Title

Railroad crossing structures for spotted turtles: Massachusetts Bay Transportation Authority– Greenbush rail line wildlife crossing demonstration project

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Railroad Crossing Structures for Spotted Turtles: Massachusetts Bay Transportation Authority–Greenbush Rail Line Wildlife Crossing Demonstration Project

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Abstract: Loss of access to critical habitats is a key wildlife concern, particularly for species listed for protection by state and federal agencies. Rail corridors pose unique design challenges by virtue of the need to avoid abrupt changes in track curves and grade in the right of way (ROW). Spotted turtles (*Clemmys guttata*) are particularly vulnerable to habitat fragmentation due to their limited mobility and dependence on a diversity of specific foraging, nesting, and aestivation habitats. Spotted turtles also display an apparent reluctance to enter or cross through narrow and confined culverts typically found under road and rail line ROWs. In association with the Greenbush Line Commuter Railroad Restoration Project, the Massachusetts Bay Transportation Authority initiated a demonstration project in spring of 2003 to determine the effectiveness of a proposed railroad crossing structure in an urbanized landscape. Three identical, open-air prototypes were positioned in the ROW of a former railroad bed between adjacent wetlands known to support spotted turtles. Each structure was linked with temporary funneling barriers along the track edges. Structure placement was in accordance with microhabitat survey assessments, radio telemetry data, and direct movement observations. To evaluate the effectiveness of the structures, remote photographic stations were established at each crossing, and radio telemetry was used to track turtle movements. Monitoring was conducted from April 2, 2003, until July 8, 2003. Study results demonstrated spotted turtle crossing patterns and frequency through the ROW during the monitoring period similar to that prior to barrier development. Crossings also were shown to be utilized by 17 other wildlife species, including reptiles, amphibians, birds, and mammals. The demonstration project concluded that location and design of the crossing structures provided an effective means of maintaining habitat connectivity for a variety of wildlife species, as well as spotted turtles. As part of the Conservation and Management Plan developed for the Greenbush Line Project, which is now under construction, 45 wildlife crossing structures are proposed at key locations along the ROW. A post-construction monitoring plan will be conducted to evaluate the use of these structures by wildlife species.

Introduction

The Massachusetts Bay Transportation Authority (MBTA) is currently proposing to reactivate an 18-mile section of the largely discontinued Old Colony Railroad right of way (ROW), which formerly extended from Braintree to Scituate Massachusetts. The rail bed exists for much of the length of the ROW, and in many areas still consists of ballast, rail ties, and rails. Portions of the ROW have become overgrown with vegetation, principally exotic and invasive species common to the surrounding urban and suburban environment. To date, the MBTA and its consultants have conducted a series of wetland mapping and habitat assessments along the full length of the corridor, determined wetland impacts, and proposed wetland mitigation designs. In 2002, additional wetland and wildlife resource surveys were conducted, including a radio telemetry study of spotted turtles (*Clemmys guttata*) (Woodlot 2002a).

Under a variety of Massachusetts environmental regulations, the MBTA is required to outline how natural resources, such as wetlands, natural communities, and wildlife species, will be affected by the completion of the Greenbush Rail Line. In general, the project must demonstrate that measures to avoid, minimize, and mitigate impacts to rare species and their habitats and wetlands have been taken and that a cumulative net benefit will be provided. Perhaps the greatest impact of the proposed ROW development is the potential for the rail line to act as a barrier or filter to smaller species of wildlife, particularly amphibians and reptiles. More specifically, those species that cannot cross over or under the rails will have restricted movement across the ROW. A primary concern was the ability of the spotted turtle to cross the ROW.

Plans to accommodate wildlife crossings through the ROW were presented by the MBTA in the Conservation Management Plan (Plan) (Woodlot 2002b). The Plan details the information and process used by the MBTA to determine the impact of the project on wildlife and natural communities, while developing long-term net benefit mitigation measures for unavoidable impacts. Four types of animal crossing structures (Types A, B, E, and F) were presented in the Plan, along with a form of funneling barrier designed to keep turtles off of the tracks and directed towards crossing openings. Two structures were further designed for single- and double-track scenarios, for a total of six crossing structure types. Crossing locations were based on 2002 spotted turtle radio telemetry data, field investigations along the entire ROW, and the likelihood of wildlife travel corridors to link targeted habitats on opposite sides of the ROW.

The type of crossing structure proposed to be most frequently used, i.e., the Type A design, is largely open to ambient conditions and, therefore, most effective in mimicking the existing natural conditions typically encountered by spotted turtles (e.g., substrate, moisture, temperature, ambient light; figure 1). Tunnel structures were not selected by the MBTA Project Team during the design process as they would likely be avoided by turtles during their seasonal movements to and from various habitats.

Ballast within Type A structures will be cleared to a depth of approximately eight to nine inches in the gaps between three adjacent rail ties (figure 2). These excavations will extend along the full length of the approximately 11-foot ties. The base of the openings will be underlain with a (40 ml) high-density polyethylene (HDPE) material formed to fit tightly between ties to demarcate the limit of excavation. Leaf debris will be placed on top of the HDPE lining to serve as substrate material and to maintain moist natural cover material. Type B structures are similar in design to Type A structures except they extend across double, rather than single, track widths. A total of 45 crossing structures, with corresponding barrier fencing, will be positioned in suitable habitats along the ROW. Type A structures are the dominant type of structure proposed for use along the rail line (33, or 73%), with both A and B structures combined constituting 88 percent of the total number of structures. The purpose of the fencing barrier is to funnel spotted turtles and other wildlife toward the crossing openings, while keeping them from potential collision hazards associated with stations and passing commuter trains.

To further the project compensation effort, the MBTA, at the request of the Massachusetts Natural Heritage and Endangered Species Program (MNHESP), agreed to develop and conduct a demonstration project for three Type A wildlife crossing structures at the proposed Nantasket Junction Station site in Hingham, MA. The objective of the project was to determine what, if any, final design modification might need to be made to the crossings to be installed. Testing of various monitoring means and methods were undertaken in the winter of 2002-2003, followed by the *in situ* placement of temporary crossing and barrier structures in March 2003. The study was subsequently initiated when turtles emerged from their hibernacula in April and continued until early July 2003 when it was determined that all nesting activity had ceased. This document presents the findings of that demonstration project study.

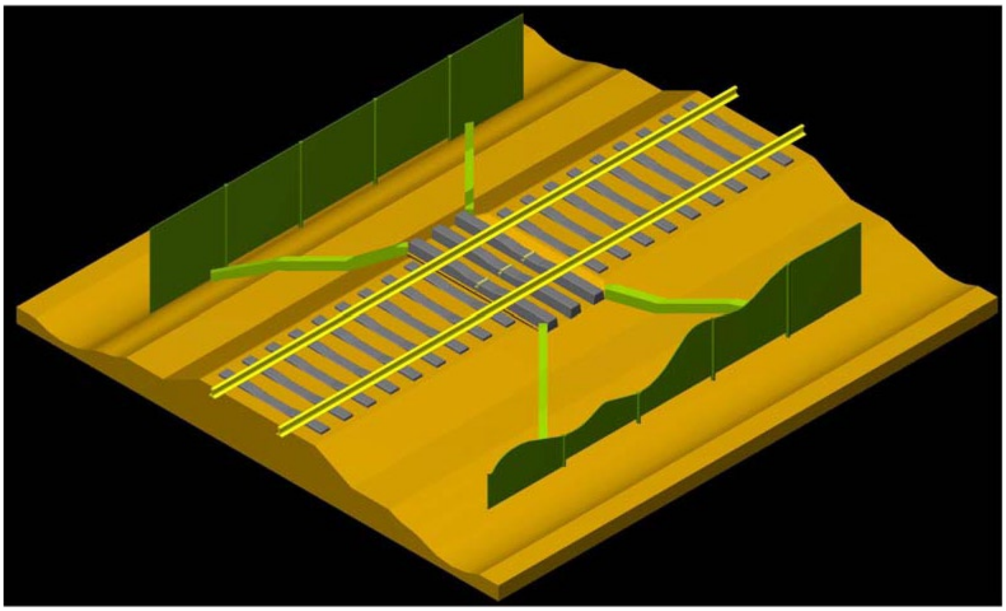

Figure 1. Type A wildlife crossing structure.

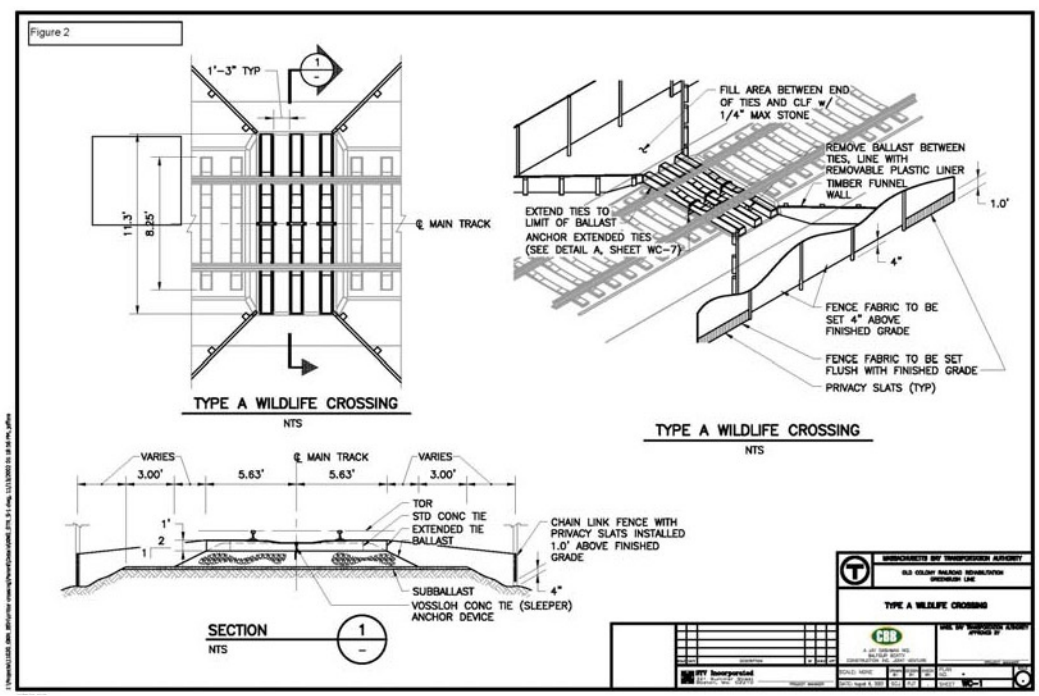

Figure 2. Type A wildlife crossing structure.

Study Area

Study area description

The Demonstration Project was located at the former Hingham Lumber Yard, now the proposed location of the Nantasket Junction Station (figure 3). This area is in a suburban portion of Hingham where active and cumulative development pressures are causing fragmentation of the remaining undeveloped habitats. The study area is situated between Kilby and Summer streets to the east and south, respectively, and contains two extensive scrub-shrub pool habitats separated by the existing ROW (the northern pool and southern pool). Woodlot Alternatives, Inc., submitted applications to certify both the northern and southern pools in 2002 under the Massachusetts Vernal Pool Certification guidelines.

The northern pool is the deeper of the two pools, with maximum depths between three and four feet. Dense button-bush (*Cephalanthus occidentalis*) dominates the entire wetland. The southern pool is forested with numerous shrub hummocks and buttressed root masses, a number of which have been found to be used by turtles for basking in the spring and for hibernacula habitats during the winter months. Additional spotted turtle habitat (i.e., aestivation, staging, and nesting) occurs within upland areas along the eastern wetland boundary of the southern pool near the corner of Route 3A and Kilby Street.

Site selection

An analysis of the 2002 radio telemetry data along the entire corridor length indicated Nantasket Junction Station had the highest number of documented individual ROW crossings by spotted turtles. Each of the turtles was found to utilize a number of upland and wetland seasonal habitats on opposite sides of the ROW. In addition, Nantasket Junction Station was found to support the largest population of spotted turtles with radio transmitters on the corridor and contained a population of both male and female sexes and of varying age class structure (table 1).

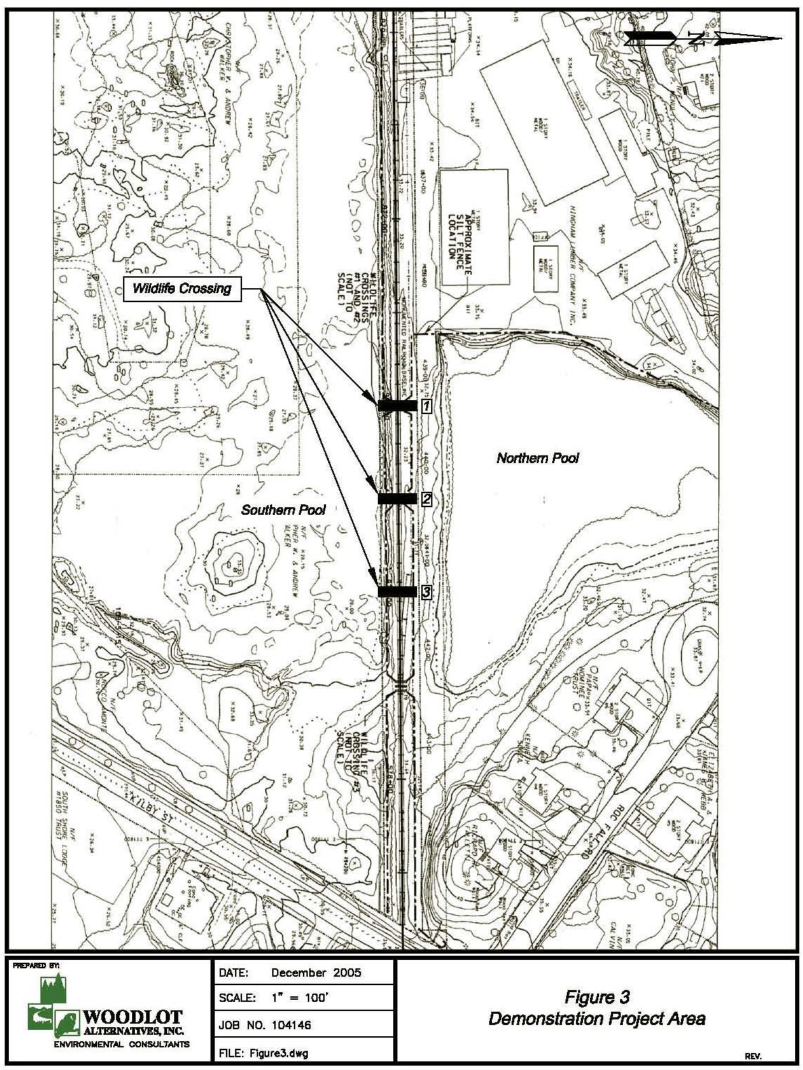

Figure 3. Demonstration project area.

Table 1. Individual spotted turtles with radio-transmitters at Nantasket Junction Station

Notch Code[1]	Sex		Age
103	Female		15+
104	Male		10+
105	Female		15+
108	Female		10+
109	Female		13+
119[2]	Male		8+
TOTALS	**Males: 2**	**Females: 4**	

Notes: 1. Notch codes are based on techniques for individually identifying and marking turtle shell scutes with triangular files described in Milam and Melvin (2001).
2. M119, captured during the Demonstration effort on April 10, 2003, was not monitored in 2002.

Spotted turtle radio telemetry data from the Nantasket Junction Station from April through November 2002 demonstrated spotted turtles were crossing the existing ROW in specific areas to utilize suitable seasonal habitats. Field observations of the existing conditions at the Nantasket Junction Station indicated that several natural gaps near station marker 977+00 were present and that spotted turtles were apparently using these openings as a travel corridor (photo 1).

Photo 1. Observed under rail gaps at Nantasket Station. Woodlot Alternatives, 2003.

Methods

In accordance with MNHESP's request to determine what, if any, final design modification might need to be made to the crossings to be installed, MBTA project team members worked collaboratively during the winter of 2003 to develop and design the demonstration project. The overall study objective was to evaluate the viability and effectiveness of the Type A crossing structure as a conduit for cross ROW movements by spotted turtles and other small wildlife species. The evaluation also included an assessment of the barrier fencing design and fence lengths as a funneling structure and barrier. All surveys were designed to be conducted with the use of remote sensory equipment at the individual crossing locations and backed by radio telemetry surveys. Prior to the design phase, MNHESP was consulted on site selection, remote sensory techniques, and duration of the demonstration project.

Installation of the crossing structures and barrier fencing

Three crossing structures were installed within the project area, one each at station markers 974+00, 975+00, and 977+00. Temporary silt fabric fencing was utilized as a form of barrier fencing and extended on both sides of the ROW between Summer and Kilby streets (photo 2). Temporary silt fabric fencing extended along the entire southern boundary of the ROW between Summer and Kilby streets. Along the northern boundary of the ROW, temporary silt fabric fencing extended from Kilby Street to the western boundary of the northern vernal pool (Station 973+25). The temporary fencing then continued in a northerly direction for approximately 150 feet along the parking lot edge. All structures were installed with snow cover and under frozen ground conditions to ensure that potential early season movements by turtles emerging from the hibernacula would be avoided during installation. This also allowed an opportunity for any resultant soil disturbances to settle.

Photo 2. Silt fencing as surrogate barrier fence in the project area. Woodlot Alternatives, 2003.

To ensure the proper identification of individual openings, each crossing structure was assigned a number, with individual structures numbered in increasing order beginning at station marker 974+00 and moving east along the tracks (figure 3). Each individual opening was designated with an identifying letter ("A" for south facing openings and "B" for north facing openings).

Selection of remote sensory equipment

Various methods (e.g., thread bobbins, scanners, and *in situ* traps) for evaluating the use of the crossing structures were initially tested. Ultimately, most of the options were abandoned for a variety of technical and logistical reasons, particularly due to the limitations of monitoring spotted turtle in the environment, i.e., slowing movements, cold-blooded, and low overall height (< 4 inches). Cutler and Swann (1999) reviewed the application of remote photography systems in 107 studies from the field of wildlife ecology and found their use to be common for studies involving nest predation, feeding ecology, nesting behavior, and species presence/activity patterns. Remote photography was found to be particularly useful in evaluating long-term and secretive 24-hour activity that can be otherwise impractical and disruptive with the use of human observers. The use of remote photography additionally prevented user bias, as time-specific and dated photographs were made available for analysis.

Infrared Photography System. Infrared motion detection equipment similar to that used with automatic garage door openers was tested with small turtle shells and deemed to be a reliable and effective trigger for detecting spotted turtle movements. Equipment was set up at ground level and the sensitivity of the infrared beam set high enough to be triggered by the slow movement and small size and height of the target species (photo 3). An infrared motion detection beam and reflector system was securely housed in a waterproof container and electronically wired into a modified DeerCam® (photo 4). Two 12-volt marine batteries were left on site to power the remote photography systems.

Photo 3. Modified Deercam® and infrared-triggered remote photography system prior to installation. Woodlot Alternatives, 2003.

Photo 4. Infrared beam and reflector (flush with ground) triggers remote camera (foreground on post) when interrupted. Similar setups were positioned at each end of three crossing structures. Woodlot Alternatives, 2003.

Field Monitoring. Late winter and early spring field conditions were regularly monitored to determine an appropriate start time for the field monitoring to begin. After a series of late season snow delays, field-monitoring activities were initiated April 2, 2003, immediately upon the determination of suitable conditions for spotted turtles to be moving from their hibernacula. The project area was initially visited two to three days a week to monitor each remote photograph system and to reload film as necessary (primarily during the month of April). The project site was subsequently visited on a regular five-day per week basis as spotted turtles began to move farther distances from hibernacula, and as ambient conditions began to regularly hit 70° F (late April). Daily monitoring continued until July 8, 2003, as the spotted turtle nesting season concluded.

Blowing leaves and debris around the structures were initially found to trigger and rapidly expose rolls of film at each camera location. Frequently, a single leave would become briefly snagged within the path of the light beam and cause a quick series of exposures to consume the available film. Limitations of this nature were also observed in studies conducted by Rice et al. (1995) and Buler and Hamilton (2000). Regular efforts were made to remove leaves on or immediately near the infrared beam to minimize the rapid exposure of film.

Radio Telemetry Surveys. Similar to the 2002 effort, spotted turtle movements were also monitored in 2003 with radio telemetry equipment. Radio tracking of spotted turtles involved locating turtles several times a week with a radio receiver to document and map habitat use in proximity to the ROW.

Results

Crossing efforts and general movement patterns by spotted turtles across the ROW and throughout the demonstration area in 2003 were essentially identical to those observed in 2002; movements between the pool habitats on either side of the ROW showed no discernable difference. Use of each of the three crossing structures was documented. Overall frequency of crossings over the ROW was found to be the same in both years, with an additional increase due to the capture and release of one additional, radio-tagged turtles in the demonstration area during the course of the study.

Nine crossings were recorded for six spotted turtles that had functional radio transmitters affixed to their carapace in 2003. Of these nine crossings, five were recorded by the infrared photography system. As already noted, early season crossings were not photo documented due to the loss of film caused by the high level of blowing leaves and debris around the crossing structure openings. However, 2002 and 2003 radio telemetry data provided evidence of regular, seasonal inter-pool travel patterns for each turtle in the demonstration area.

A total of seven crossings were recorded for four of the same spotted turtles equipped with functional radio transmitters in 2002. Female 109 (F109) did not cross the ROW prior to May 14, 2002. However, the transmitter failed in late May of 2002; therefore, no crossings after that date could be documented. One additional male turtle (M119) was captured in 2003 and fitted with a radio transmitter and released. This turtle recorded one crossing in 2003.

The infrared-triggered cameras also recorded eight passages through the crossing structures by snapping turtles (*Chelydra serpentina*) and one by a painted turtle (*Chrysemys picta*), denoting a total of 17 crossing that occurred in 2003 among the three turtle species observed at the demonstration project site.

It is important to note that cold temperatures and several late season snowstorms delayed spotted turtle hibernacula emergence and movement in 2003. This was in stark contrast to the early spring conditions of 2002. Initial observations of spotted turtles in 2003 were on average 23 days later than in 2002 (table 2) at each of the spotted turtle monitoring locations within the corridor in Hingham and Cohasset. Within the demonstration project site, four spotted turtles were also observed crossing through the structures up to 23 days later in 2003 than in 2002 (table 2).

Table 2. Comparison of initial observation dates of radio-tagged spotted turtles at various sites in Hingham and Cohasset, MA (2002-2003)

Town	**Site Location**	**2002 Average Date of First Observation**	**2003 Average Date of First Observation**
Hingham	Foundry Pond	March 21	April 29
	Hingham Lumber Yard	March 29	April 10
Cohasset	Castle	March 28	April 15
AVERAGE FOR ALL TURTLES		**March 26**	**April 18**

The timing and total number of spotted turtle ROW crossings from 2002 and 2003 were not significantly different. For many of the turtles, differences is crossing times can be directly attributed to seasonal variation in ambient conditions (table 3). Female 103 (F103) crossed the ROW during similar time periods in 2002 and 2003. Female 108 (F108) and Male 104 (M104) each crossed the ROW two to three weeks later in 2003 than in 2002; however, seasonal variation is a plausible explanation for these differences. Female 105 (F105) was encountered along the temporary barrier fencing on May 20, 2003, traveling towards crossing structure #3 (station marker 977+00) in an attempt to travel to the northern vernal pool. The six to seven week timing difference in crossing dates for F105 between 2002 and 2003 could possibly be due to seasonal variation, but an additional factor may include balking or a temporary inability to locate a crossing structure. However, in both 2002 and 2003, F105 was documented to have crossed the ROW within a two- to three-day window in late June/early July. F109 recorded one crossing in 2003 that was similar to dates of crossings of F105, M104, and F103 this year. M119 was a new capture in 2003, and it is hypothesized that M119 exhibits similar seasonal movement patterns as other turtles being monitored.

Another observation involved the effect of "privacy fencing" along the ROW edge. Segments of temporary silt fabric barrier fencing were originally located directly in front of each crossing at the edge of the ROW, as part of the demonstration project. These segments of fencing provided a field representation of conditions expected to occur with the establishment of "privacy fencing" along certain portions of the ROW. Each of the fence segments was positioned to allow a five-inch gap between the fence bottom and the ground. Several crossings of spotted turtles were recorded with the fencing in place. After a further review of the proposed fencing plans for the entire route, it was noted that all known proposed crossing locations were in areas that would not require the use of privacy fencing. As a result, the apron fencing was removed after several weeks. This also helped alleviate potential balking concerns for other wildlife species. In any event, the crossings were found to allow crossings to occur with the fencing in place.

Table 3. 2002 – 2003 Radio Telemetry Crossing Dates (April 2002-July 2003)

Spotted Turtle Notch Code	**Date of Documented Crossings in 2002**	**Date of Documented Crossings in 2003**
F103	April 25 and May 15	April 18 – May 7, and June 25 – 30
M104	April 8	May 1
F105	April 4, June 9, and June 25	May 20, June 27 – 30, and July 3 – 8
F108	April 9	April 21
F109	Transmitter failure in early May	May 18 – June 10
M119	Not captured in 2002	June 25 – July 3
TOTAL DOCUMENTED ROW CROSSINGS	7	9

Note: Notch codes based as described in Milam and Melvin (2001). "F" depicts female; "M" depicts male.

Times of entry and exit from the crossing structures generally occurred during the mid-day to late afternoon. Time-specific photographs occurred between 1200 and 1600 hours on May 20, June 9 and 30, and July 1, 2003 (table 4), with the exception of one crossing at 0733 hours on June 28. All of the spotted turtle crossings took between two and four minutes for the individual to completely pass through the crossing structure.

Table 4. Photographic Spotted Turtle Crossing Data from Nantasket Junction Station

Crossing Structure No.	Date	Entry Time	Exit Time	Direction of Movement
3	May 20	12:56	?	North
3	June 9	15:52	15:56	North
2	June 28	?	07:33	South
1	June 30	15:05	15:08	North
2	July 1	12:13	12:15	North

Note: Eight additional instances of snapping turtles traveling north and south through the crossing structures at Stations 1, 2, and 3. One painted turtle was also documented traveling north using Station 1. Average time within the crossing structure among all three turtle species was similar to that of spotted turtles.

Other wildlife also used the crossings. Between April 2 and June 30, 2003, 11 mammal species, 4 reptile species, 1 amphibian, and 2 bird species were documented using the crossing structures (table 5). Species ranging in size from green frogs (*Rana clamitans*) and mice (*Peromyscus* spp.) to coyotes (*Canis latrans*) were documented, suggesting that a wide variety of species was able to use the crossings. Waterfowl species used crossing structures when moving with young between the northern and southern pools (photo 5).

Photo 5. Brood of mallards (*Anas platyrhynchos*) traveling from the north pool to the south pool; May 14, 2003, at 16:07. Woodlot Alternatives, Inc. 2003.

Table 5. Species photographed using crossing structures between April 2 and June 30, 2003

Common Name	Species	Crossing Structures Used
Spotted Turtle	*Clemmys guttata*	1, 2, 3
Eastern Painted Turtle	*Chrysemys picta picta*	1
Snapping Turtle	*Chelydra serpentina*	1, 2, 3
Eastern Garter Snake	*Thamnophis sirtalis sirtalis*	3
Green Frog	*Rana clamitans melanota*	1, 2, 3
Coyote	*Canis latrans*	2, 3
Grey Fox	*Urocyon cinereoargenteus*	1, 3
Muskrat	*Ondatra zibethica*	2, 3
Longtail Weasel	*Mustela frenata*	1, 3
Eastern Cottontail	*Sylvilagus floridanus*	1, 2, 3
Raccoon	*Procyon lotor*	1, 2, 3
Skunk	*Mephitis mephitis*	1, 2, 3
Opossum	*Didelphis marsupialis*	1, 2, 3
Mouse	*Peromyscus* spp.	1, 2, 3
Eastern Gray Squirrel	*Sciurus* carolinensis	1, 2, 3
Eastern Chipmunk	*Tamias striatus*	1, 2, 3
Wood Duck	*Aix sponsa*	3
Mallard	*Anas platyrhynchos*	1, 2, 3
Northern Flicker	*Colaptes auratus*	N/A
Blue Jay	*Cyanocitta cristata*	N/A
Catbird	*Dumetella carolinensis*	N/A
American Robin	*Turdus migratorius*	N/A
Common Grackle	*Quiscalus quiscula*	N/A
House Sparrow	*Passer domesticus*	N/A
Northern Saw-whet Owl	*Aegolius acadicus*	N/A

Conclusions

Field observations made during the 2003 monitoring effort at the Nantasket Junction Station demonstration project site support evidence that the crossing structure location and design provide an effective means for maintaining habitat connectivity for a variety of wildlife species. Crossing structures and funneling barrier fences were successful in allowing movements by spotted turtles through the ROW. Radio telemetry methodology documented the ability of spotted turtles in the study area to locate, travel to, and utilize the designed gaps under existing rail ties in order to travel between adjacent vernal pool habitats. No changes to seasonal spotted turtle behavior patterns were observed during the course of the 98-day active photo-monitoring period. The current Type A design did not appear to significantly influence balking behavior along the barrier fencing or near the crossing structures.

The demonstration project indicated the viability and effectiveness of the combined crossing and funneling barrier design as a means of maintaining cross-corridor connectivity. No major modifications or design refinements of the crossing structures were made. The demonstrated success shown by the lack of change in the number of spotted turtle crossings through the ROW and the lack of discernable change in their general behavior within the adjacent habitats provides a justification for the expanded use of the crossing structures to other locations previously selected by the MBTA project team along the project corridor. We anticipate that the expanded use of this same system would work as well in other corridor areas.

Biographical Sketches: Steve Pelletier is a certified wildlife biologist, professional wetland scientist, and certified and licensed professional forester with over 20 years of professional experience. A co-founder and principal of Woodlot Alternatives, Inc., he specializes in a variety of landscape and site-level habitat analyses, including avian risk assessments related to windpower development, forest ecology and management, wetland assessments, and impact mitigation. He offers particular expertise in rare species impact evaluations and for developing impact avoidance and mitigation measures for a variety of projects ranging from transportation and energy development.

Lars Carlson is manager of projects for the Boston office of Jacobs Civil, Inc. His responsibilities include identification and evaluation of ecological resources, preparation of National Environmental Policy Act documents, permitting support, and regulatory compliance oversight for infrastructure projects. Dr. Carlson is a professional wetland scientist and a certified senior ecologist. He has a B.S. in biology from the University of Delaware and a Ph.D. in botany from the University of Massachusetts, Amherst.

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Appendix A

Remote Camera Photos

Photo A1. Spotted turtle at crossing structure 2A; 6/28/03, 07:33.

Photo A-2. Spotted turtle at crossing structure 2B; 7/1/03, 12:14.

Photo A-3. Eastern painted turtle at crossing structure 1A; 6/8/03, 14:43.

Photo A-4. Snapping turtle at crossing structure 2B; 4/29/03, 13:58.

Photo A-5. Garter snake and chipmunk at crossing structure 3A; 7/1/03, 09:33.

Photo A-6. Green frog at crossing structure 1A; 5/19/03, 20:24.

Photo A-7. Coyote at crossing structure
3A; 5/20/03, 21:43.

Photo A-8. Grey fox at crossing structure
1A; 5/9/03, 23:53.

Photo A-9. Longtail weasel at crossing structure
1A; 4/23, 00:35.

Photo A-10. Muskrat at crossing structure
3A; 6/19/03, 00:18.