BRIDGE REPLACEMENTS:
AN OPPORTUNITY TO IMPROVE HABITAT CONNECTIVITY

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ABSTRACT

Bridges crossing wildlife movement corridors are often sites of roadkill collisions and habitat fragmentation. Bridges should be extended to span uplands that provide habitat and a movement corridor for terrestrial wildlife. Thousands of bridges are being replaced and rehabilitated across the United States over the next few decades which presents an exceptional opportunity to incorporate design modifications that reestablish or improve habitat connectivity. This paper discusses the number of bridges to be replaced, bridge design, examples, costs, funding sources, and laws pertaining to bridges, wildlife, and wildlife habitat.

INTRODUCTION

Fragmentation of habitat is identified as a major threat to the existence of wildlife populations. Fragmentation caused by roadways carries with it the direct problem of roadkill where the elevated span meets the surface level, as well as other adverse impacts to wildlife and wildlife habitat, such as, disection and eventual isolation of populations, edge effects that change the character of the native habitat (e.g., intrusion by exotics), increased human access to and disturbance of previously remote habitat, and facilitation of development and urbanization (Noss 1996, Ruediger 1998, Jackson 1999). Bridges are a component of roadways (vehicle and rail) that form the juncture of travel corridors for people and wildlife that can either exacerbate or reduce the fragmentation problem.

Riverine systems serve as movement corridors and habitat linkages for many species of terrestrial wildlife, as well as provide essential habitat functions in and of themselves (Smith 1996, Forman 1995). While varying degrees of protection are now being afforded to wetlands, riparian areas, rivers and tributaries, it is only in recent years that recognition has been given to the importance of protecting these systems for their importance in landscape connectivity for animal movement. Today local, state, and federal land use regulations may result in the protection of waterways and wetlands, oftentimes with narrow buffers through otherwise converted and developed habitat. However, even these attempts at maintaining a thin line of habitat connectivity are thwarted by bridges that span the water but not the land connections. The movement and flow of water continues[1], yet the movement and flow of terrestrial animal life is abruptly severed.

Thousands of bridges are being replaced and rehabilitated in the United States over the next few decades. The purpose of this paper is to inform and encourage action to reestablish habitat connectivity as the nation=s bridges are reconstructed. Let=s put our ever growing ecological and technological knowledge to work and, to borrow a phrase, build bridges for the 21st century.

METHODS

Information for this paper was gathered through literature and web searches, interviews, and drawing from experience in the fields of conservation biology, as well as, transportation planning and policy analysis and advocacy. The interviews included federal and state agency personnel from environmental and engineering sections, private consultants, and researchers.

NUMBERS OF BRIDGES IN U.S. TO BE REPLACED & REHABILITATED

The federal highway inventory lists over 575,000 bridges in the United States, approximately 200,000 of which are identified as Adeficient@ (Cooper 1995) Over 118,000 were classified as structurally deficient and over 80,000 were considered functionally obsolete. Thirty percent is the national average for bridges in each state rated as substandard (MDOT 1997).

The National Bridge Inventory reports that each year 2,000-3,000 bridges undergo major repairs or replacement. Many of the bridges are situated in areas where wildlife habitat has been fragmented, yet connectivity could be restored with appropriate bridge reconstruction.

Transportation specialists have been calling for an improved bridge assessment process and increased research on bridge integrity and impact (Cooper 1995). The National Bridge Inspection Standards program should include a thorough assessment of each bridges=s ecological impacts, including its effect on wildlife and wildlife habitat. If a bridge is causing habitat fragmentation or constitutes a high risk area for roadkill collisions, this factor should be noted in the bridge evaluation, rating and priority ranking.

BRIDGE DESIGN

The most important design feature for reestablishing or maintaining terrestrial habitat connectivity at bridges crossing rivers and riparian systems is to extend the span beyond the waterway so that unsubmerged land is also bridged and available for wildlife use and movement. Ecologically one can conclude that the bridging should reach into the adjacent upland habitat, and even span upland areas themselves (Smith 1996) The habitat fragmentation problem leads to a need to elevate roadways across valuable upland habitat with viaducts that help sustain viable wildlife populations. Minimally, the span should extend over at least a designated buffer zone. Land use regulations often call for buffer zones as narrow as 8 m (25 ft) from wetland jurisdictional lines.

Site specific ecological factors, such as, the topography, the habitat type, the resident, dispersing, and migratory species utilizing the area,

[1] It should be noted that bridges can also have significant impacts on aquatic systems; however, this paper addresses terrestrial wildlife and habitat.

as well as the non-ecological considerations, will determine how the bridge will be constructed. Some of the factors to consider in bridge design include:

- Spans & Approaches
  - Length
  - Width
  - Elevation
  - Median/ Lane separation - two bridges or one
  - Right of way
  - Median and right of way vegetation and maintenance, including, amount of cover and use of native vegetation
  - Pollution control measures
  - AKilling zone@ characteristics
    - Site where bridge approach joins ground surface
    - Site of nearby ecotone (wetland - upland interface)
- Beneath bridge considerations
  - Degree of slope of bank
  - Substrate
  - Cover - vegetative, other
  - Light filtration
  - Artificial lighting
  - Sound
- Near bridge considerations
  - Context, landscape level land uses
  - Next closest safe passage, rarity of linkage
  - 100 year flood plain
- How the bridge itself will be used
  - E.g., bat roosting, swallow nesting

- If extended spanning is not possible, consider bridge improvements additional to those above, such as,
  - retrofitting with above water surface pathways

EXAMPLES

The literature search revealed several papers pertaining to wildlife movement in relation to bridges; however, there are very few examples in which habitat connectivity was an intentional element of bridge design. These studies ranged from reindeer/Norway (Klein 1971, railway), to river otters/Canada (Reid 1984), moose/USA (McDonald 1988), and European otters/Denmark & Europe (Madsen 1990, 1996). Below are two examples representing an extant and a proposed bridge project: 1) bridges at Glacier National Park have proved successful for mountain goat movements, and 2) an extensive bridge and vicinity model for wildlife movement, in particular, ocelots and jaguarundis, to span the Mexico - United States border across the Rio Grande River. The rapidly growing information base on roads and wildlife, including bridge design and results, is most recently to be reported in the Proceedings of the 1999 International Conference on Transportation and Wildlife Ecology. Also, note the State Road 46 bridge in Florida explained under the ACosts@ section of this paper.

<u>Glacier National Park, US/ Mountain Goats</u>
(Singer 1985)

Two bridge projects resulted in a successful effort to provide safe passage to mountain goats at Glacier National Park 1) by Agouging@ a flat bench (12 feet high x 12 feet wide x 24 feet through) over which animals travel to a mineral lick and 2) by providing a crossing area. A bridge was built over US 2 as an underpass (12-28 feet high x 90 feet wide x 44 feet through). The mineral lick access was 200 feet to the east of a bridged stream crossing. Existing goat trails were obliterated, new trails were dug leading to the entrances of both bridges, conifers were planted at approaches, while goat trails were redirected traditional crossing routes were maintained, off-road parking and viewing areas were established that avoided safety hazards and interfering with the goats, and sequential construction allowed gradual adaptation by goats. As a result, goats exhibited less disturbance behavior, used the trails, extended their season of visits to the lick, and doubled their number of visits to the lick per year.

<u>Lower Rio Grande, US-Mexico Border/ ocelots, jaguarundis, bobcats</u>
(Tewes and Blanton 1998)

The Port of Brownsville International Bridge at Brownsville, Texas is used as a model for resolving a potentially difficult conflict between endangered cats and construction of an international bridge. A 500 foot span from the center line of the Rio Grande over the north bank will allow wildlife movements to occur under the bridge adjacent to the river. The right-of-way width will be no greater than 80 feet including the vehicle and railway components of the bridges structure. The road and railway structures will be placed on fill above the 100 year flood plain, elevating the auditory and visual disturbances from ground-level. An interconnected system of Aupland corridors@ will be developed parallel to and under the roadway leading north from the international bridge. This system will enable free-ranging cats to use alternative passage sites if the river corridor is blocked by territorial conspecifcs, feral dogs, or other biological obstructions. Multiple corridors should increase the likelihood of successful felid passage. Other measures include additional corridors, a 5 acre habitat on each side of the river corridor to provide cover for cats prior to and during passage under the bridge, planting characteristic species, existing buildings will be relocated, selected visual and noise barriers will be used to minimize behavioral impact of the endangered cats, and hours of operation will be restricted to 16 hours per day. Habitat mapping, a trapping survey, and public education are also planned.

COSTS

The cost of bridge construction is figured by the square foot and, as with other highway costs, can vary widely throughout the country. In the southeast it may range from $37 to $45 per square foot for short, reinforced concrete, flat slab, simple spans to $60 to $96 for bridges of long span, segmental, concrete box girders - cantilevers (Florida Department of Transportation 1999). Surveys indicated comparable figures on the west coast may be $85 to $150. Typical state and federal concrete or steel highway bridges were reported to generally cost $60 to $80 per square foot, although exceptionally long bridges like those spanning the Mississippi or Ohio Rivers should be estimated at closer to $100 or $120

The numerous variables unique to each site and bridge make it difficult to calculate a Atypical@ project cost. However, using the figures above one can make a very rough estimate of the direct cost of extending the span of a bridge. For instance, extending a two lane bridge by 100= on each side of a waterway would be approximately $616,000. That is, 44= (two 12= lanes and two 10= safety side zones), times 100= of extended bridge span on both sides of the river (200= total), times an average $70 per sq ft, or $616,000. Clearly, each bridge has a unique setting that may call for much longer or shorter spans.

When transportation departments evaluate the expense of bridge expansion, the cost of failing to act must also be considered. Direct, short-term cost savings can be expensive in the long run. Public funds will eventually be needed to pay for increased land management, land acquisition, species recovery efforts and other measures that may not be successful in mitigating the effects of severing habitat connections. Humphrey (1992) states for example, ASimply fencing wildlife away from highways without attempting a conservation-oriented solution is less expensive for a transportation agency; the costs of the unresolved conservation problem then must be absorbed by a natural-resources agency.@

The Ocala National Forest-Wekiva River Basin of central Florida is one of the last strongholds of the Florida black bear, a threatened subspecies. The state continues to spend significant funds (> $100M) in land acquisition to maintain the Ocala-Wekiva Region and Greenway in large part to protect the Florida bear; however, the area is at risk due to a growing latice-work of roadways and development. Upon the recommendation of the state wildlife agency and urging of the public, FDOT increased the span of a bridge along State Road 46 in the Wekiva area. The bridge was extended 153= (addition of three 51= spans) on the western, relatively undeveloped side of the river at a cost of approximately $433,000. This action by FDOT has helped maintain habitat connectivity and protect the public=s investment in the region=s natural resources.

In addition, human safety is always of highest concern in road and bridge design. Human injury (and property loss) due to wildlife on roadways is probably vastly underestimated. Designs that allow for passage of wildlife beneath bridges could yield incalculable savings in terms of protection for the public.

SOURCES OF FUNDS

PROGRAMS UNDER TEA-21, THE TRANSPORTATION EQUITY ACT FOR THE 21ST CENTURY (PUBLIC LAW 105-178).

Funds are available for mitigation of current projects; in addition, TEA-21 provides funds to rectify old, existing road impacts. Following is a brief review of bridge and highway funding sources.

Highway Bridge Replacement and Rehabilitation Program (HBRRP)
Section 1109

Section 1109 of TEA-21 reauthorized the Highway Bridge Replacement and Rehabilitation Program. Pursuant to 23 U.S.C. 144(g), not less than 15 percent nor more than 35 percent of the TEA-21 amount apportioned to each state shall be expended for bridge program projects located on public roads, other than those on the federal-aid highway system. Bridges Program funds may be expended to replace and rehabilitate existing bridges. Funds are distributed according to state needs.

HBRRP apportionments to states amounted to a total of $3,210,979,453 for FY 1999. Projects are funded at an 80 percent federal share.

Discretionary Bridge Program (DBP)

The HBRRP includes a Discretionary Bridge Program component that is for the replacement or rehabilitation of high-cost highway bridges and for the seismic retrofit of highway bridges. To be eligible for funding under the DBP, the project has to be for the replacement or rehabilitation of a deficient bridge that is located on a federal-aid highway and has an estimated cost of more than $10 million, or a cost that is twice the amount of HBRRP funds apportioned to the state in which the bridge is located. Projects are funded at an 80 percent federal share.

TEA-21 authorizes $100 million annually in FY 1999 through FY 2003. Selection criteria for the projects range from a Rating Factor (see 23 CFR 650 Subpart G), to national geographic distribution, congressional Aguidance,@ leveraging of funds with other public and private sector sources, to projects relating to Olympic events.

Surface Transportation Program (STP)
Section 1108

STP is for highway and road construction, intermodal connections, and transit. It includes eligibility provisions for mitigation of the transportation system construction and ecological mitigation banking. Funds can be used for new construction and retrofitting.
Ten percent of the funds apportioned to a state for its STP shall be used for transportation enhancement activities.

Enhancement Funds
Section 1201

Included in the passage of TEA-21 were additions to the qualifying criteria for Transportation Enhancement activities. Enhancement activities are not for project mitigation; they are additive to mitigation. There is a specific list of activities that qualify for enhancement funds which includes projects like facilities, safety and educational measures for pedestrians and bicycles, scenic easements and sites, and preservation and conversion of abandoned railway corridors. The new provision is for environmental mitigation to insure human safety and reduce vehicle-caused wildlife mortality while maintaining habitat connectivity. Bridge extensions to provide or improved wildlife passage and wildlife habitat connectivity qualify for these funds, as do other measures, such as, wildlife underpasses and overpasses, fencing, lighting, signs, and research. It is important to note that the provision applies to all wildlife and is not limited to listed threatened and endangered species.

TEA-21 earmarked approximately $3.6 billion over six years for the Transportation Enhancements Program. Specifically, TEA-21 provides that 10 percent of the funds apportioned to a state for its Surface Transportation Program shall be used for transportation enhancement activities.

National Highway System (NHS)

Section 1106

NHS is only used for highways that are designated as part of the National Highway System. This includes interstates, primary and secondary federal aid highways, which are significant components of the interstate commerce system.

As with the STP, funds can be used to mitigate direct project impacts, rectify existing impacts, or avoid anticipated future impacts through concurrent action with project construction or through mitigation banking.

Public Lands Highways & Public Lands Highways Discretionary Programs (PLH)

Section 1101

The PLH program (or Afederal highways program@) was established to provide improved access to and within our federal lands. The conservation community generally looks unfavorably upon more road building on public lands; however, retrofitting with the intent of reestablishing or maintaining wildlife habitat could be supported for the substantial ecological gains.

TEA-21 provides $246 million in each of fiscal years 1999 through 2003 for Public Lands Highways. It is expected that approximately $70 million will be available for discretionary funds candidate projects each of fiscal years 2000 through 2003. Federal share of costs is 100 percent.

PLH funds are available for transportation projects within, adjacent to, or providing access to the areas served by the public lands highways. A Apublic lands highway@ means a forest road under the jurisdiction of and maintained by a public authority and open to public travel or any highway through unappropriated or unreserved public lands, nontaxable Indian lands, or other federal reservations under the jurisdiction of and maintained by a public authority and open to public travel. The PLH funds are available for transportation planning, research, engineering, and construction of the highways, roads, and parkways, or of transit facilities within the federal public lands.

Transportation and Community and System Preservation Pilot Program (TCSPPP)

Section 1221

The TCSPPP is a research and grants initiative to investigate the relationships between transportation and community and system preservation and private sector-based initiatives. States, local governments, and metropolitan planning organizations are eligible for grants to plan and implement stategies that address the following issues: efficiency of the transportation system, reducing environmental impacts, reducing the need for costly future public infrastructure, ensuring efficient access to jobs, services, and centers of trade, and examining private sector development patterns and investments that support these goals. Non-governmental organizations are encouraged to partner with an eligible recipient as the project sponsor.

A total of $120M was authorized for the TCSPPP for FY 1999-2003.

State and Local Funds

Although not reviewed here, each state, as well as many local governments, provide funds for transportation projects.

LAWS, RULES, REGULATIONS

Transportation departments, in particular regional districts, differ widely in their receptivity to expending money on environmental and wildlife protection. However, they are compelled to mitigate transportation system impacts by many legal instruments. The conservation of wildlife and/or habitat is considered, recommended, or required to varying degrees in many treaties, laws, rules, and regulations at international, federal, state, and local levels. Among these are[2]:

Transportation Equity Act for the 21st Century (TEA-21, Public Law 105-178)
National Environmental Policy Act
Department of Transportation Act/@Section 4(f)@
Endangered Species Act
Fish and Wildlife Coordination Act
Migratory Bird Treaty Act,
Clean Water Act, Section 404
Public Land Management Laws
    e.g., National Forest Management Act, Wild and Scenic Rivers Act,
    Wilderness Act, National Wildlife Refuge Administration Act
State transportation acts and local transportation regulations
State and local NEPAs, ESAs, land use plans and regulations

These legal instruments represent a range of guidelines and mandates that pertain to environmental and wildlife protection: For instance, NEPA is a procedural act that requires completion of an Environmental Impact Statement, alternatives analysis, and consideration of impact minimization and avoidance; however, it is not a regulatory permitting mechanism. The Endangered Species Act is considered the strongest of all wildlife protection laws, yet the ESA possesses a fair amount of flexibility with regard to alternatives. The ESA requires consultation with the US Fish and Wildlife Service or National Marine Fisheries Service, as applicable, if the project involves any federal agency action and if any federally listed threatened or endangered species would be affected. A project may be denied permitting, or at least, must be mitigated if it causes take of a listed species, including significant adverse habitat modification.

As evidenced by U.S. District Court action in *Sierra Club vs Federico Pena, Secretary of the U.S. DOT* (Civil No. 4-96-547), the National Wild and Scenic Rivers Act includes provisions that can block construction of a bridge that would adversely impact a designated river=s wild and scenic values, including wildlife and habitat. In this Minnesota case, the authority of the National Park Service was found to prevail over the Federal Highway Administration with respect to the Stillwater Bridge which was deemed by the Court to constitute a Awater resource project.@ In doing so, the Court may have also opened the door to legal arguments that bridges should be considered water resource projects under the Fish and Wildlife Coordination Act. If this is the case, then wildlife conservation would have to be considered as a formal purpose of a bridge project and habitat connectivity would be a significant factor in bridge permitting and design.

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[2] A source of further information on resource protection law and highway projects is the National Cooperative Highway Research Program. and the National Research Council., Transportation Research Council.

CONCLUSIONS

The need to replace an aging inventory of bridges throughout the U.S. presents an exceptional opportunity to incorporate design modifications that benefit both people and wildlife by reducing the incidence of roadkill collisions and mitigating for past impacts that have fragmented wildlife habitat. Many factors combine to compel us to action: wildlife populations are being eliminated due to habitat fragmentation, thousands of bridges are awaiting replacement and retrofit, transportation and wildlife professionals have built an adequate information base to demonstrate that extended bridge spans and other design features can reduce the habitat fragmentation problem, funding sources are available, and the law calls upon federal and state DOTs to mitigate adverse ecological impacts. Caution should be used in generalizing to new, poorly sited road projects; a good bridge can=t mitigate for a bad road.

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