic Coastal, and Pinelands, which are each characterized by similar landforms, soils, vegetation, and hydrological regimes that support distinctive habitat and species mixes (Fig. 3.1; see Chapter 2 of the [Landscape Project Report](#) for descriptions of the regions).

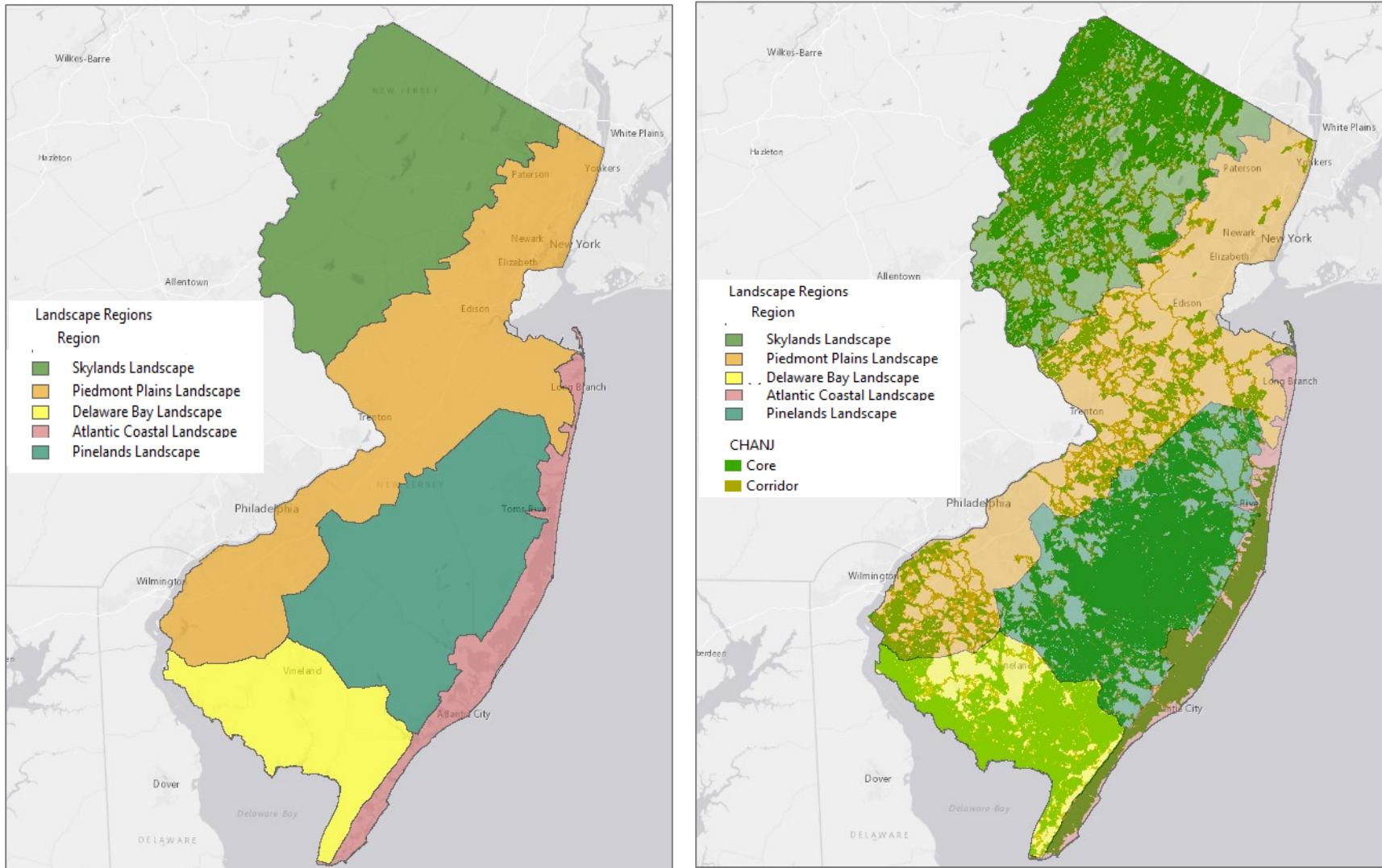


Figure 3.1. Landscape regions of New Jersey (left) and Landscape regions with the CHANJ mapping (Cores and Corridors) overlaid (right).

Table 5.I. Habitat and Road statistics based on CHANJ V 1.0 Mapping

CHANJ Assessments						
Variable	State	Landscape Regions				
		Skylands	Piedmont	Delaware Bay	Atlantic Coastal	Pinelands
Habitat						
Number of Cores	815	242	241	114	27	192
Core size: mean (SD) km ²	10.50 (30.18) km ²	9.98 (21.88) km ²	3.90 (5.87) km ²	12.9 (33.26) km ²	33.09 (77.62) km ²	14.79 (39.59) km ²
Total area of Cores: km ² (% of state/region)	8558.81 km ² (42.69%)	2414.05 km ² (44.67%)	940.25 km ² (14.58%)	1470.99 km ² (64.09%)	893.32 km ² (67.54%)	2839.74 km ² (62.06%)
Total area of Corridors: km ² (% of state/region)	2904.71 km ² (14.49%)	990.94 km ² (18.33%)	1055.84 km ² (16.37%)	261.42 km ² (11.39%)	48.24 km ² (3.65%)	548.25 km ² (11.98%)
Shortest Corridor length between Core pairs in state/region: mean (SD) km	1.56 (2.81) km	1.63 (2.75) km	2.93 (3.93) km	0.51 (1.23) km	1.16 (2.61) km	0.94 (1.91) km
Number of Stepping Stones	934	289	373	96	5	171
LP v3.3 ¹ valued threatened/endangered species habitat within Cores: km ² (% of Core area in state/region)	7594.79 km ² (88.74%)	2239.58 km ² (92.77%)	539.24 km ² (57.35%)	1345.47 km ² (91.47%)	876.01 km ² (98.06%)	2594.49 km ² (91.36%)
LP v3.3 ¹ valued threatened/endangered species habitat within Corridors: km ² (% of Corridor area in state/region)	1268.98 km ² (43.73%)	574.61 km ² (57.99%)	338.34 km ² (32.04%)	100.27 km ² (38.36%)	23.64 km ² (49.00%)	232.12 km ² (42.34%)
LP v3.3 ¹ valued threatened/endangered species habitat within state/region: km ² (% of state/region)	10408.3 km ² (51.92%)	3413.39 km ² (63.16%)	1408.21 km ² (21.84%)	1568.48 km ² (68.58%)	997.22 km ² (75.39%)	3021.00 km ² (66.20%)
LP v3.3 ¹ valued t/e species habitat within Cores and Corridors relative to LP v3.3 Rank 3-5 within state/region	85.16%	82.45%	62.32%	92.17%	90.22%	93.57%
Terrestrial species habitat ² within Cores: km ² (% of Core area in state/region)	8483.74 km ² (99.12%)	2382.35 km ² (98.67%)	929.52 km ² (98.86%)	1461.98 km ² (99.39%)	890.75 km ² (99.71%)	2819.14 km ² (99.27%)
Terrestrial species habitat ² within Corridors: km ² (% of Corridor area in state/region)	2072.33 km ² (71.34%)	702.09 km ² (70.93%)	805.01 km ² (76.24%)	179.27 km ² (68.58%)	28.48 km ² (59.04%)	357.48 km ² (65.20%)
Terrestrial species habitat ² within state/region: km ² (% of state/region)	13451.72 km ² (67.10%)	3920.8 km ² (72.55%)	3011.97 km ² (46.70%)	1930.63 km ² (84.12%)	1025.07 km ² (77.50%)	3562.23 km ² (77.85%)
Terrestrial species habitat ² within Cores and Corridors relative to terrestrial species habitat within state/region	78.47%	78.67%	57.59%	85.01%	89.67%	89.18%
TWH Preserved Lands ³ within Cores: km ² (% of Core area in state/region)	3910.60 km ² (45.69%)	1133.39 km ² (46.95%)	187.15 km ² (19.9%)	749.69 km ² (50.97%)	401.88 km ² (44.99%)	1437.80 km ² (50.63%)
TWH Preserved Lands ³ within Corridors: km ² (% of Corridor area in state/region)	234.22 km ² (8.06%)	83.54 km ² (8.43%)	78.13 km ² (7.40%)	20.51 km ² (7.85%)	12.75 km ² (26.43%)	39.17 km ² (7.14%)
TWH Preserved Lands ³ within state/region: km ² (% of state/region)	4387.85 km ² (21.89%)	1271.65 km ² (23.55%)	401.98 km ² (6.24%)	781.91 km ² (34.08%)	429.59 km ² (32.62%)	1501.66 km ² (32.80%)
TWH Preserved Lands ³ within Cores and Corridors relative to TWH Preserved Lands within state/region	94.46%	95.69%	65.99%	98.50%	96.52%	98.36%

¹ Landscape Project V.3.3 Landscape Rank 3-5 (Threatened & Endangered species habitat)

² Terrestrial species habitat used as base layer for Core mapping (see Chapter 2 of Guidance Document)

³ Terrestrial Wildlife Habitat Preserved Lands (see Chapter 2 of Guidance Document; mapping available on [CHANJ Web Viewer](#))

Chapter 3. Connectivity Assessments

CHANJ Assessments						
Variable	State	Landscape Regions				
		Skylands	Piedmont	Delaware Bay	Atlantic Coastal	Pinelands
Roads						
Total length of CHANJ Road Segments ⁴ within Cores: km (% of CHANJ Road Segments in state/region)	2766.61 km (39.66%)	1099.49 km (47.82%)	340.77 km (21.21%)	394.02 km (42.36%)	78.88 km (29.26%)	853.45 km (42.73%)
Total length of CHANJ Road Segments ⁴ bisecting Cores: km (% of CHANJ Road Segments in state/region)	1473.41 km (21%)	335.03 km (14.57%)	179.93 km (11.19%)	293.57 km (31.56%)	95.35 km (35.37%)	609.13 km (30.50%)
Total length of CHANJ Road Segments ⁴ within Corridors: km (% of CHANJ Road Segments in state/region)	2736.36 km (39.22%)	864.65 km (37.61%)	1086.33 km (67.60%)	242.59 km (26.08%)	95.39 km (35.38%)	534.81 km (26.77%)
Culvert inventories ⁵ completed within CHANJ mapped Cores and Corridors						
Scored for Aquatic Passability: number (% of estimated culverts present)	269 (2.95%)	110 (3.11%)	28 (1.00%)	43 (5.22%)	11 (4.64%)	77 (4.43%)
Scored for Terrestrial Passability: number (% of estimated culverts present)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Road Segment Reports completed	0	0	0	0	0	0
Road Wildlife Mitigation Projects ⁶						
Constructed	14	3	4	1	1	5
In Progress	16	10	4	0	0	2

⁴ CHANJ Road Segments (see Chapter 2 of Guidance Document; mapping available on [CHANJ Web Viewer](#))

⁵ Culvert inventories following North Atlantic Aquatic Connectivity Collaborative ([NAACC](#)) protocol (see

⁶ Road Wildlife Mitigation Projects (see Chapter 2 of Guidance Document; mapping available on [CHANJ Web Viewer](#))

State of CHANJ Summary

There are 815 habitat Cores across New Jersey, ranging in size from 0.80 to 376.70 km² each, with a mean (SD) of 10.50 (30.18) km². There are also 934 Stepping Stones that fall within the habitat Corridors. Over 1/3 of the connectivity network (Cores and Corridors) is comprised of Terrestrial Wildlife Habitat (TWH) Preserved Land: permanently protected lands that have terrestrial wildlife habitat value now, and that have a high likelihood of being managed for wildlife conservation (see Chapter 2 of Guidance Document for additional details). Even more impressive, the connectivity networks in the Pinelands and Atlantic Coastal regions consist of greater than 40% of TWH Preserved Land, and in the Delaware Bay region, the percentage is close to 50%. Based on the connectivity metrics, the Piedmont region is by far the most fragmented and will be the greatest challenge for restoring and conserving connectivity across New Jersey. Its position, dividing the state between north and south, make it a critical component for connecting habitats for wildlife mobility. The long-term persistence of many species in the southern regions of the state, particularly, are dependent on functional connectivity to the northern regions because southern New Jersey is bounded by large water bodies (the Atlantic Ocean on the east and south, and the Delaware Bay and Delaware River on the southwest).

Across the state there are close to 7,000 km of Road Segments, segments of roads within CHANJ Cores and Corridors, not adjacent to urbanization, and serve as starting points for targeting road/wildlife mitigation efforts. So far, just 3% of the structures under roadways (e.g., culverts, bridges) have been inventoried and scored as to their predicted passability by wildlife, so we have our work ahead of us! There are, however, 30 Road Wildlife Mitigation Projects across New Jersey (14 constructed and 16 in progress) designed to provide safe passage for terrestrial wildlife across roadways.

Statewide

The statewide connectivity network consists of 815 habitat Cores (contiguous natural land cover (land and water) of at least 0.79 km²; see Chapter 2 of Guidance Document for additional details), that range in size from 0.80 to 376.70 km² each, with a mean (SD) of 10.50 (30.18) km². CHANJ Cores in total encompass 8,559 km² across the state, which represents 43% of the total land area in New Jersey. CHANJ Corridors (continuous swaths of habitat representing the most efficient movement routes between Cores; see Chapter 2 of Guidance Document for additional details) in total encompass 2,905 km², which represents 14% of the total land area in New Jersey. The CHANJ Mapping, then, or connectivity network makes up 11,464 km² or 57% of the state's land area. The mean (SD) shortest distance between Core pairs across the state is 1.56 (2.81) km, but ranges widely from 0.02 – 25.14 km.

The amount of State Threatened and Endangered wildlife habitat as represented by the [Landscape Project 3.3](#) mapping that falls with the connectivity network is 85% (89% in Cores and 44% in Corridors). The Landscape Project mapping represents terrestrial and non-terrestrial wildlife. The CHANJ mapping, on the other hand, is focused only on terrestrial species and regardless of conservation status. The amount of terrestrial species habitat, specifically the habitat layer that was used as the base layer for the Core habitat mapping (see Chapter 2 of Guidance Document), that falls within the connectivity network is 78% (99% in Cores and 71% in Corridors). It is expected that the Corridors contain less intact and lower quality habitat than the Cores. And, the connectivity

network contains 934 Stepping Stones (Contiguous areas of natural land cover at least 12.56 ha in size that occur within CHANJ Corridors).

In total, New Jersey has 4,388 km² (22% of the state) of Terrestrial Wildlife Habitat (TWH) Preserved Land (permanently protected lands that have terrestrial wildlife habitat value now, and that have a high likelihood of being managed for wildlife conservation; see Chapter 2 of Guidance Document for additional details). Of the total statewide, 94% of TWH Preserved Land falls within the CHANJ Cores and Corridors. Within the Cores, 46% of the area is TWH Preserved Land and within the Corridors, just 8% of the area is TWH Preserved Land, such that of the statewide connectivity network, 36% (4,145 km²) is TWH Preserved Land.

Of the mapped Road Segments (segments of roads within CHANJ Cores and Corridors, not adjacent to urbanization, and serve as starting points for targeting road/wildlife mitigation efforts; 6,876 km total), 40% (2,767 km) fall within Cores, 21% (1,473 km) bisect Cores creating two separate Cores, and 39% (2,736 km) fall within Corridors. Ultimately the goal is to inventory all culverts that are located within the Road Segments and have them scored for aquatic and terrestrial passability. Based on an intersection of streams and roads, we estimate that there are approximately 9,128 structures present under NJ roadways, and so far, 269 (3%) have been inventoried and scored for aquatic passability and none have been scored for terrestrial passability. However, the terrestrial metrics and scoring are being finalized by the North Atlantic Aquatic Connectivity Collaborative ([NAACC](#)), and [Montclair State University Passaic River Institute](#) is conducting surveys and actively recruiting additional volunteers for this inventory (see below and the [CHANJ Projects & Partners webpage](#)). No Road Segment Reports have been completed yet, but animal movement data collection is underway in pilot areas (see below and the [CHANJ Projects & Partners webpage](#)) that will be used to develop these reports. Lastly, there are a total of 30 Road Wildlife Mitigation Projects (14 constructed and 16 that are in progress) designed to provide safe passage for terrestrial wildlife across roadways that have been compiled in the Road Wildlife Mitigation Projects database (Note: there may be additional projects of which are unaware).

Regions

Skylands

This landscape region combines two of New Jersey's physiographic regions, the Ridge & Valley and the Highlands. It encompasses all or parts of Sussex, Warren, Hunterdon, Somerset, Passaic, Essex, Bergen, and Morris Counties. The region is a mosaic of habitat types including forest, forested wetland, and scrub-shrub habitats that are vital to a variety of species.

The conditions of the region's habitats vary significantly between both types and places. Some of the highest quality habitats can be found on conserved properties where there are extensive tracts of interior forest habitat for area-sensitive species. Threats to forests in the region, however, include a lack of long-term management that has reduced structural diversity; deer browse and a lack of sunlight that have left the understory barren in many places; and an abundance of invasive species. Scrub-shrub habitat is uncommon due to succession to closed canopy forest, and remaining patches are threatened by development and over-browsing by deer. – Excerpted from [New Jersey's Wildlife Action Plan \(2018\)](#)

The Skylands region consists of 242 Cores (30% of the Cores in the state), the mean size of which (9.98 km²) is slightly smaller than the statewide average. The total area represented by Cores in the region is 2,414 km² (45%

of the region). The total area represented by Corridors in the region is 991 km² (18% of the region). The connectivity network in the Skylands, then, makes up 3,405 km² or 63% of the region's land area, slightly more than statewide (57%). The mean (SD) shortest distance between Core pairs across the state is 1.63 (2.75) km, which is slightly more than the statewide mean, though the longest minimum distance in the Skylands is 8.78 km compared to 25.14 km at the statewide level. Generally, the Core and Corridor metrics indicate that the Skylands region is slightly more fragmented than the state as a whole, but the patterns of connectivity vary across the region, with the largest, most intact areas being situated in the northwest portion of the region (see Fig 3.1), north of Interstate 80 and west of Interstate 287.

The amount of State Threatened and Endangered species habitat as represented by the [Landscape Project 3.3](#) mapping that falls with the connectivity network is 82% (93% in Cores and 58% in Corridors), which is slightly more compared to the statewide levels. The amount of terrestrial species habitat that falls within the connectivity network is 79% (99% in Cores and 71% in Corridors), which matches the statewide values closely. The connectivity network contains 242 Stepping Stones.

In total, the Skylands region has 1,272 km² (24% of the region) of Terrestrial Wildlife Habitat (TWH) Preserved Land. Of the total in the region, 96% of TWH Preserved Land falls within the CHANJ Cores and Corridors. Within the Cores, 47% of the area is TWH Preserved Land and within the Corridors, just 8% of the area is TWH Preserved Land, such that of the Skylands region connectivity network, 36% (1,217 km²) is TWH Preserved Land.

Of the mapped Road Segments in the region, which total 2,299km, 48% (1,099 km) fall within Cores, which is more than any other region, and 15% (335 km) bisect Cores creating two separate Cores, and 38% (865 km) fall within Corridors. So far, 110 structures have been inventoried, which represents 48% of the culvert inventory effort statewide. Lastly, in the Skylands Region, there are a total of 13 Road Wildlife Mitigation Projects (3 constructed and 11 that are in progress) designed to provide safe passage for terrestrial wildlife across roadways, which represents 43% of the statewide total.

Piedmont

This landscape region combines two of New Jersey's physiographic regions, the Piedmont and the Inner Coastal Plain. It encompasses all or parts of Burlington, Gloucester, Salem, Mercer, Middlesex, Monmouth, Hunterdon, Somerset, Union, Essex, Hudson, Passaic, and Bergen counties. It is a network of waterways drained by the Delaware and Raritan Rivers and is characterized by farmed areas, extensive grasslands, fragmented woodlands, and some of the world's most productive tidal freshwater marshes.

The conditions of the region's habitats vary, but all have been influenced by human settlement as most of this region has been logged, farmed, and developed. Threats today and in the future include invasive species, continued development, and over-browsing by white-tailed deer. Sea level rise may also impact the freshwater tidal marshes as the saltwater moves farther up into the freshwater tidal areas of the Delaware, Raritan, and Hudson Rivers and their tributaries. – Excerpted from [New Jersey's Wildlife Action Plan \(2018\)](#)

The Piedmont region consists of 241 Cores, the mean size of which (3.90 km²), are significantly smaller than both the statewide average and the mean size of Cores in any of the other regions. The total area represented by Cores in the region is 940 km² (15% of the region), which again is significantly smaller than both statewide as well

as any of the other regions. The total area represented by Corridors in the region is 1,056 km² (16% of the region). The connectivity network in the Piedmont, then, makes up 1,408 km² or 22% of the region's land area, which is significantly less than statewide percentage and the percentage in any of the other regions. The mean (SD) shortest distance between Core pairs in the Piedmont region is 2.93 (2.93) km, which is significantly larger than the statewide mean, as well as the means of any of the other regions. The Core and Corridor metrics indicate that the Piedmont region is significantly more fragmented than any of the other regions with many more and smaller Cores separated from each other by longer distances.

The amount of State Threatened and Endangered species habitat as represented by the [Landscape Project 3.3](#) mapping that falls with the connectivity network is 62% (57% in Cores and 32% in Corridors), which is significantly less than in any of the other regions, though the region in general has a smaller percentage of State Threatened and Endangered species habitat compared to any of the others. The amount of terrestrial species habitat that falls within the connectivity network is 58% (99% in Cores and 76% in Corridors), which also is significantly lower than in any other region, as is the percentage of terrestrial species habitat in general in the Piedmont region. The connectivity network contains 241 Stepping Stones.

In total, the Piedmont region has 402 km² (6% of the region) of Terrestrial Wildlife Habitat (TWH) Preserved Land, which is significantly lower than any other region. Of the total in the region, 66% of TWH Preserved Land falls within the CHANJ Cores and Corridors, again, much lower than in any other region. Within the Cores, 20% of the area is TWH Preserved Land and within the Corridors, just 7% of the area is TWH Preserved Land, such that of the Piedmont region connectivity network, 19% (265 km²) is TWH Preserved Land. Therefore, there is both little TWH Preserved Land in the Piedmont and only a small percentage of it is within the connectivity network compared to the other regions in the state.

Of the mapped Road Segments, which total 1,607.03 km, 21% (341 km) fall within Cores, and 11% (180 km) bisect Cores, creating two separate Cores, both of which are smaller percentages than the other regions and is logical since there is a much smaller area comprised of Cores in the region. On the other hand, 68% (1,086 km) of Road Segments fall within Corridors, which is much larger than in any of the other regions and makes sense given the corresponding large Corridor area in the region. So far, 28 structures have been inventoried, which represents 10% of the culvert inventory effort statewide. Lastly, in the Piedmont region, there are a total of 8 Road Wildlife Mitigation Projects (4 constructed and 4 that are in progress) designed to provide safe passage for terrestrial wildlife across roadways.

Delaware Bay

This landscape region encompasses all or parts of Cape May, Atlantic, and Cumberland counties. The region still contains vast woodland tracts that are among the largest in the state and are critical to migratory neotropical birds and raptors. The region's expansive habitat mosaic of rivers and streams flowing into the tidal Delaware Bay supports concentrations of rare wildlife and wintering waterfowl. Extensive salt marsh and sandy overwash beaches support a significant horseshoe crab breeding area and important stopover areas for migrating shorebirds, including the red knot, a federally threatened species of worldwide significance.

These important habitats remain in good condition for most species and the Cape May Peninsula remains one of the country's most important migratory stopovers for hundreds of bird and insect species. That

said, the region is vulnerable. All of the region's habitats are threatened by development that fragments natural landscapes and invasive species that outcompete native species. The loss of peninsula habitat is a particular threat to migratory birds and to other species that reside permanently in this limited area. The vast tidal marshes of Delaware Bay are vulnerable to sea level rise and shoreline erosion, as are interior wetlands that could be affected by storm surge. Natural subsidence of marshes and alteration for salt hay farms could continue to significantly reduce high salt marsh habitat which is important for species like black rail and northern harrier. Inappropriate silvicultural practices could also degrade the habitat value of forests for many interior-dependent forest wildlife species. – Excerpted from [New Jersey's Wildlife Action Plan \(2018\)](#)

The Delaware Bay region consists of 114 Cores, the mean size of which (12.9 km²) is slightly larger than the mean size at the statewide level. The total area represented by Cores in the region is 1,471 km² (64% of the region) is more than the Skylands and Piedmont regions and higher than the statewide percentage. The total area represented by Corridors in the region is 261 km² (11% of the region). The connectivity network in the Delaware Bay, then, makes up 1,568 km² or 69% of the region's land area, which is more than the statewide percentage. The mean (SD) shortest distance between Core pairs in the Delaware Bay region is 0.51 (1.23) km, which is shorter than in any of the other regions. The Core and Corridor metrics indicate that the Delaware Bay region is far less fragmented than the Piedmont region.

The amount of State Threatened and Endangered species habitat as represented by the [Landscape Project 3.3](#) mapping that falls with the connectivity network is 92% (91% in Cores and 38% in Corridors), which is the second highest amount among the regions. The amount of terrestrial species habitat that falls within the connectivity network is 85% (99% in Cores and 69% in Corridors), which also is in line with the other regions. The percentage of terrestrial species habitat in the region is highest among all of the regions. The connectivity network contains 114 Stepping Stones.

In total, the Delaware Bay region has 782 km² (34% of the region) of Terrestrial Wildlife Habitat (TWH) Preserved Land, which is highest among all of the regions. Of the total in the region, 99% of TWH Preserved Land falls within the CHANJ Cores and Corridors, again, the highest among the regions. Within the Cores, 51% of the area is TWH Preserved Land and within the Corridors, just 8% of the area is TWH Preserved Land, such that of the Delaware Bay region connectivity network, 49% (770 km²) is TWH Preserved Land. The region has the highest percentage of TWH Preserved Land among the regions overall as well as within its connectivity network.

Of the mapped Road Segments, which total 930.18 km, 42% (394 km) fall within Cores, and 32% (294 km) bisect Cores creating two separate Cores, both of which are in the middle of the range of the other regions. In the Delaware Bay region, 243 km (26%) of Road Segments that fall within Corridors, which corresponds with the fact that the region has the mean (SD) shortest distance between Core pairs, as mentioned earlier, of any of the other regions. So far, 43 structures have been inventoried, representing slightly over 5% of those likely present in the region, which is the highest percentage of the regions. Lastly, in the Delaware Bay region, there is just one Road Wildlife Mitigation Project, constructed and designed to provide safe passage for terrestrial wildlife across roadways.

Atlantic Coastal

This landscape region encompasses parts of Monmouth, Ocean, Cape May, and Atlantic counties and consists of barrier islands and beaches, tidal salt marshes, rivers, shallow bays, and lagoons along New Jersey's coastline. New Jersey's Atlantic coast beaches and marshes are among the most productive coastal habitats in the country. That said, the region also includes extensively degraded locales with few natural areas.

Threats to the region's habitats are led by development that impairs the ability of the coastal system to function normally. Upland portions of the barrier islands are almost entirely developed, and to protect these areas, the islands have been stabilized through extensive use of groins, seawalls, jetties, and intense beach replenishment programs. These engineering efforts preclude the normal, dynamic functions of coastal systems and thereby reduce the suitability of habitats for wildlife. Their effects are intensified by sea level rise and marsh subsidence, both of which have affected and will continue to impact the marshes and barrier islands. – Excerpted from [New Jersey's Wildlife Action Plan \(2018\)](#)

The Atlantic Coastal region consists of 27 Cores, the mean size of which (34 km²), are significantly larger than mean size of Cores in any of the other regions. The total area represented by Cores in the region is 893 km² (68% of the region) represents the highest percentage of any of the regions. The total area represented by Corridors in the region is 48 km² (4% of the region), the smallest percentage of any of the regions. The connectivity network in the Atlantic Coastal, then, makes up 942 km² or 71% of the region's land area, which is one of the highest percentages in any of the regions. The mean (SD) shortest distance between Core pairs in the Atlantic Coastal region is 1.16 (2.61) km, which is mid range compared to the means of the other regions. The Core and Corridor metrics indicate that the Atlantic Coastal region is one of the least fragmented regions in the state with a high percentage of Core areas and small percentage of Corridor areas.

The amount of State Threatened and Endangered species habitat as represented by the [Landscape Project 3.3](#) mapping that falls with the connectivity network is 90% (98% in Cores and 49% in Corridors), which is among the highest of the other regions, and the region in general has the highest percentage of State Threatened and Endangered species habitat compared to any of the others. The amount of terrestrial species habitat that falls within the connectivity network is 90% (nearly 100% in Cores and 59% in Corridors), which is the highest among the regions, and the region has among the highest percentages of terrestrial species habitat in general among the regions. The connectivity network contains just 5 Stepping Stones, likely because so much of the intact habitat represent larger Core areas.

In total, the Atlantic Coastal region has 430 km² (33% of the region) of Terrestrial Wildlife Habitat (TWH) Preserved Land, which is among the highest of any of the regions. Of the total in the region, 97% of TWH Preserved Land falls within the CHANJ Cores and Corridors, again, similar to all of the other regions with the exception of the Piedmont (66%). Within the Cores, 45% of the area is TWH Preserved Land, similar again to the other regions except the Piedmont (20%) and within the Corridors in the Atlantic Coastal, 26% of the area is TWH Preserved Land, which is significantly higher than any of the other regions. Within the Atlantic Coastal region's connectivity network, then, 44% (415 km²) is TWH Preserved Land. Therefore, nearly 1/3 of the Atlantic Coastal region is comprised of TWH Preserved Land and a disproportionately higher percentage of TWH Preserved Land is within the region's connectivity network, just like the Delaware Bay and Pinelands regions.

Of the mapped Road Segments, which total 269.62km, 29% (79 km) fall within Cores, which is mid-range among the regions, and 35% (95 km) bisect Cores creating two separate Cores, which is the highest percentage among the regions and is logical since there is such a large area comprised of Cores in the region. In the Atlantic Coastal region, 35% (95 km) of Road Segments fall within Corridors, which is similar to the other regions, with the exception of the Piedmont, which is much higher. So far, 11 structures have been inventoried in the region. Lastly, in the Atlantic Coastal region, there is just one Road Wildlife Mitigation Project, constructed and designed to provide safe passage for terrestrial wildlife across roadways, similar to the Delaware Bay region.

Pinelands

This landscape encompasses all or parts of Atlantic, Ocean, Burlington, Camden, and Gloucester counties. New Jersey's Pinelands (or Pine Barrens) are an internationally recognized ecosystem consisting predominantly of pine and pine-oak mesic upland forests, pitch pine lowlands, and cedar swamps supporting extremely diverse reptile, amphibian, and invertebrate populations (including interior forest and area-sensitive species). Extensive cedar swamps and wetland systems contain numerous insect species, as well as sustainable populations of many neotropical birds. Its waterways support aquatic communities unique among the mid-Atlantic states, and its aquifers provide drinking water to a vast portion of the surrounding region.

Overall, the conditions of the region's habitats are very high, with vast forest and wetlands ecosystems preserved and intact, thanks not only to abundant state park and forest holdings but also to the federal designation of the more than one-million acre "Pinelands National Reserve." This designation carries strong stewardship and regulatory protections that are implemented by the New Jersey Pinelands Commission.

Notwithstanding these protections, certain habitats remain at risk. The region's scant topographic diversity makes it particularly susceptible to impacts from climate change, a current example being the region-wide introduction of southern pine beetle. Other impacts are associated with the illegal recreational use of off-road vehicles in wetlands and sensitive forest habitats, the effects of regional groundwater withdrawals, and the slow conversion of the climax forest structure. This forest structure was historically maintained by wildfires and more recently by human activities such as logging and charcoal production which maintained re-occurring openings in the canopy and sustained a pine-dominated composition. Combined with restrictions and market-driven reductions in logging or forestry activities, the changes in wildfire patterns are converting the forest to a consistently closed canopy condition, and the species composition is slowly changing to include more deciduous hardwoods. – Excerpted from [New Jersey's Wildlife Action Plan \(2018\)](#)

The Pinelands region consists of 192 Cores, the mean size of which (14.79 km²), are on the larger side compared to Cores in the other regions. The total area represented by Cores in the region is 2,840 km² (62% of the region), which is a similar percentage to the Delaware Bay and Atlantic Coastal regions. The total area represented by Corridors in the region is 548 km² (12% of the region). The connectivity network in the Pinelands, then, makes up 3,388 km² or 74% of the region's land area, which is the highest percentage of any of the other regions. The mean (SD) shortest distance between Core pairs in the Piedmont region is 0.94 (1.91) km, which is among the lowest of

any of the other regions. The Core and Corridor metrics indicate that the Pinelands region is one of the least fragmented regions in the state with large Cores sizes that comprise well over 50% of the region's land area and there are relatively short distances between Core pairs.

The amount of State Threatened and Endangered species habitat as represented by the [Landscape Project 3.3](#) mapping that falls with the connectivity network is 94% (91% in Cores and 42% in Corridors), which is the highest percentage of any of the other regions. The amount of terrestrial species habitat that falls within the connectivity network is 89% (99% in Cores and 65% in Corridors), which among the highest of any of the regions. The connectivity network contains 171 Stepping Stones.

In total, the Pinelands region has 1,502 km² (33% of the region) of Terrestrial Wildlife Habitat (TWH) Preserved Land, which is among the highest of the regions. Of the total in the region, 98% of TWH Preserved Land falls within the CHANJ Cores and Corridors, again, among the highest of the regions. Within the Cores, 51% of the area is TWH Preserved Land and within the Corridors, just 7% of the area is TWH Preserved Land, such that of the Pinelands region connectivity network, 44% (1,477 km²) is TWH Preserved Land. Therefore, 1/3 of the Pinelands region is comprised of TWH Preserved Land and a disproportionately higher percentage of TWH Preserved Land is within the region's connectivity network, just like the Delaware Bay and Atlantic Coastal regions.

Of the mapped Road Segments, which total 1,997.39 km, 43% (853 km) fall within Cores, 31% (609 km) bisect Cores creating two separate Cores, and 27% (535 km) of Road Segments fall within Corridors, so similar to the Delaware Bay and Atlantic Coastal regions, the Road Segment totals are fairly evenly distributed across those three contexts within the connectivity networks. So far, 77 structures have been inventoried, and there are a total of 7 Road Wildlife Mitigation Projects (5 constructed and 2 that are in progress) designed to provide safe passage for terrestrial wildlife across roadways.

MONITORING STUDIES OR ANIMAL MOVEMENT DATA

It is critical to collect empirical data on animal movement patterns to gain a better understanding of the locations to implement work that are going to be most effective at increasing the functional connectivity of the landscape, as well as to monitor the success of that work to justify the use of limited available resources, to adaptively manage projects, and to improve techniques over time. Monitoring protocols specific to road barrier mitigation efforts have been developed and adapted over years of field-testing and are currently being used by CHANJ partners across the state. The data are being used to inform Road Segment Reports that summarize everything known about a particular road segment from data collected at that location (e.g., GIS analyses, roadkill surveys, camera monitoring, culvert assessment, genetic analyses), and the reports provide recommendations on the design of a wildlife passage system at that location informed by the data collected. Below are descriptions and links to the monitoring protocols currently being used and a template for the Road Segment Report.

Road Segment Reports – A summary of what is known about an individual or group of CHANJ Road Segments, including a description and characterization of the segment, wildlife use, options for mitigation (if necessary), road mitigation construction details, and monitoring and evaluation. The reports are meant to serve as a standardized tool to help organize information on Road Segments that can be useful to justify a road mitigation

project, apply for funding opportunities, and serve as a repository for individual surveys and efforts that may be completed by more than one partner. See Appendix I for a Road Segment Report outline. Examples of the survey and evaluation protocols that may be included in the reports are described here:

- **Road Segment Roadkill Surveys** – Used to track wildlife mortality events along and/or near CHANJ road segments. A Road Segment Roadkill Survey Protocol and data sheet are available in Appendix II.
- **NAACC Culvert Inventories** – This aquatic connectivity portal is a one-stop shop for tools and regional collaboratives focused on aquatic organism passage (“fish passage”) and fragmentation of river and stream ecosystems. It is a starting place for stakeholders, users, and tool developers who wish to keep track of the latest initiatives and better identify opportunities for collaboration and action. The protocol includes the ability to score culverts for terrestrial wildlife passage, as well. To learn more about NAACC efforts in NJ, see Appendix III.
- **Camera Monitoring** – Used to monitor structures that run under or over roadways (e.g., culverts, bridges, overpasses) to assess if and how different species are using those structures. Camera monitoring is also useful for monitoring wildlife use of habitat Cores and Corridors. A Photo Classification Protocol is available in Appendix IV.



Chapter 4. Guidance for CHANJ Cores and Corridors

PRIORITIZING CONSERVATION ACTIONS

The Cores, Corridors, and Road Segments depicted in the CHANJ Mapping are meant to highlight the most advantageous places to implement conservation actions for wildlife connectivity, as they represent New Jersey’s most contiguous remaining habitat areas and the best opportunities to keep those areas functionally linked. But when viewing this mapping from a broad, even statewide scale, tackling the connectivity challenge can seem very daunting. With resources being limited, it is important to prioritize our actions to have the greatest positive impact.

One approach is to prioritize areas based on high Biological Value and Opportunity or Need. Figure 4.1 offers scenarios from the CHANJ Mapping where conservation action – **Habitat Protection, Habitat Restoration and Management, or Road Mitigation** – would be most beneficial to terrestrial wildlife connectivity based on criteria of Biological Value and Opportunity or Need. The [CHANJ Web Viewer](#) provides supplemental mapping layers, detailed in the About section, to inform decision making as well.




Conservation Action Guidance for Habitats		
Biological Value		Opportunity or Need
<p><i>Protect/Restore/Manage habitat when...</i></p> <p>CHANJ Core or Corridor supports occurrences of priority terrestrial wildlife, such as Federal or State listed species or Species of Greatest Conservation Need (see Appendix B of NJ's Wildlife Action Plan). Look for intersections with NJDEP Landscape Project mapping.</p>		<p><i>Protect/Restore/Manage habitat when...</i></p> <p>Parcel intersects with other conservation planning tools (e.g., NJ Conservation Blueprint).</p>
<p><i>Protect/Restore/Manage habitat when...</i></p> <p>Corridor features small Cores (CHANJ Stepping Stones) that can be used as live-in habitat for wildlife moving between larger Cores.</p>		<p><i>Protect/Restore/Manage habitat when...</i></p> <p>Core or Corridor contains un-protected land adjacent to a Road Segment where safe passage for wildlife exists or could be created.</p>
<p><i>Protect/Restore/Manage habitat when...</i></p> <p>Core or Corridor contains land that is currently un-protected.</p>		<p><i>Protect/Restore/Manage habitat when...</i></p> <p>Opportunities exist closer to the center of a Corridor. (Habitat quality may decrease along the margins of a Corridor, as shown in darker brown in the Corridor Gradients layer.)</p>
<p><i>Protect/Restore/Manage habitat when...</i></p> <p>Smaller Core or Corridor features unique or high-quality habitat or great restoration potential.</p>		<p><i>Protect/Restore/Manage habitat when...</i></p> <p>Only a single Corridor option exists between Cores.</p>

Figure 4.1a. Guidance for prioritizing areas for conservation action. Implementers can take strategic action for habitat connectivity by prioritizing CHANJ-mapped areas of high *Biological Value* and *Opportunity or Need* that fall within the region of interest or jurisdiction. (Adapted from [CorridorDesign](#), accessed 11/2017)

Conservation Action Guidance for Roads		
Biological Value		Opportunity or Need
<p><i>Mitigate road barriers when...</i></p> <p>Priority terrestrial wildlife, such as Federal or State listed species or Species of Greatest Conservation Need (see Appendix B of NJ’s Wildlife Action Plan) are documented along or in close proximity to a CHANJ Road Segment. Look for a completed CHANJ Road Segment Report and/or adjacent habitat intersections with NJDEP Landscape Project mapping.</p>		<p><i>Mitigate road barriers when...</i></p> <p>A road transect is mapped as a CHANJ Road Segment, indicating it is within Core or Corridor habitat and is not adjacent to urbanization. The darkest black Road Segments represent the most severe barriers to wildlife movement, with high traffic volumes (>10,000/day), and are therefore among the highest priorities for mitigation. Look for a completed CHANJ Road Segment Report for more information, or if one does not exist, assess the location for opportunity and need.</p>
<p><i>Mitigate road barriers when...</i></p> <p>A diversity and/or abundance of wildlife have been documented crossing or attempting to cross at the CHANJ Road Segment. Look for a completed CHANJ Road Segment Report for these details.</p>		<p><i>Mitigate road barriers when...</i></p> <p>Habitat is protected and managed on both sides of the barrier. It is better to invest in a wildlife passage system where adjacent lands are likely to remain wildlife-friendly, and the risk of conversion or development is low. Check the CHANJ Road Segment’s proximity to Terrestrial Wildlife Habitat Preserved Land (a CHANJ Web Viewer layer).</p>
		<p><i>Mitigate road barriers when...</i></p> <p>A high number of wildlife-vehicle collisions have been reported along a CHANJ Road Segment. Look for a completed CHANJ Road Segment Report for these details.</p>
		<p><i>Mitigate road barriers when...</i></p> <p>The CHANJ Road Segment intersects with a transportation plan, such as the NJDOT Statewide Transportation Improvement Program or a municipal plan, or a regulatory nexus mitigation opportunity (e.g., Flood Hazard Area Control Act, Freshwater Wetlands Protection Act).</p>

Figure 4.1b. Guidance for prioritizing areas for conservation action. Implementers can take strategic action for habitat connectivity by prioritizing CHANJ-mapped areas of high *Biological Value* and *Opportunity or Need* that fall within the region of interest or jurisdiction. (Adapted from [CorridorDesign](#), accessed 11/2017)

TAKING CONSERVATION ACTION

*The three types of conservation actions – **Habitat Protection, Habitat Management and Restoration, and Road Mitigation** – are not only important on their own; they are critically intertwined in the effort to secure and improve functional habitat connectivity. A wildlife tunnel will not function well if the land on one side is not protected and gets converted into a parking lot, just as a large protected area may become an “island” if it’s surrounded by unsuitable land uses or bisected by a high-traffic roadway, preventing wildlife from getting from one side to the other. Indeed, taking effective action for wildlife connectivity requires a great deal of thought and collaboration.*

Once the opportunities for conservation action have been evaluated and priorities set, the next step is to find the resources to protect, restore, and/or manage those habitats or facilitate movement across roads that we've identified as important to New Jersey’s landscape connectivity. Fortunately, New Jersey has a large and well-established network of land trusts and stewardship organizations ready to guide and assist with land acquisition and management. Some of these potential partners are listed in the **Habitat Protection, Restoration, and Management section** below. The road mitigation network is currently far smaller, but a few resources to guide and/or fund road mitigation projects are listed near the end of this chapter.



To further coordinate proactive, collaborative conservation amongst implementers, we are developing CHANJ Action Teams for the northern, central, and southern regions of New Jersey. The CHANJ Action Teams are a network of partners from the land use, conservation and transportation fields who can be alerted to important opportunities for land acquisition, habitat restoration, and other conservation actions as they come up. See Chapter 5 for more information on the CHANJ Action Teams framework.

CONSERVATION ACTION: HABITAT PROTECTION

Permanently protecting habitat through acquisition or easement is often the first step in securing or restoring connectivity for wildlife. The following agencies and organizations are some of New Jersey's best resources when it comes to preserving land.

Statewide Partners

Please contact the CHANJ team if your organization should be added to a list.

New Jersey Department of Environmental Protection – Green Acres Program

The Green Acres Program serves as the real estate agent for the Department of Environmental Protection (DEP), acquiring land that becomes part of the system of state parks, forests, natural areas, and wildlife management areas. Its mission is to achieve, in partnership with others, a system of interconnected open spaces, whose protection will preserve and enhance New Jersey's natural environment and its historic, scenic, and recreational resources for public use and enjoyment.

Green Acres also provides open space grants and low interest loans to local governments and works with them through project completion. Green Acres also provides matching grants to eligible nonprofit organizations to acquire land for public recreation and conservation. See a list of Green Acres partner organizations [here](#).

Property owners can offer their land for sale by completing an Application for Sale of Real Estate form, available on the Green Acres website. Land and easement interests can be donated or left through bequests as well.

Natural Resources Conservation Service

The U.S. Department of Agriculture's NRCS in New Jersey offers easement programs to landowners to preserve or enhance their land for agriculture and/or the environment. All NRCS easement programs are voluntary.

The Conservation Fund

The Conservation Fund believes that protecting valuable, conservable land is essential to America's environmental health and economic vitality. Through land acquisition, sustainable programs, and leadership training, the Conservation Fund and its partners work to safeguard properties for wildlife, recreation, historic significance, or to help balance our built environment.

The Land Conservancy of New Jersey

The Land Conservancy of New Jersey is an accredited land trust that preserves land and water resources, conserves open space, and inspires and empowers individuals and communities to protect our natural land and environment. They work with municipalities and nonprofit organizations throughout New Jersey by providing planning, land stewardship, and open space advising services.

The Land Trust Alliance

The Land Trust Alliance is a national advocate for land trusts and land conservation. They can be used as a resource to connect with local land trusts across America.

The Nature Conservancy in New Jersey

The Nature Conservancy's global mission is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.

New Jersey Audubon Society

New Jersey Audubon fosters environmental awareness and a conservation ethic among New Jersey’s citizens; protects New Jersey’s birds, mammals, other animals, and plants, especially endangered and threatened species; and promotes preservation of New Jersey’s valuable natural habitats. In addition to active management, restoration and enhancement of public and private lands throughout the state, New Jersey Audubon maintains a network of sanctuaries and visitor centers.

New Jersey Conservation Foundation

The New Jersey Conservation Foundation preserves land and natural resources for the benefit of all. Their land preservation plan envisions a network of interconnected open space and farmland, using Garden State Greenways as a guide. NJCF preserves land with fee simple acquisition, conservation and agricultural easements, reserve life estate or remainder interest, and bequest.

New Jersey Natural Lands Trust

The New Jersey Natural Lands Trust preserves land in its natural state for enjoyment by the public and to protect natural diversity through the acquisition of open space. The Trust manages its properties to conserve elements of natural diversity, such as habitat for rare plant and animal species and rare ecological communities.

Trust for Public Land

The Trust for Public Land helps communities raise funds, conduct research and planning, acquire and protect land, and design and renovate parks, playgrounds, trails, and gardens across the United States.



Local Partners

Please contact the CHANJ team if your organization should be added to a list.

D&R Greenway Land Trust

D&R Greenway’s mission is to preserve and care for land and inspire a conservation ethic, now and forever. Their land preservation focuses on protecting interconnected greenways in urban, suburban, and rural communities.

Hunterdon Land Trust

The mission of the Hunterdon Land Trust is to preserve the integrity of the rural landscapes in the Hunterdon County region. Hunterdon Land Trust works with landowners who wish to permanently protect the ecological, agricultural, scenic, historic, or recreational qualities of their land. They also work in partnership with municipal, county, and state governments as well as other nonprofit organizations to acquire and manage environmentally sensitive properties and farmland.

Monmouth County Park System

The Board of Recreation Commissioners is committed to improving the quality of life of the citizens of Monmouth County by providing open space, park and recreation areas, facilities, programs, and services of the highest quality and to furnishing these opportunities in the most effective, efficient, and economical manner possible.



Natural Lands

Natural Lands is a non-profit organization with the goal of protecting our region’s natural assets by building a network of interconnected open space throughout the Delaware Valley of New Jersey and Pennsylvania.

Ocean County Natural Lands Trust Fund

The Natural Lands Trust Fund was established to acquire and maintain environmentally sensitive lands, natural areas and open spaces in Ocean County. The program generates over \$10 million per year for natural lands acquisitions and farmland preservation.

Pinelands Preservation Alliance

The Pinelands Preservation Alliance is dedicated to preserving the NJ Pinelands through advocacy and education.

Ridge and Valley Conservancy

Ridge and Valley Conservancy is a private, non-profit accredited local land trust that preserves natural areas within the Appalachian Valley and Ridge Region of northwestern New Jersey for the benefit of people and wildlife. They protect forests, meadows, farmland and watercourses, and practice sound ecological management of their preserves. RVC acquires both land and conservation easements. They also assist in the stewardship of public land and advise landowners as to their conservation options.

Together North Jersey

Together North Jersey (TNJ) was created to help develop a regional plan for North Jersey. TNJ brought together a coalition of nearly 100 diverse partners—

counties, municipalities, educational institutions, nonprofits, businesses and other groups—to develop the first comprehensive plan for sustainable development for the 13 northern New Jersey counties: Bergen, Essex, Hudson, Hunterdon, Middlesex, Monmouth, Morris, Ocean, Passaic, Somerset, Sussex, Union and Warren. The plan includes a broad range of topics such as housing, economic development, education, land use, energy, water, arts, stewardship and transportation.

CONSERVATION ACTION: HABITAT RESTORATION AND MANAGEMENT

Habitat restoration and management for wildlife is a broad category of possible actions, ranging from changing the land use (e.g., converting agriculture to forest), to increasing native plant diversity or buffers, to maintaining current conditions that are already favorable to an assemblage of species. The following agencies and organizations are some of New Jersey's best resources to assist with habitat management planning and implementation.



Statewide Partners

Please contact the CHANJ team if your organization should be added to a list.

U.S. Fish and Wildlife Service – NJ Field Office – Partners for Fish and Wildlife

The U.S. Fish and Wildlife Service's Partners program is a habitat restoration program based on the understanding that the majority of wildlife in the U.S. is found on private land and, therefore, successful wildlife conservation requires engaging private landowners. *Partners* works with private, corporate, municipal, county, and non-profit landowners to pursue voluntary fish and wildlife habitat restoration projects. They do not work on State or federally owned land but do work with State and federal agencies in a variety of ways, including planning and partnering efforts to support habitat restoration.

Natural Resources Conservation Service

U.S. Department of Agriculture's NRCS in New Jersey offers conservation programs to help landowners and agricultural producers to reduce soil erosion, improve water quality, enhance wildlife habitat, and reduce damages caused by floods and other natural disasters. Participation in NRCS conservation programs is voluntary, and requests for technical assistance and applications for financial assistance are accepted throughout the year.

National Wildlife Federation

The National Wildlife Federation educates and empowers people to turn their own small pieces of Earth into thriving habitat for birds, bees, butterflies, and other wildlife. In doing so, people across North America are making a difference in their cities, towns, and neighborhoods—all while deepening their connections to the

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natural world. NWF's Certified Wildlife Habitat program guides landowners to provide wildlife with food, water, cover, and places to raise young.

New Jersey Invasive Species Strike Team

The Invasive Species Strike team's vision is to protect our natural lands, with their full abundance and diversity of native plants and animals, from future damage through coordinated strategic invasive species management involving a team of partners and volunteers. The focus is eliminating threats posed by newly emerging invasive species before they become widespread pests and protecting our most pristine lands and rare species habitats.

Wildlife Habitat Council

The Wildlife Habitat Council promotes and certifies habitat conservation and management on working lands through partnerships and education.

Local Partners

Please contact the CHANJ team if your organization should be added to a list.



Ridge and Valley Conservancy

Ridge and Valley Conservancy is a private, non-profit accredited local land trust that preserves natural areas within the Appalachian Valley and Ridge Region of northwestern New Jersey for the benefit of people and wildlife. They protect forests, meadows, farmland and watercourses, and practice sound ecological management of their preserves. RVC acquires both land and conservation easements. They also assist in the stewardship of public land and advise landowners as to their conservation options.

Wallkill River Watershed Management Group

The WRWMG works to restore, enhance, and protect the surface waters of Sussex County, New Jersey, by conducting water quality monitoring, organizing volunteers to assist with streamside planting projects, assisting local farmers with conservation activities, and helping homeowners better understand the stream conditions on their properties. The WRWMG strives to create a more informed citizenry, foster a greater sense of environmental stewardship, and implement watershed restoration initiatives to help ensure the long-term sustainability of Sussex County's natural resources for future generations.

Private and Smaller-Scale Landowner Resources

Please contact the CHANJ team if your organization should be added to a list.

Small properties matter, too! Particularly within CHANJ-mapped Corridors, smaller-scale parcels and even residential yards can serve as important move-through habitat and help to expand "Stepping Stones" for wildlife in

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between the larger habitat Cores. There are several great resources aimed at helping private and smaller-scale landowners to manage their land in a meaningful way for wildlife. Here are a few of them:

Duke Farms – Stewardship at Home

No matter how big or small your home landscape, there are always ways to implement habitat restoration. The resources on this page guide homeowners through actions like building a bat roost, creating a perennial meadow, installing a rain garden, and more.

Jersey-Friendly Yards

This page gives a variety of resources to help home and property owners learn about environmentally sound landscaping techniques.

National Wildlife Federation – Designing Your Wildlife Garden at Home

In addition to NWF’s Certified Wildlife Habitat program (listed in the previous section), this page describes some simple ways to provide the essential habitat components of food, water, cover, and places for wildlife to raise young while designing a garden space that appeals to your aesthetics and enhances the natural landscape.

Staying Connected – Management Recommendations for Landowners

The Staying Connected Initiative seeks to conserve, restore, and enhance landscape connectivity across the Northern Appalachian/Acadian region of the U.S. and Canada for the benefit of nature and people. This guide gives landowners an overview of habitat management strategies to enhance wildlife movement and survival.

YardMap

This site encourages the public to turn yards into wildlife habitat and provides articles and resources.



CONSERVATION ACTION: ROAD MITIGATION PRACTICES

A critical step in restoring wildlife connectivity is facilitating the movement of animals across roads. Installation of crossing structures with wildlife fencing (Figure 4.2) is an effective means of reducing wildlife vehicle collisions and allowing safe movement across road barriers, thus maintaining connectivity. These wildlife passage systems can be in the form of new structures and fencing or retrofits to existing culverts or bridges. While road mitigation measures are still unfamiliar to many resource managers and planners, it is well known within the road ecology community that mitigation measures (structures and fencing) that are designed properly, implemented in the correct locations, and well-maintained are very effective at providing safe passage across roadways and reducing road mortality for a variety of animals, from large mammals to small amphibians. These measures also help to safeguard drivers from the property damage and personal injury that can result from wildlife collisions.

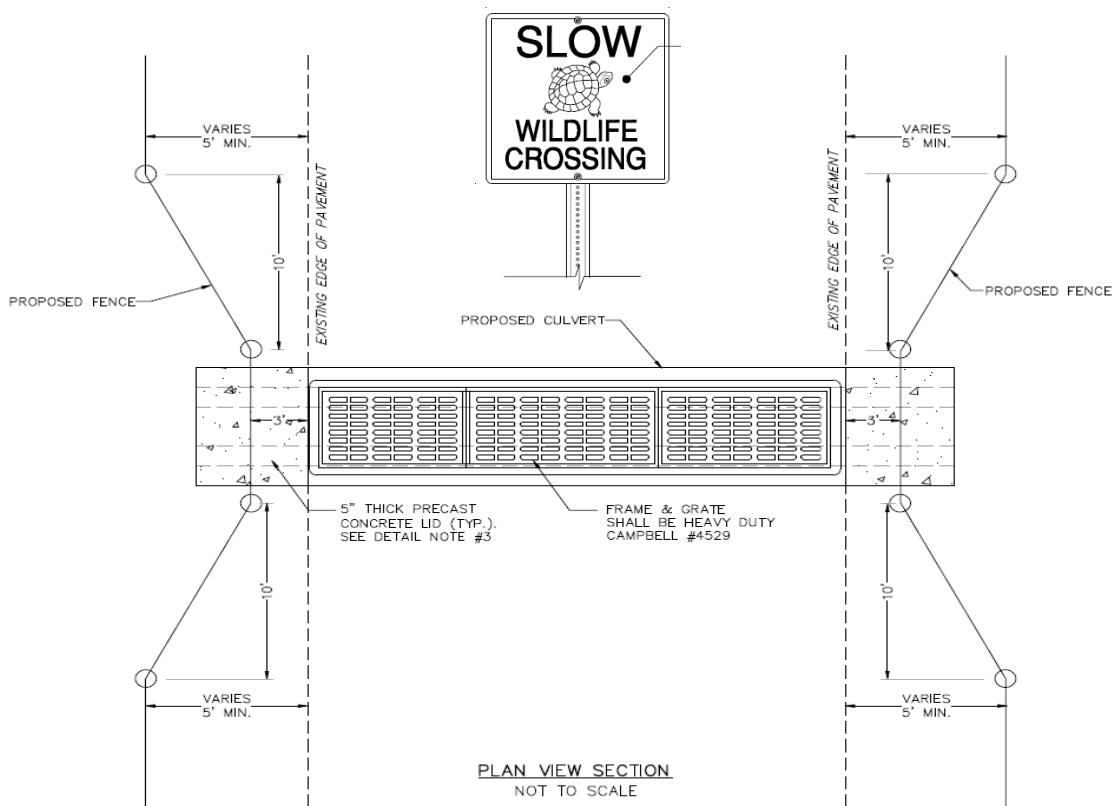


Figure 4.2. An example schematic of a grated-top crossing structure, showing tie-in with fencing.

As road mitigation projects become more commonplace, it is important to monitor and evaluate their effectiveness at achieving our conservation goals to justify the use of limited available resources, to adaptively manage projects, and to improve road mitigation techniques over time.

CHANJ incorporates several tools to assist in planning, monitoring, and tracking road mitigation projects. The tools are described in Table 4.1, along with where you can find them.

Table 4.I. Tools to inform and track road mitigation projects in New Jersey.

Road Mitigation Tools		
Tool	Description	Where to Find It
CHANJ mapping layers	Consists of habitat Cores, Corridors, and Road Segments. The Road Segments identify areas where Cores and Corridors are intersected by road barriers of varying severity. These serve as starting points for targeting road/wildlife mitigation efforts.	CHANJ Web Viewer ; Tools of CHANJ webpage
Road Segment Reports	Describes what is known about a Road Segment based on a variety of monitoring approaches conducted at that location (e.g., GIS analyses, roadkill surveys, camera monitoring, culvert assessment, genetic analyses) and provides recommendations on the design of a wildlife passage system.	Report Outline – Appendix I of the Guidance Document
Culvert Inventory	The NJ portion of the regional (13-state) North Atlantic Aquatic Connectivity Collaborative (NAACC) database identifies road/stream crossing structures across the state. For those that have been surveyed following NAACC protocols, the Culvert Inventory displays results and a wildlife passability rating (from “No” barrier to “Severe” barrier).	CHANJ Web Viewer ; Available as its own NJDEP NAACC Web App ; Tools of CHANJ webpage ;
Best Practices for Wildlife Passage Systems	Guidelines for designing effective crossing structures and guide fencing for terrestrial wildlife, small to large.	Next in this Chapter; By clicking any Road Segment in the CHANJ Web Viewer ;
Road Wildlife Mitigation Projects Database	A central repository for information on permitted and constructed wildlife passage systems across the state. Can be used to help inform future projects.	CHANJ Web Viewer

BEST PRACTICES FOR WILDLIFE PASSAGE SYSTEMS

These best practices are a short guide to designing effective wildlife passage systems for terrestrial wildlife species of various mobility guilds. Table 4.II lists the species belonging to each of the mobility guilds referenced throughout the guide. Wildlife passage systems might include under-road tunnels or overpasses, with guide walls or fencing to funnel movement. Fencing plays a critical function in intercepting animals as they approach the roadway and directing them to the crossing structure. Wildlife passage systems do not always need to be new structures. In many cases, existing bridges, culverts, and underpasses can be modified to accommodate the needs of wildlife.

Please note that construction of new crossing structures, or the replacement, modification or rehabilitation of existing structures, may require permits or approvals from agencies with local, State, or Federal jurisdiction. For information on potential State jurisdiction under the Flood Hazard Area Control Act Rules (NJAC 7:13) or the Freshwater Wetlands Protection Act Rules (NJAC 7:7A), contact the NJ DEP Division of Land Use Regulation at (609) 777-0454.

Table 4.II. Species belonging to low mobility, moderate mobility, high mobility, and high openness guilds.

Low Mobility Terrestrial Wildlife					
Mammals		Reptiles		Amphibians	
Allegheny Woodrat * (E)	Water Shrew *	Bog Turtle * (E)	Red-bellied Snake	Allegheny Mountain Dusky Salamander *	Green Frog
Eastern Chipmunk	White-footed Mouse	Common Five-lined Skink *	Rough Greensnake *	American Bullfrog	Jefferson Salamander * (SC)
Eastern Mole	Woodland Jumping Mouse *	Common Gartersnake	Smooth Earthsnake *	American Toad	Marbled Salamander * (SC)
Hairy-tailed Mole *	Woodland Vole	Dekay's Brownsnake *	Smooth Greensnake *	Atlantic Coast Leopard Frog *	New Jersey Chorus Frog *
Least Shrew *		Eastern Box Turtle * (SC)	Spotted Turtle * (SC)	Blue-spotted Salamander * (E)	Northern Dusky Salamander *
Long-tailed Shrew *		Eastern Fence Lizard *	Wood Turtle * (T)	Carpenter Frog * (SC)	Northern Red Salamander *
Masked Shrew		Eastern Mud Turtle *		Cope's Gray Treefrog * (E)	Northern Slimy Salamander *
Meadow Jumping Mouse *		Eastern Musk Turtle		Eastern Cricket Frog *	Northern Spring Salamander *
Meadow Vole		Eastern Painted Turtle *		Eastern Long-tailed Salamander * (T)	Northern Two-lined Salamander *
Pygmy Shrew *		Eastern Ribbonsnake *		Eastern Mud Salamander * (T)	Pickrel Frog
Short-tailed-shrew		Eastern Wormsnake *		Eastern Red-backed Salamander	Pine Barrens Treefrog * (T)
Smoky Shrew *		Little Brown Skink *		Eastern Spadefoot *	Red-spotted Newt
Southern Bog Lemming *		Northern Diamond-backed Terrapin *		Eastern Tiger Salamander * (E)	Southern Leopard Frog *
Southern Red-backed Vole		Northern Ring-necked Snake *		Four-toed Salamander *	Spotted Salamander *
Star-nosed Mole *		Northern Scarletsnake *		Fowler's Toad * (SC)	Spring Peeper
Tuckahoe Masked Shrew *		Queensnake * (E)		Gray Treefrog	Wood Frog

(Continued on next page) E – State Endangered; T – State Threatened; SC – State Special Concern; * – NJ Species of Greatest Conservation Need (SGCN; from [New Jersey's Wildlife Action Plan](#))

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Moderate Mobility Terrestrial Wildlife			High Mobility Terrestrial Wildlife	High Openness Fauna
Birds	Mammals	Reptiles	Mammals	Mammals
American Bittern * (E)	American Beaver	Eastern Hog-nosed Snake *	Black Bear	White-tailed Deer
American Black Duck *	Common Raccoon	Eastern Kingsnake * (SC)	Bobcat * (E)	
American Woodcock *	Eastern Cottontail	Eastern Milksnake	Common Gray Fox	Insects
Black Rail * (E)	Eastern Gray Squirrel	Eastern Ratsnake *	Coyote	Frosted Elf * (T)
Clapper Rail *	Ermine	Northern Black Racer *	Fisher *	Georgia Satyr * (SC)
King Rail *	Long-tailed Weasel	Northern Copperhead * (SC)	Northern River Otter	Northern Metalmark * (SC)
Least Bittern * (SC)	Marsh Rice Rat *	Northern Pinesnake * (T)	Red Fox	Silver-bordered Fritillary * (T)
Northern Bobwhite *	Mink	Northern Red-bellied Cooter *		
Ruffed Grouse *	Muskrat	Northern Watersnake		
Virginia Rail *	Northern Flying Squirrel *	Red Cornsnake * (E)		
Whip-poor-will * (SC)	Porcupine	Snapping Turtle		
Wild Turkey	Red Squirrel	Timber Rattlesnake * (E)		
	Southern Flying Squirrel			
	Striped Skunk			
	Virginia Opossum			
	Woodchuck			

(Continued from previous page) E – State Endangered; T – State Threatened; SC – State Special Concern; * – NJ Species of Greatest Conservation Need (SGCN); from [New Jersey's Wildlife Action Plan](#)



Hundred Year Films

Table 4.III. Wildlife passage system structure specifications recommended for different species mobility guilds.

Wildlife Passage System: Structure Specifications													
SPECIES GUILD	STRUCTURE TYPE*	SUBSTRATE	SPAN (if conveying water)	WIDTH (internal)		HEIGHT (internal)		LENGTH		SPACING of STRUCTURES		GRATED TOP (openings along road surface for climate)	
				recommended	min	recom'd	min	recom'd	max	recom'd	max	recom'd	min
Low mobility	Open bottom bridge / culvert	Leave natural	1.2x bankfull width at both ends, minimum	2'	18"	2'	1'	≤ 40'	125'	120'	200'	Entire length	At ends
	Box, circular, or elliptical culvert	Backfill with >6" natural substrate											
Moderate mobility	Open bottom bridge / culvert	Leave natural	1.2x bankfull width at both ends, minimum	4'	3'	4'	3'	≤ 40'	125'	500'	1,000'	Entire length	At ends
	Box, circular, or elliptical culvert	Backfill with >6" natural substrate											
High mobility	Open bottom bridge / culvert	Leave natural	1.2x bankfull width at both ends, minimum	8'	6'	8'	6'	≤ 40'	125'	500'	1 mile	-	-
	Box, circular, or elliptical culvert	Backfill with >6" natural substrate											
High Openness Fauna	Open bottom bridge / culvert	Leave natural	1.2x bankfull width at both ends, minimum	20'	10'	10'	8'	≤ 40'	125'	0.5 miles	1 mile	-	-
	Box, circular, or elliptical culvert	Backfill with >6" natural substrate											
NOTES:		<ul style="list-style-type: none"> • Tunnel should be perpendicular to road, situated at base of slope below road grade, completely level or minimum grading (3%) • Design for the needs of all species utilizing the area; multiple structures of different types and sizes may be preferable, and in general, the bigger the better. • Maximize continuity of native vegetation, natural material (e.g., rocks, logs), and soils adjacent to and within structure • * Overpasses are effective across all species guilds, especially when designs include natural substrate, continuous vegetation cover, a diversity of microhabitats, and separation from human use areas. 											

Table 4.IV. Wildlife passage system specifications for shelves and dry pathways recommended for different species mobility guilds.

Wildlife Passage System: Shelf / Dry Pathway Specs					
SPECIES GUILD	WIDTH of shelf / dry pathway (Structure width specs still apply)		CLEARANCE from pathway surface to ceiling		SHELF / PATHWAY MATERIAL and PLACEMENT (Applies to all species guilds)
	<i>recommended</i>	<i>minimum</i>	<i>recommended</i>	<i>minimum</i>	
Low mobility	2'	18"	2'	1'	<ul style="list-style-type: none"> • No exposed gabion baskets or rip-rap should be used for shelf or dry pathway, as these materials are difficult or dangerous for many types of wildlife to traverse; • If the structure conveys water, a shelf or dry pathway should be available on both sides inside the structure; • Pathway should be above the high water line of 2-year storms; • A transition ramp or extended pathway should connect the shelf or dry pathway to the landscape around it at both ends of the structure, mimicking surrounding substrate and vegetation.
Moderate mobility	4'	3'	4'	3'	
High mobility	4'	3'	5'	4'	
High Openness Fauna - deer	4'	3'	10'	8'	

Table 4.V. Wildlife passage system fencing and guide wall specifications recommended for different species mobility guilds.

Wildlife Passage System: Fencing and Guide Wall Specs			
SPECIES GUILD	FENCE HEIGHT	MATERIAL	ORIENTATION (Applies to all species guilds)
Low mobility	≥ 1.5'	Solid/opaque material that is smooth and non-grippable to climbing animals (e.g., firm plastic, concrete, treated wood)	<ul style="list-style-type: none"> Fencing should be angled 25-45 degrees from the road to create a funnel effect toward the crossing structure No gaps should exist between the fencing and passage structure, as animals may slip through Fencing should be buried 6-12" into the ground to prevent animals from burrowing under Top of fencing should have an overhang or "lip" up to 12" long on the side facing the habitat, to prevent breaching by climbing animals (particularly important for reptiles and amphibians and some mammals) Consider all species likely to utilize the passage structure when choosing the fence material and design Regular maintenance is critical for identifying problems and making timely repairs
Moderate mobility	3-6'	<u>For Reptiles/Amphibians:</u> Solid/opaque material that is smooth and non-grippable to climbing animals (e.g., firm plastic, concrete, treated wood)	
		<u>For All Other Species:</u> See-through materials are acceptable and may include fine wire mesh, hardware cloth, welded-wire fence, etc. (max 1" x 1" mesh size)	
High mobility	6'	Fencing should have max mesh openings of 2" x 4", and bottom 4 ft. should be a smooth, non-grippable surfaces such as fine wire mesh or flashing for climbing animals.	
High Openness Fauna - deer	8-9'	Woven metal wire fence with 6" x 6" mesh size	

CONSIDERATIONS FOR WILDLIFE PASSAGE STRUCTURES AND SHELVES / DRY PATHWAYS

Structure Type and Materials

- A. In stream/wetland/riparian environments:
 - 1. Open-bottom structures that preserve natural ground substrate and hydrology are preferred. When feasible, the structure should span a minimum of 1.2 times the bankfull width to allow dry passage on both sides of watercourse. (*Bankfull width is the distance between a stream or water body's top-of-banks at normal full water level.*)
 - 2. Four-sided box culverts and circular or elliptical culverts should be backfilled with native substrate (>6 inches deep) while still meeting minimum internal height recommendations (Table 4.III). Ensure that the substrate will remain stable against velocities of the stream.
- B. In upland environments:
 - 1. Open-bottom structures are preferred to maintain continuity of the natural substrate.
 - 2. Four-sided box culverts and circular or elliptical culverts should be backfilled with native substrate (>6 inches deep) when possible, while still meeting minimum internal height recommendations (Table 4.III).

Placement

- C. Install the structure perpendicular to the road it crosses to allow for a clear line-of-sight through the structure. The shorter the structure length, the better for wildlife movement.
- D. Tunnels should be designed to conform to local topography and should be situated at the base of the slope below the road grade.
- E. Install the structure parallel with the stream flow through it, when applicable.



- F. The structure should be installed completely level or with minimal grading (up to 3%), both at the entrances and throughout the tunnel.
- G. On divided highways, structures should be continuous across all lanes, below-grade, and should not open up in the central median unless barrier fencing is in place to guide animals into the structures and to prevent animals from entering the highway.

Considering Species' Needs

For Low to Moderate Mobility Species:

- H. Reptiles and Amphibians: A grated top or similar design is preferable, allowing natural light to enter the structure from above and helping to keep soil moisture, humidity and temperature consistent with ambient conditions. If a grated top option is not feasible for the entire length, consider grating at the structure's ends beyond the edge of roadway.
- I. Small, low mobility species often need cover when moving through an open area in order to maintain body climate and/or to feel secure from predators. Their cover requirements can be met by placing, for example, PVC tubes of varying diameters and/or woody debris inside the structure, along the sides, spanning the entire length of the structure. Also ensure that cover is available outside the structure for continuity with surrounding habitats.

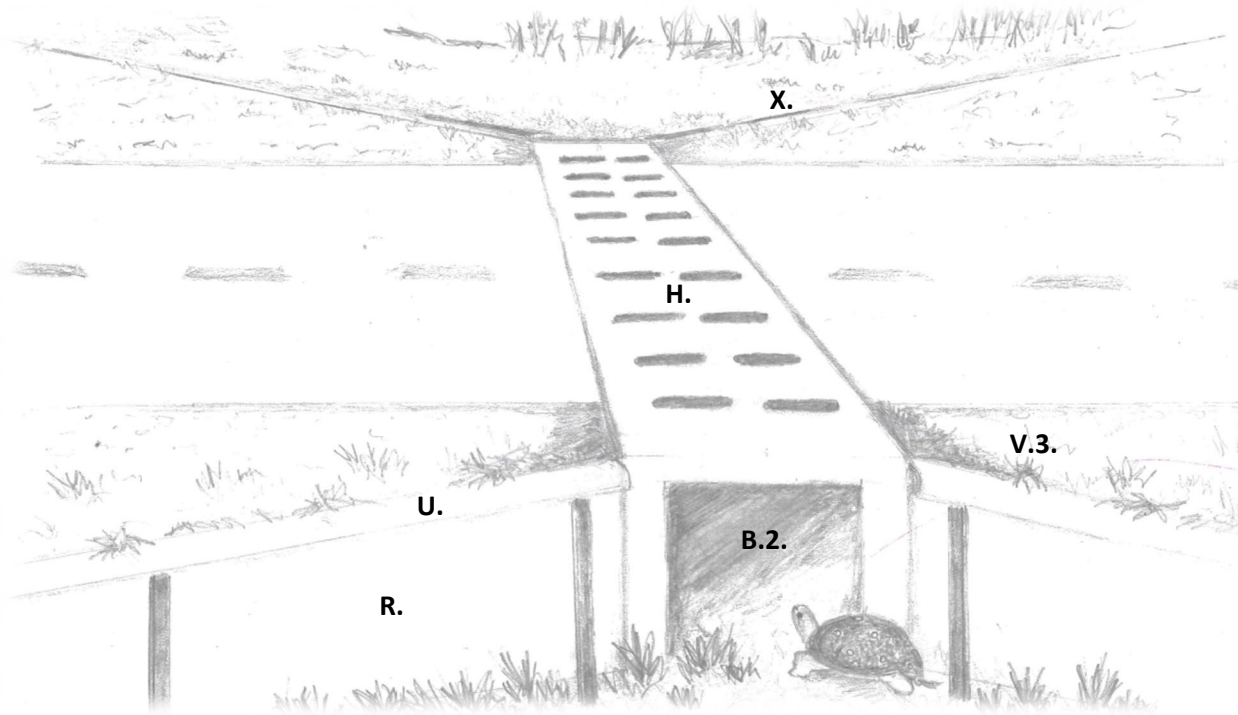


Figure 4.2. Sketch of a wildlife passage system appropriate for the low mobility species guild. This example uses a four-sided box culvert back-filled with natural substrate (described in B.2.) with a grated top (H.) and angled guide fencing (R.) with overhang (U.), on both sides of the road (X.). The back side (road side) of the fence is level with the earth (V.3.), allowing animals to escape the road.

For Moderate to High Mobility Species:

- J. Semi-aquatic species such as river otters, muskrats, and beavers may not use structures unless aquatic habitat is present or nearby. Maintain riparian vegetation throughout the structure to encourage use by these species.

For ALL Species:

- K. Having closely-spaced crossing structures representing a diversity of structure types and sizes creates safe passage opportunities for a variety of species guilds.
- L. Minimize the intensity of noise and light coming from the road.
- M. Maximize continuity of native vegetation, natural material (e.g., rocks, logs), and soils adjacent to and within the structure. Avoid importation of soils from outside the project area.
- N. Riprap is difficult or even dangerous for many animal species to traverse and should not be placed in front of or on the slopes adjacent to a passageway. If riprap is required, then it should be buried, back-filled with topsoil, and planted with native vegetation; there should be no exposed

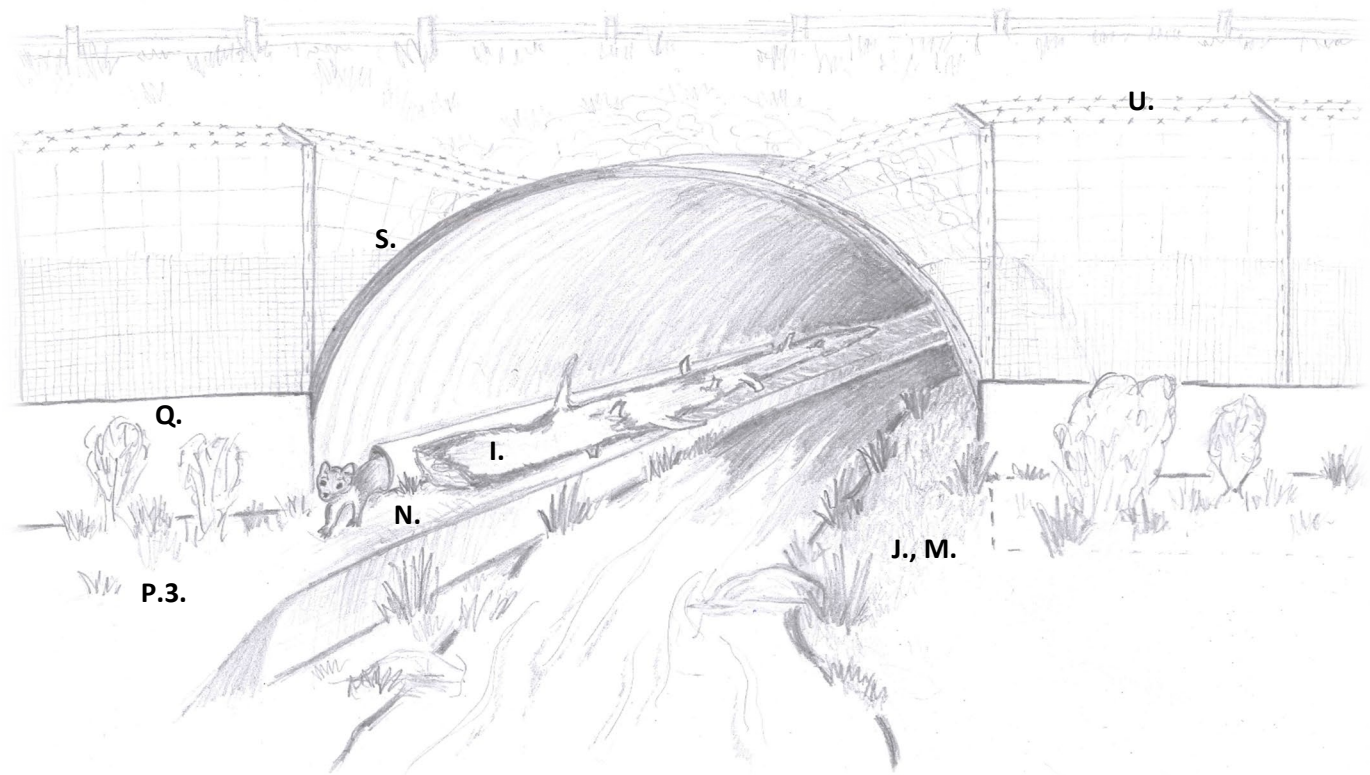
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gabion baskets or mattresses. In situations with high stream velocity, an aggregate, sediment-choked riprap can be used to create a smooth surface while maintaining stability in accordance with FHA Rules, including N.J.A.C 7:13-12.7 (f)4.

- O. Design drainage features such that runoff from the roadway and from flooding does not cause dry passageways within the structure to become submerged by standing or flowing water.
- P. Structures that need to accommodate flowing water should maintain or replicate the stream's natural channel conditions as specified in the FHA Rules including N.J.A.C. 7:13-11.1 (b):
 1. To facilitate passage by both aquatic and terrestrial species, the structure should be wide enough to provide dry passage with dry ground or an elevated shelf that is above the high water line of a 2-year storm. This can be accomplished by ensuring that the crossing structure width is at least 1.2 times that of the stream at normal full water level (1.2x bankfull width) on both ends of the structure. Width and height specifications for structures and dry passages are given in Tables 4.III and 4.IV, respectively.
 2. The surface of the dry passageway should be set at or just above the vegetation line, which generally marks the 2-yr flood elevation. The intent of the dry passageway along a watercourse is to mimic a streamside wildlife trail (not a cliff!).
 3. Dry passageways should be connected to traversable habitat on both sides of the road to allow for seamless animal movement. They may include a gently sloping ramp to transition from the passageway to the surrounding landscape.
 4. Stream velocities and depths under a variety of flow conditions should replicate the stream's natural channel conditions and meet FHA Rules including N.J.A.C. 7:13-11.1(b).
 5. Water flow should not be constricted within the structure and should not result in hydrologic drops or jumps upstream of, within, or immediately downstream of the structure. Refer to FHA Rules including N.J.A.C. 7:13-12.7(d)1 or (e)1 as appropriate.
 6. The structure should provide continuity of stream bed materials, both in type and texture, allowing for similar passage conditions for animals that are sensitive to substrate.

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Figure 4.3. Sketch of a stream culvert with a shelf on one side and natural dry pathway on the other to facilitate terrestrial wildlife passage (described in P.1.). This example includes a shelf with natural substrate and vegetation (no exposed riprap or gabion baskets; N.), woody cover and a PVC tunnel for small animals (I.), and a smooth transition between the shelf and adjacent habitats (P.3.). Both the shelf and dry pathway have natural vegetation throughout the structure for continuity (J., M.). The guide fencing is tiered for animals of all mobility guilds (Q.), includes an overhang to prevent climbing (U.), and attaches flush with the crossing structure entrance (S.).



Fencing and Guide Walls

- Q. Fencing/guide walls should be designed based on all species likely to utilize the passage structure.
- R. Fencing/guide walls should angle out from each end of the crossing structure at approximately 25-45 degrees to help funnel animals towards the structure.
- S. Fencing/guide walls should attach flush with the crossing structure entrance, with no gaps that small animals might slip through. Avoid any surface irregularities that might impede or distract animals moving toward the entrance.
- T. Fencing/guide walls should be buried 6-12 inches into the ground to prevent animals from digging under it or gaps from being created by erosion.
- U. The top of fence should have a 6-12-inch overhang or “lip” to prevent breaching by climbing animals. This is particularly important for reptiles and amphibians and some mammals. The overhang should face the habitat side (angled away from the roadway).
 1. Eliminate or maintain vegetation and materials that would allow animals to climb over the fence and onto the roadway.

- V. The design should allow animals that do enter the roadway to safely escape it.
 1. Natural objects such as brush or woody debris (for climbing species), or ramps can be placed on the roadway side of the fence to allow escape.
 2. Backfilling with soil or adding textured materials to the road side of the fence gives animals the ability to climb over and escape from the road.
 3. The top of the guiding wall/fence can be installed level with ground on the road side, while still meeting minimum fence height recommendations (Table 4.V) on the habitat side.
 4. Earthen ramps or jump-outs can be employed for high mobility species and deer. They need to be of an appropriate height to allow animals to jump down and outside the roadway, but not back up and into the roadway. Also the non-road side should be non-grippable material to prevent animals from climbing up onto the roadway.
- W. Fence ends should angle away from the road, orienting wildlife toward the natural habitat and away from the road.
- X. Fencing should extend on both sides of the structure, along the entire length of suitable, traversable habitat. Fencing should extend to equal lengths on both sides of the road, as conditions allow.

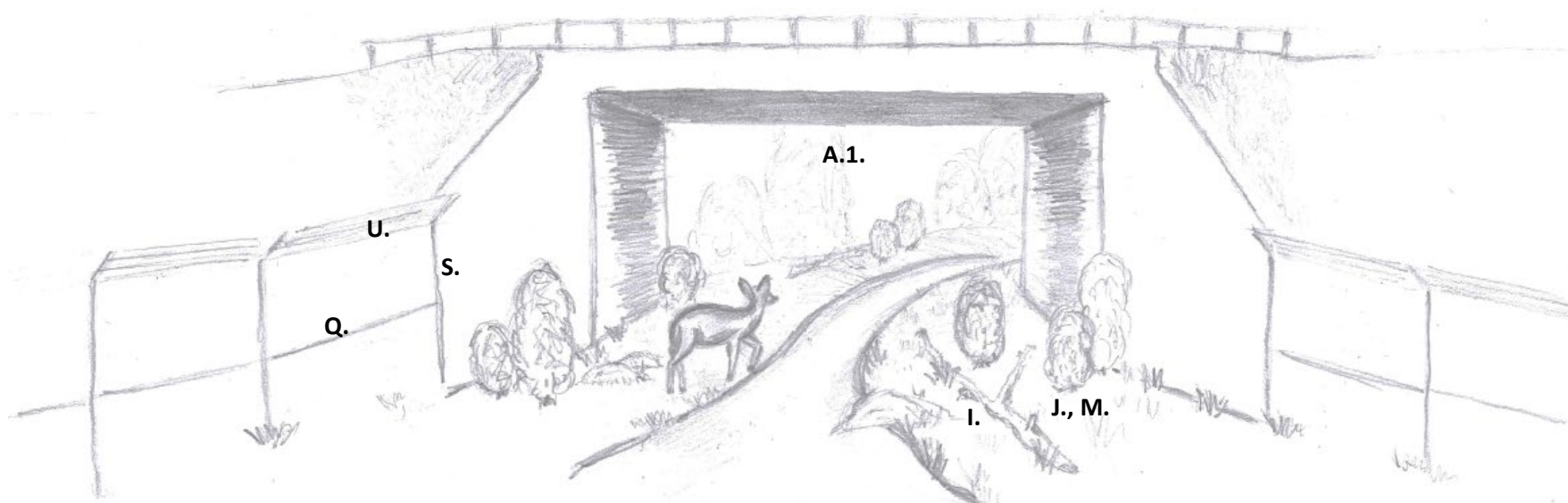


Figure 4.4. Sketch of a stream overpass suitable for all species mobility guilds, including the High Openness Fauna which are less apt to travel through confined spaces. The open-bottom structure spans at least 1.2 times the bankfull width to preserve natural stream and riparian conditions and to provide dry passage on both sides of watercourse (A.1.). The dry pathways have natural vegetation, logs, and rocks throughout the structure for continuity with adjacent habitat (J., M.) and cover for small animals (I.). The guide fencing could be tiered for animals of all mobility guilds (Q.); it includes an overhang to prevent climbing (U.) and attaches flush with the crossing structure entrance (S.)

MAINTENANCE

Wildlife passage systems should be thoroughly inspected and maintained on a routine basis to ensure good function. Maintenance should be done at least once per year, and perhaps more often depending on the intensity of use and the forces acting on the system (e.g., if vulnerable to tree fall, scouring, vandalism, etc.). The maintenance schedule may also vary based on the phenology of animals using the system, such as in preparation for early spring amphibian migrations or turtle nesting season. Crossing structures should be checked for obstacles, foreign matter, overgrown vegetation, or other issues within or near the structure that might affect wildlife use. Fencing should be checked for any damage, vandalism, gaps or breaches, fallen trees, or overgrown vegetation affecting its function. Make repairs and address any issues in a timely manner, prior to the target animals' seasonal movements or peak activity period, as applicable.

MONITORING

It is important to evaluate a passage system's effectiveness at allowing wildlife to move safely across the roadway. Monitoring should be seen as an integral part of road mitigation projects and include an evaluation of both wildlife usage of the passage system as well as the amount of roadkill occurring at the location and adjacent areas before and after construction. These metrics tell us whether the project is achieving our conservation goals as planned, or if adaptive management is needed to make them more effective. Monitoring also helps us to justify investing in similar projects elsewhere and to improve road mitigation techniques over time.





Monitoring protocols are always fairly specific to the site and situation, but certain methods have been developed and adapted over years of field-testing by various researchers and should be considered. Motion-triggered cameras (a.k.a. camera traps) are continually more dependable as technologies improve, with simpler field deployment, better image quality, increased file storage capacity, and better ability to capture a variety of species – including small, ectothermic, and nocturnal types. Cameras are particularly useful for monitoring animal usage of tunnels and other discrete structures. Well-thought roadkill survey protocols have also been developed to investigate the need for and the effectiveness of road mitigations for wildlife. Refer to the Appendix of the full [Guidance Document](#) for camera and roadkill survey protocols, among others.

ADDITIONAL GUIDANCE (DOs AND DON'Ts)

In addition to the main road mitigation tools and resources described earlier in this Chapter, Table 4.VI offers a short list of guidance to help minimize impacts to wildlife during everyday transportation planning. Many of these items are easy to implement; they simply need to become part of the lexicon, and eventually, the standard practice.

Table 4.VI. Guidance to minimize wildlife impacts in basic, broad-scale transportation planning.

Do	Do NOT
CURBING	
<p>✓ <u>Gently sloped or Cape Cod Curbing</u></p> <ul style="list-style-type: none"> Allows small animals such as amphibians and turtles to easily and safely escape the roadway Where sloped curbing is not convenient, provide escape slopes for small animals 	<p>✗ <u>Traditional Vertical Curbing</u></p> <ul style="list-style-type: none"> Small animals cannot climb over, causing them to travel parallel to curb or into the roadway Leads animals to fall directly into side box outlets
STORM DRAINS	
<p>✓ <u>Seasonal adaptation for storm drains</u></p> <ul style="list-style-type: none"> In early spring during amphibian migration season, a wire mesh can be placed under grate to catch animals that fall in, if storm drain would otherwise be a trap (must check daily) 	<p>✗ <u>Storm drains with side box outlets</u></p> <ul style="list-style-type: none"> Pose a trap to small animals that fall inside
NOISE BARRIERS	
<p>✓ <u>Noise barriers with openings at the bottom</u></p> <ul style="list-style-type: none"> Openings allow wildlife to escape roadways Recommended size of openings is 8”H x 18”W Noise barriers in combination with wildlife crossing structures are ideal when habitat is present on both sides of the road 	<p>✗ <u>Noise barriers or walls without openings</u></p> <ul style="list-style-type: none"> Trap animals on the road or prevent them from reaching habitat on the other side
BARRIER WALLS	
<p>✓ <u>Barriers of non-transparent materials or markings</u></p> <ul style="list-style-type: none"> Opaque, non-transparent walls (such as concrete or wood) are less apt to have bird or bat strikes Add markings or vertical striping <6” apart on transparent walls for visibility Leave openings at the base of barriers for wildlife passage (see “NOISE BARRIERS”) 	<p>✗ <u>Barriers with clear or transparent walls</u></p> <ul style="list-style-type: none"> Pose a collision risk to birds and bats, which frequently fly into them, causing injury or death
EROSION CONTROL FENCING	
<p>✓ <u>Biodegradable erosion control products</u></p> <ul style="list-style-type: none"> Jute, sisal and coir fiber are examples of 100% biodegradable erosion control materials Netting should be a loose weave to reduce wildlife entanglement 	<p>✗ <u>Plastic erosion netting</u></p> <ul style="list-style-type: none"> Netting is an entanglement hazard for wildlife These products require UV-light to degrade and do not break down properly in shaded forests

ADDITIONAL ROAD MITIGATION RESOURCES

The following are a couple of additional resources to guide and/or fund road mitigation projects for wildlife in our region:

The Roads and Wildlife Portal

The Roads and Wildlife Portal, a collaborative effort of the Staying Connected Initiative and Ontario Road Ecology Group, is a dynamic, interactive website to share information about road mitigation projects, guidance, designs, and studies related to maintaining and restoring connected habitats for fish and wildlife across eastern Canada and the northeastern United States.

Federal Highway Administration – Transportation Alternatives

The U.S. Department of Transportation’s Federal Highway Administration reserves a set-aside of Surface Transportation Block Grant (STBG) program funding for “transportation alternatives,” which can include environmental mitigation related to stormwater and habitat connectivity.

REFERENCES

- Andrews, K.M., Nanjappa, P., & Riley, S.P.D. (2015). Roads and Ecological Infrastructure: Concepts and Applications for Small Animals. Baltimore, MD: Johns Hopkins University Press. Retrieved March 22, 2019, from Project MUSE database.
- Arizona Game and Fish Department, Habitat Branch. (November 2008). Guidelines for Bridge Construction or Maintenance to Accommodate Fish & Wildlife Movement and Passage [PDF File]. Retrieved From <https://www.azgfd.com/PortallImages/files/wildlife/planningFor/wildlifeFriendlyGuidelines/BridgeGuidelines.pdf>.
- Arizona Game and Fish Department, Habitat Branch. (November 2006). Guidelines for Culvert Construction to Accommodate Fish & Wildlife Movement and Passage [PDF File]. Retrieved From https://www.azgfd.com/PortallImages/files/wildlife/planningFor/wildlifeFriendlyGuidelines/Culvert%20guideline%205_27_16.pdf.
- Beier, P., Majka, D., Newell, S., & Garding, E. (January 2008). Best Management Practices for Wildlife Corridors. Flagstaff, AZ: Northern Arizona University. Retrieved From http://corridordesign.org/dl/docs/corridordesign.org_BMPs_for_Corridors.pdf.
- Bissonette, J.A., & P.C. Cramer. (2008). Evaluation of the use of and effectiveness of wildlife crossings. Report 615 for National Academies’,

Chapter 4. Guidance for CHANJ Cores and Corridors

Transportation Research Board, National Cooperative Highway Research Program, Washington, DC.

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_615.pdf.

Clevenger, A.P., & Huijser, M.P. (2009). Handbook for Design and Evaluation of Wildlife Crossing Structures in North America. Bozeman, MT: Western Transport Institute (Montana State University).

Foresman, KR. (2004). Proceedings from the 2003 International Conference on Ecology and Transportation (ICOET 2003): Small Mammal Use of Modified Culverts on the Lolo South Project of Western Montana - An Update. Lake Placid, NY: New York State Department of Transportation.

Huijser, M.P., Kociolek, A.V., Allen, T.D.H., McGowen, P., Cramer, P.C., & Venner, M. (2015). Construction Guidelines for Wildlife Fencing and Associated Escape and Lateral Access Control Measures [NCHRP Project 25-25, Task 84]. Washington D.C.: National Cooperative Highway Research Program. Transportation Research Board of the National Academies. Retrieved from [http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP25-25\(84\)_FR.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP25-25(84)_FR.pdf).

Iuell, B., Bekker, G.J., Cuperus, R., Dufek, J., Fry, G., Hicks, C., Hlavác, V., Keller, V.B., Rosell, C., Sangwine, T., Tørsløv, N., Wandall, & le Maire, B. (Eds.). (2003). Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions. Bussels, BE: KNNV Uitgeverij.

Kintsch, J. & Cramer, P.C. (2011). Permeability of Existing Structures for Terrestrial Wildlife: A Passage Assessment System [Research Report No. WA-RD 777.1]. Olympia, WA: Washington State Department of Transportation.

Kintsch, J., Jacobson, S., & Cramer, P. (2015). Proceedings of the 2015 International Conference on Ecology and Transportation: The Wildlife Crossing Guilds Decision Framework: A Behavior-Based Approach to Designing Effective Wildlife Crossing Structures. Raleigh, NC. Retrieved from http://www.icoet.net/ICOET_2015/program-proceedings.asp.

Maine Department of Transportation, Environmental Office. (2008). Waterway and Wildlife Passage Policy and Design Guide (3rd ed.). Augusta, ME: Maine DOT, Environmental Office.

Minnesota Department of Natural Resources. (2014). Best Practices for Meeting DNR General Public Waters Work Permit [GP 2004-0001] (ver. 4). Retrieved from http://www.dnr.state.mn.us/waters/watermgmt_section/pwpermits/gp_2004_0001_manual.html.

Ontario Ministry of Natural Resources. (2013). Reptile and Amphibian Exclusion Fencing: Best Practices, Version 1.0. Species at Risk Branch Technical Note. Peterborough, Ontario: ONMR. Retrieved from http://files.ontario.ca/environment-and-energy/species-at-risk/mnr_sar_tx_rptl_amp_fnc_en.pdf.

Chapter 4. Guidance for CHANJ Cores and Corridors

River and Stream Continuity Partnership. (2006). Massachusetts River and Stream Crossing Standards (Revised March 1, 2011) [PDF File]. Retrieved from https://www.nae.usace.army.mil/Portals/74/docs/regulatory/StreamRiverContinuity/MA_RiverStreamCrossingStandards.pdf.

Ruediger, W. & DiGiorgio, M. (2007). Safe Passage: A User's Guide to Developing Effective Highway Crossings for Carnivores and Other Wildlife. Denver, CO: Southern Rockies Ecosystem Project. Retrieved from <http://www.elkhornsloughctp.org/uploads/files/1182793716carnivoresafepassage.pdf>.

Rytwinski, T., Xu, J., Soanes, K., Jaeger, J.A.G., Fahrig, L., Findlay, C.S., Houlahan, J., van der Ree, R., & van der Grift, E.A.. (2016). How Effective Is Road Mitigation at Reducing Road-Kill? A Meta-Analysis. PLOS ONE, 11(11). Retrieved from <https://doi.org/10.1371/journal.pone.0166941>.

U.S. Department of Transportation, Federal Highway Administration. (2008). Wildlife-Vehicle Collision Reduction Study: Report to Congress [Publication No. FHWA-HRT-08-034]. Washington D.C., USA. Retrieved from <http://www.fhwa.dot.gov/publications/research/safety/08034/index.cfm>.

U.S. Department of Transportation, Federal Highway Administration. (2011). Wildlife Crossing Structure Handbook: Design and Evaluation in North America [Publication No. FHWA-CFL/TD-11-003]. Lakewood, CO: Central Federal Lands Highway Division. Retrieved from https://roadecology.ucdavis.edu/files/content/projects/DOT-FHWA_Wildlife_Crossing_Structures_Handbook.pdf.

Van der Ree, R., Smith, D.J., & Grilo, C. (Eds.). (2015). Handbook of Road Ecology. Chichester, England: Wiley Blackwell.

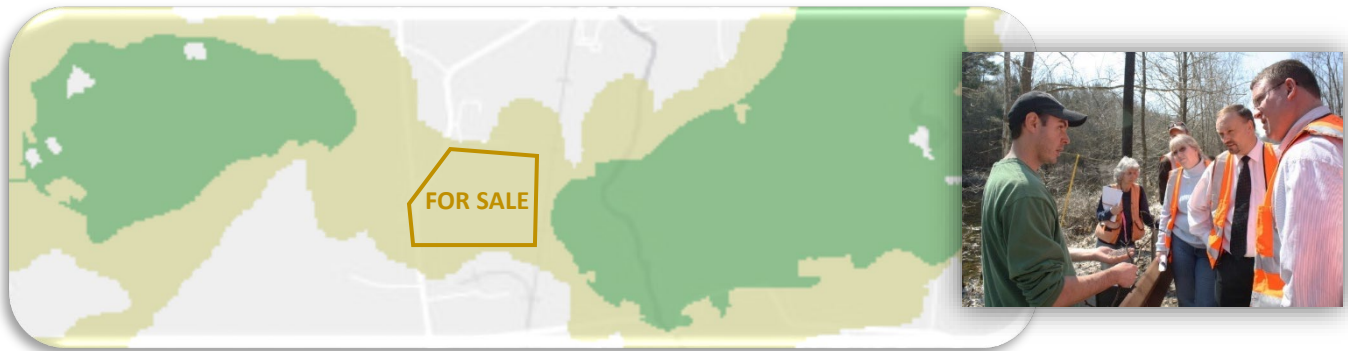




Chapter 5. CHANJ Action Teams

Making effective strides for wildlife connectivity involves both protecting and managing habitats in key areas that facilitate animal movement, and mitigating roads and other landscape features that impede it (Ament et al. 2014). Because these different actions fall under the scopes of different agencies, organizations, and land ownership types, partnerships are critical for implementation (Keeley et al. 2018). We have organized CHANJ Action Teams as a way of bringing implementers together to advance connectivity across New Jersey.

The Action Teams are a network of partners from various land protection, habitat management, wildlife biology, conservation planning, transportation management, and engineering backgrounds with the combined expertise to “make CHANJ happen.” These partners can be alerted to important opportunities for conservation action as they arise, so that pro-connectivity projects have a greater chance of being implemented.



The goals of the Action Teams include:

1. Enhancing coordination of habitat protection, restoration and management, and road mitigation efforts that advance functional landscape connectivity;
2. Creating a team framework for cooperation and support among implementation partners within each region of New Jersey;
3. Improving project tracking and promoting successes; and
4. Encouraging feedback on the CHANJ products so that they can be refined over time for maximum usefulness and currency.

Chapter 5. CHANJ Action Teams

The Action Teams are organized across three regions of New Jersey: North, Central, and South (Figure 5.1). The three regions are based on the state’s physiographic boundaries, with the North region encompassing the Skylands, the Central region following the Piedmont, and the South region combining the Pinelands, Delaware Bay, and Atlantic Coastal landscapes. The CHANJ Action Regions also mirror the Regional Assessment Zones described in Chapter 3. You can view these CHANJ Action Regions interactively in the [CHANJ Web Viewer](#) or access a GIS layer on the [Tools of CHANJ website](#).

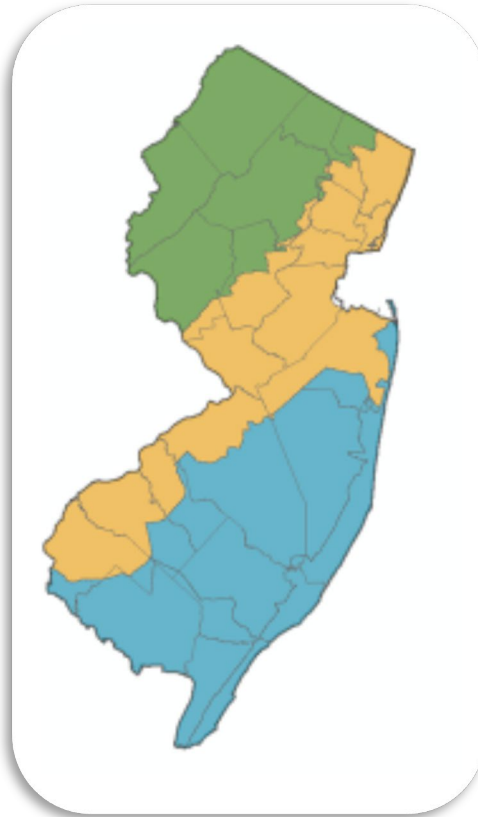


Figure 5.1. Outline of the three CHANJ Action Regions. In this map, green represents the North region, orange is the Central region, and blue is the South region.

The Action Team members are in contact with each other and with the CHANJ project coordinators so that all members can be made aware of relevant conservation opportunities as they present themselves. Action Team members are also asked once per year (in September/October) to fill out a survey of conservation actions they’ve implemented within CHANJ-mapped areas. The combined regional Action Teams meet in person one time annually (in October/November) to review statewide successes and challenges and to establish goals for the coming year.

The CHANJ leaders will produce an annual “State of CHANJ” report (in January/February) as a way to track CHANJ-related statistics and accomplishments and highlight partner involvement. Information assembled in the report will be gathered from the regional Action Team surveys, the annual in-person meeting, and in-house analyses of Land Use/Land Cover changes and other remote-generated metrics.

REFERENCES

- Ament, R., Callahan, R., McClure, M., Reuling, M., & Tabor, G. (2014). Wildlife connectivity: Fundamentals for conservation action. Accessed from <http://largelandscapes.org/media/publications/Wildlife-Connectivity-Fundamentals-for-Conservation-Action.pdf>.
- Keeley, A.T., Basson, G., Cameron, D.R., Heller, N.E., Huber, P.R., Schloss, C.A., Thorne, J.H. & Merenlender, A.M. (2018). Making habitat connectivity a reality. *Conservation Biology*, 32: 1221-1232. doi: [10.1111/cobi.13158](https://doi.org/10.1111/cobi.13158)



Appendices

Appendix I. Road Segment Report Outline

Appendix II. Road Segment Roadkill Survey Protocol

Appendix III. NAACC Culvert Inventory

(Available at: https://www.njfishandwildlife.com/ensp/images/chanj/hab_con_poster.jpg)

Appendix IV. Camera Monitoring

Appendix I.

CHANJ ROAD SEGMENT REPORT OUTLINE

Road Name, CHANJ Road_ID, CHANJ Road_Threat

Table of Contents

Chapter 1. Segment Description & Assessment	1
1.1. Location, Extent, and Description	1
<i>Road name, Road_ID, Municipality, County; Monitored start and end coordinates/mile markers and length of monitored segment; Road authority, speed limit, number of lanes, traffic volume.</i>	
1.3. Adjacent Land Ownership	1
<i>Parcel-based land ownership on both sides of monitored road segment</i>	
1.4. Transportation Plans	1
<i>Monitored road segment intersect with any known regional, state, or local transportation plans</i>	
1.5. Land Uses and Human Activity.....	1
<i>Description of any adjacent land use practices or infrastructure that might influence wildlife use of road- adjoining habitat or crossing of road through the segment. Examples could include a description of agricultural practices, presence of hiking trails or sidewalks, bridge underpasses used by fishermen, etc.</i>	
1.6. Potential Wildlife Barriers	1
<i>Via on-site inspection and/or Google Street View, any obvious barriers to wildlife movement across the road, including vertical curbing, Jersey barriers, large medians, soundwalls, etc.</i>	
1.7. NAACC Culvert Inventory	1
<i>This section will be completed by a trained partner.</i>	
Chapter 2. Wildlife Use & Survey Results	2
2.1. Roadkill Surveys.....	2
<i>Summary of data, including sampling frequency, duration, totals, and taxa/species breakdowns.</i>	

2.2. Camera Monitoring	2
Chapter 3. Road Mitigation Recommendations	3
Chapter 4. Road Mitigation Construction Details and Documentation	4
<i>Included in this chapter may be information also found in the Road Wildlife Mitigation Projects database.</i>	
4.1. Conceptual Designs	4
4.2. Engineering Plans	4
4.3. Project Costs	4
4.4. Construction Photographs.....	4
Chapter 5. Post-construction Monitoring and Evaluation	5
5.1. Monitoring.....	5
<i>Summary of post-construction monitoring data, including comparisons to data pre-construction.</i>	
5.2. Evaluation	5
<i>Objective determination if the mitigation action resulted in achieving pre-defined goals and any recommendations for future modification or improvement.</i>	



Connecting Habitat Across New Jersey



Last updated April 2019

Appendix II. Road Segment Roadkill Survey Protocol

Monitoring Goal: To track wildlife mortality events along CHANJ Road Segments.

BASIC PROTOCOL

1. Transects will be monitored at least once per week for seven of twelve months annually.
2. Record survey information on the field forms: Survey Summary Sheet and the Roadkill Data Sheet. It is important to record if no wildlife was observed, so please fill in field form even if nothing is observed. See information below on CHANJ Datasheets.
3. Walk (against traffic) or drive entire distance of transect up and down both sides of the road.
4. Focus on the side of the road and look for new, old, dried up or flattened roadkill.
5. Alive and injured wildlife should be recorded as well. Injured wildlife should be reported to licensed wildlife rehabilitator: http://www.njfishandwildlife.com/pdf/rehab_list.pdf
6. Do Not Record Duplicate Data. If you find something dead on the road remove it from the road several feet off the shoulder so it is not double-counted by the next observer.
7. Early morning surveys are the best to maximize roadkill detection before scavengers, traffic, or weather remove or degrade specimens.

CHANJ DATA SHEETS

Survey Summary Sheet: There should only be one copy of this sheet for a specified group of road segments. The sheet will contain information on the timing, number of observations, genetic samples (if applicable), and other pertinent notes for each survey. It's intended to give an overview of the survey results in the area.

Roadkill Data Sheet: This is where the bulk of the information is written. Every survey day will have *at least* one row filled out. On days you did not observe any animals, you will mark an X in the third column and leave the rest blank. For every animal observation during a survey, you will fill out one row with detailed information on the observation including coordinates, alive or dead, species, genetic sample name, segment sub-ID, etc. Each animal observation requires one separate row. This data will be used to enter data into the NJ Wildlife Tracker online app.

Document roadkill near a CHANJ Road Segment and note info on the sheet. This information is useful since sometimes an animal may emerge from a CHANJ segment and move into a non-mapped segment to cross the road. Also be sure to take down information on live animals you see crossing roads (BUT note that to save time – live observations of chipmunks, squirrels and deer do not have to be documented, you'll likely see a lot of these species crossing).

EXPANDED SOURCE PROTOCOL

BERKSHIRE WILDLIFE LINKAGE: ROADS AND WILDLIFE CROSSINGS A Report to The Massachusetts Chapter of The Nature Conservancy

Andrew J. Wood
Field Naturalist Graduate Program
Department of Plant Biology
University of Vermont
February 2, 2018

Revised Appendix B. Roadkill Survey Resources

Introduction

Thank you for your interest in surveying wildlife roadkill. Your data will help biologists, conservation organizations, and transportation agencies improve roads for wildlife *and* people. Please read this manual carefully before heading out to collect roadkill data.

What to Expect

- Walking, biking, or driving several miles of road.
- Identifying and photographing dead animals.
- Using a GPS unit and camera.
- Managing risk along busy roads.

What to Wear and Bring

- Sturdy, comfortable footwear
- Rain gear
- Reflective vest
- Field Forms/Clipboard
- Pencils/Pens
- Camera
- GPS unit
- Food and water
- Cell phone
- First aid kit

Getting Set Up to Survey

If you park your car in preparation for a survey, or during a driving survey, make sure you park in a safe, legal place. Public areas, such as a picnic area or city park are a good option. Avoid parking on private land, unless you

have received permission from the landowner. Make sure your vehicle is completely off the road and not in the path of traffic. In all cases, use your judgement: if it seems like a bad place to leave a car, it probably is! Ideally, perform surveys in teams, or if you go out alone, make sure someone knows where you are and when you will return.

Walking the Road

Walking along roads can be hazardous. Follow these tips to stay safe.

- Walk against the flow of traffic, so you can see oncoming vehicles in time to step far off the road. However, if the road shoulder is very narrow, walk whichever side of the road feels safer.
- Wear a reflective vest and bright-colored clothing.
- Only perform surveys during daytime and in good weather. Avoid surveying during low-visibility times: early morning, evening, foggy conditions, and heavy rain can all reduce drivers' ability to see you on the road.
- Step as far off the road as possible when you see oncoming traffic. Walk on the far side of guardrails where possible. If the road shoulder is narrow, survey from the safer side of the road, or walk along the outside of the guardrail. Avoid the inside lane of blind curves; drivers may not see you and have limited reaction time in these areas.
- Stay alert and bring a friend to keep an eye out for oncoming cars.
- If it seems unsafe to walk, it probably is! Contact your project coordinator to discuss alternative options.

Driving the Road

- Conduct driving surveys in teams of two or more so one person can focus on driving while the other person scouts for roadkill.
- If you park your car to inspect a carcass, choose an area where you can pull your vehicle completely off the road.
- Make sure the speed you drive falls within a normal range of traffic speed for that stretch of road. Driving faster or slower than the average speed puts you at risk.
- On busy roads, the surrounding speed of traffic may prohibit you from driving at a slow enough pace to accurately record roadkill; in this case, this site may not be appropriate for a driving survey.
- If road conditions are unsafe, do not conduct driving roadkill surveys.

Photographing Roadkill

- When photographing roadkill, include an object for scale reference. The best option is to place a small ruler or tape measure next to the animal.
- If you do not have a tape measure or ruler, use another common object such as a pencil, GPS device, or car key. Some field notebooks contain printed rulers, which can be useful for photographing small animals.
- Lay out the measuring device next to the roadkill (assuming it is safe to do so), and take the photo. This will make it easier for other people to determine the size of your roadkill, which can be important for determining the age and other biological information.
- You may need to move the carcass to get a better picture. Avoid handling roadkill: use a stick or your shoe to reposition the carcass.

Improving Habitat Connectivity in New Jersey

Habitat fragmentation is on the rise...

New Jersey is the **most densely** populated state in the US, and many road crossings, culverts, and bridges degrade river systems. The result is often that fish and other animals lose access to important habitat, an issue called **habitat fragmentation**.

...But we're doing something about it!

The Passaic River Institute (at Montclair State University) is part of a 13-state coalition called the North Atlantic Aquatic Connectivity Collaborative (NAACC), which is tasked with **restoring fragmented habitat** from Virginia to Maine. A major part of this work is conducting stream crossing assessments – field-based surveys to determine the integrity of crossing structures and their effects on stream dynamics. PRI is also collaborating with NJ Division of Fish & Wildlife to assess fragmentation for terrestrial animals, such as deer, bear, and bobcat. With more than 150 individual sites to assess, **we need help** from people like you!

Volunteer With Us!

We are **recruiting volunteers** to conduct stream crossing assessments throughout New Jersey. Your training will include:

- Protocol training online (3 hours)
- In-person field training (4-6 hours)
- Shadowing an experienced observer at 20 sites

Once trained, you will be free to conduct as many assessments as possible.



Lake Hopatcong, NJ.
Every black dot is a crossing to be assessed!



For more information, contact
Kevin Zerbe at the Passaic River Institute, Montclair
State University:
zerbek1@montclair.edu





Connecting Habitat Across New Jersey



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Appendix IV. Photo Classification Protocol

Monitoring Goal: To track wildlife use of structures under or over roadways.

CREDIT

This protocol is modified from a unpublished manual: 'Banff Wildlife Crossing Project Photo Classification Manual' 2012 developed by Mirjam Barrueto, who graciously shared it with us at the time. Mirjam and her colleague's photo classification work was also presented as a paper at the 2013 International Conference on Ecology and Transportation (ICOET 2013):

Barrueto, Mirjam, Clevenger, A., Dorsey, B & Ford, A. (2013). A Better Solution for Photo-classification, automatic storage and data input of camera data from wildlife crossing structures. 1-11.

SET UP

- Get photos for processing organized with a folder for each Camera deployed, which should each have a unique Camera ID assigned. Within each folder:
 - Folders with date ranges on them representing the date range between camera checks
 - A 'Processed' folder
- Copy the camera_data folder Gretchen gives you to your C drive so that it is directly under C (C:\camera_data)
- Download MapView Professional software: <http://www.reconyx.com/software/mapview> (Reconyx, Holmen, WI) *Note: users only have access to this software if you have purchased a Professional series camera from Reconyx. The software is designed to read the metadata from Reconyx cameras, however, you can use the software with other camera brands, it is just that some of the data, such as date and time, won't be automatically read by the software so will need to be manually entered.*
 - Choose the Download MapView Professional option
 - A popup window will appear that says Opening MapViewSetup.exe – have it Save File
 - Open the downloaded MapViewSetup.exe file
 - Another popup window will appear asking you if you want to run the file – select the Run option
 - Another popup window will appear asking if you want to install the application – select Install
 - Once the application opens, you'll select Map to get started

- In MapView Professional:
 - Go to Tools -> Image Folder Settings
 - Select the Add option and navigate to the C:\camera_data folder and then OK
 - Go to Tools -> Set up Keywords and then select Import (ENSP has a Keywords.xml file that we can share with you, please contact the CHANJ Team.
 - Navigate to the C:\camera_data folder and select the Keywords.xml file and select Save and then OK when it tells you the import was successful.

DATA MANAGEMENT PROTOCOL

Notes

- Do NOT delete any photos, even if nothing appears visible in them. Once they are gone, they are gone.
- Import one series of photos at a time that you plan to process in one sitting if possible. If you can't get through them all in one sitting, make a note of where you left off when you get back to it. When you import them into MapView, they are saved to a new location on your machine.
- Naming convention that is used to identify locations of cameras in MapView, Google Maps, and Access db (reconyx_cameras_tracking.mdb):
 - Site = name of road (for example: Route23)
 - Location = unique# + cardinal direction where camera is in relation to road + cam# (for example: 1Ncam302)

Importing Photos

When you have a new set of photos, go to the appropriate Name under 'Marker locations' → click 'Other >' → Select 'Load New Images' and select source

A 'Load New Images Wizard' pops up:

- Select 'Check All' in the top left of the window
- Select 'Next' in the bottom right
- Select 'Next' again
- Images will load into the c:/camera_data folder
- Select 'Finish'

Double click the name of the Marker location you want to work on and the Images will pop up. If you don't see the Image Toolbox, Select the 'Image data' button at the top of the window.

Processing the Data

There are 3 types of data that you will be recording using the Image Toolbox:

- **Camera Check:** This is when one of our staff are checking the crossing structure camera.
- **Cool Photo/Video:** This is a mechanism for tagging photos that would be good for use in presentations (good quality, clear photo of an animal(s)), are funny, are interesting, etc. so that we can more easily find them later.
- **Represents an Event:** One photo that represents one event where an animal triggered the camera. In almost all cases there will be a series of pictures relating to one event, but you'll just be tagging one representative of that series.

Camera Check:

Just one photo from a camera check event will be tagged. It doesn't matter which one, but it would be helpful to select one where the staff member is somewhat recognizable. Camera checks should appear both at the beginning of a series of photos and at the end, so be cautious not to mark two camera checks for one event (the last photo from one card and the first photo from the next card). It's possible that a camera check photo won't appear at the end of a series of photos if the camera ran out of batteries or the card filled up before someone got out checking it. If this is the case, where only one camera check photo appears please record this information in the *Camera_offline_report* spreadsheet*. Choose the representative camera check photo and then in the Image Toolbox complete the following two fields:

- *ENSP Camera ID* – This is the ID assigned to the camera – it is written on the camera, and the Location name is also based on this ID.
- *Camera Chk* – Select 'add' on this field and it will then be marked as a camera check.

**Camera_offline_report* record:

ENSP Camera ID - same as above

Offline start date – Date of last photo in the series. This photo will be of something other than personnel checking the camera.

Offline end date – Date of next camera check, when personnel are seen setting the camera up again. This photo will be the first in a series of photos.

Problem Des – If known, indicate why the camera stopped functioning.

Cool Photo/Video:

Again, this is a mechanism for tagging photos that would be good for use in presentations, are funny, interesting, etc. It could be one photo or a series of photos that would make for a good video if stitched together. Choose the photo(s). It is possible to add tags to multiple photos at a time by selecting multiple images and in the Image Toolbox you will see the option 'Other Multi-Image Actions', select 'apply keyword'. In the Image Toolbox complete the following fields. It is possible that you'll want to mark a 'Represents an Event' photo as cool, in which case tag all the fields needed for 'Represents an Event' as well as *Cool Photo* or *Cool Video*.

- *ENSP Camera ID* – This is the ID assigned to the camera – it is written on the camera, and the Location name is also based on this ID.
- *Cool Photo* - Select 'add' on this field and it will then be marked
- *Cool Video* - Select 'add' on this field and it will then be marked. A consecutive series of photos will need to be marked as 'Cool Video' of course to work.
- *Species* – Select the species from the options, or type in Species (Other) as needed.

Represents an Event:

We want to tag one photo that represents one event where an animal triggered the camera. Look for the first image where an animal is likely to have triggered the camera. Examine the picture and determine which species is crossing. The camera may take 3 pictures for this ONE event, sometimes the camera will take many more depending on how directed the animal is moving. However, we only need to 'process' one of the images. It is important to look at all the images in this one event to gather clues on animal behavior, to assist in species ID, and to make sure the animal is travelling alone. Select the FIRST or EARLIEST image that most clearly identifies the crossing event. In the Image Toolbox complete the following fields based on your interpretation of the event:

- *ENSP Camera ID* – This is the ID assigned to the camera – it is written on the camera, and the Location name is also based on this ID.
- *Event Rep* – Select 'add' on this field and it will be marked as the representative photo for this event.
- *Species* – Select the species from the options, or type in Species (Other) as needed.
- *Number Individuals* – Record the number of individuals that were present during this event. Note that animals traveling in groups may trigger the camera multiple times, so it is very important to review a whole series of photos after the initial trigger. It is important to pay close attention to the date/time stamps for the photos. To make a consistent assessment among interpreters, *classify a single crossing event if animals cross 2 minutes or less of each other*. An exception to this rule is 'family units'. Young individuals are not likely to be traveling without an adult. So, if, for example, an adult deer triggers the camera and then 3 minutes after the last picture of the adult, there is a picture of a fawn with no other adult deer with it or within a couple of minutes, it

is likely that the adult and fawn were a family unit and the photos of them should be treated together as one event. Note: for Human + dog photos, just count the humans. For human photos, include the # of individuals and for sex, age, passage, mark N/A. For species behavior, mark Other, and then in the behavior comments describe if they were hiking, bike riding, on ATV, on snowmobile, fishing, etc.

- **Sex** – This is often difficult to determine from photos. It is possible for ungulates during certain times of the year (antlers or stumps) ('Males'), ungulates with fawns and bears with cubs ('Females'). Classify a mother with young as a 'Female' here and then as 'Adult w/young' in the age category. Err on the side of 'Unknown' if you cannot distinguish.
- **Age** – This can often be determined based on size, time of year and sex. Juvenile carnivores and ungulates '<1year old' are smaller and will not likely be seen traveling without an adult. Individuals who appear smaller than a typical adult but likely are not traveling with an adult would be considered 'Subadult'. Family groups (often herds of deer) will include all sex and ages (variable sizes) and should be classified as a 'Mixed group' if together. If you see a lone doe-fawn or sow-cub classify as 'Adult w/young'.
- **Species Behavior** – Describe what the animal(s) appears to be doing.
 - Walking: *casual movement*, clear image in daylight, often multiple images picked up with rapid fire photos because of slow animal movement.
 - Running: *blurry image*, extended legs, dust kicked up
 - Foraging: Ungulate species, bears, ground hogs, raccoons may spend considerable time eating vegetation or searching for food outside the entrance of crossing structures or while crossing the overpasses. They may also lick for salt inside the underpasses.
 - Milling around: *casual movement*, looking around, not moving very much
 - Other in behave comments: If there are behaviours that are not described in our designations please check this box and describe event in the comments box below.
 - N/A
- **Other Behave Comments** – Describe other behavior if none of the designations above fit well.
- **Passage**: This field is meant to capture whether or not the animal went through the crossing structure or not. It will be difficult to tell in some cases since animals may leave the field of view and come back. At this point it will be difficult to tell if it is the same animal. Take your best guess if it is the same animal or not.
 - N approach hesitates*: The animal does NOT pass through crossing structure. It hesitates before the entrance and turns away.

- N enters turns back: The animal does NOT pass through crossing structure. It enters the structure, but then turns back, but not in an alarmed way.
- N alarmed flight: The animal does NOT pass through crossing structure. Either before or after entering the structure, it turns back seemingly having been spooked by something and is seen to run out and away.
- N outside avoidance: The animal does NOT pass through crossing structure. This is when an animal just travels in front of the crossing structure, not showing any intention to approach or go through it.
- Y hesitates* then passes: The animal DOES pass through crossing structure, after hesitating.
- Y no hesitation: The animal DOES pass through crossing structure, with no hesitation
- N/A:
- Unknown: If it's just not possible to make a determination because of, for instance, lack of clarity of the photo.

**Note: Hesitates*: Here we define hesitates as animals interrupting their movement towards or through the crossing structure from what appears to be a negative response to the structure. Foraging or licking behavior would NOT be classified as Hesitant

Quality Control

It is important to quality control the classified photos. This is most effectively accomplished by having one person familiar with the protocol, process the photos and then a second person, also familiar with the protocol, reviews that same set of processed photos and review all tags applied.

Storing Data

At ENSP, we retain both the original photos as well as completely processed photos (processed and quality controlled) if at all possible. This can be challenging given the amount of storage space required.

Analyzing Data

From the MapView software, a csv file can be exported and analyzed in a program of choice such as an Access DB. ENSP has conducted analyses using data from photos following this protocol and can offer suggestions on the types of queries to run.

Note

ENSP presented a [poster](#) (small size below) on the complete process described above at the Northeast Transportation and Wildlife Conference in 2014.



Gotcha!: Partner Friendly Photo Processing Protocol

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Introduction

Motion-triggered cameras are a valuable tool being used to validate and inform the Connecting Habitat Across New Jersey (CHANJ) project, which is a strategic plan that will identify key areas and actions needed for preserving and restoring habitat connectivity for terrestrial wildlife in NJ.



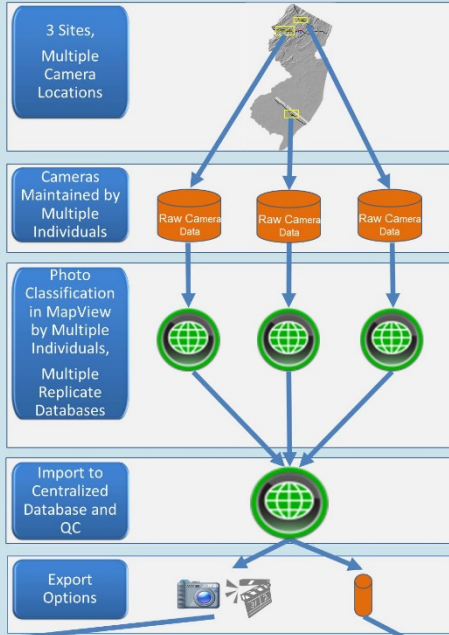
- Fourteen potential road crossing structures under 3 high traffic volume roadways are being monitored for wildlife use and behavior using 20 cameras by multiple camera maintainers/photo classifiers.
- The cameras are a fairly inexpensive, effective, non-invasive tool, used widely in ecological field studies.
- However, they produce large quantities of data that needs to be managed and processed before they can be analyzed.

Objectives

- To develop a standardized photo processing protocol for managing and interpreting data from the motion-triggered cameras that is efficient, user-friendly, and customizable to enable effective evaluation of study objectives.

Benefits of Photo Processing Protocol

- User friendly set up:** Uses MapView (image management software freely available from Reonxyx, Inc.), can use same set up across multiple machines
- Customizable:** Create keywords for tagging photos that help meet study objectives
- Efficient photo tagging:** Individuals choose from list of pre-defined keywords as they view each photo in MapView software and select just one photo to tag that is representative of each crossing event
- Data consolidation:** Data from multiple photos of one crossing event are represented by one data point
- Standardized data interpretation:** All individuals use same guidelines for photo classification
- Easy to query:** MapView search tools enable easy retrieval of tagged photos



NJ Route 23: 3 structures, 3 cameras, operated year round
Existing structures, high volume road

Interstate 80: 8 structures, 10 cameras, operated year round
Existing structures, high volume road

Atlantic City Expressway: 5 structures, 8 cameras, operated year round
Post-monitoring; wildlife mitigation retrofit of existing structure

- Cameras at each roadway monitored by different individuals
- Camera maintenance every 3-4 weeks (batteries changed, images downloaded from memory cards)

- Each processor imports data into own instance of MapView software (Reonxyx, Inc. Holmen, Wisconsin)
- Photo Classification Manual guides photo interpretation. Protocol modified from Mirjam Barrueto's 'Banff Wildlife Crossing Project Photo Classification Manual' 2012.
- One representative photo depicting a crossing event is tagged using pre-defined options



Customized Tags	
Black bear	Black bear
Bobcat	Bobcat
Human	Human
Deer	Deer
White-tailed Deer	White-tailed Deer
Other	Other

- Image data imported into Master MapView database
- Quality Control of image data in MapView

- Photos/Videos, easily queried and exported
- Image data exported as .CSV for import into Microsoft Access, Excel, etc.
 - User-defined attributes
 - Metadata from photos automatically transferred

