

Mapping and Assessing the Environmental Impacts of Border Tactical Infrastructure in the Sky Island Region

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Abstract—In this project we mapped the different types of border barriers, identified impacts of border infrastructure on public and private lands and conducted spatial analyses within the approximately 200 miles of international border in the Sky Island region. The Sky Island region, bisected by the U.S.-Mexico border, is critically important for its biodiversity and continental connectivity. Only on the Arizona side is the border lined with protected areas such as San Bernardino and Buenos Aires National Wildlife Refuges, San Pedro Riparian National Conservation Area, Coronado National Memorial, and several Wilderness Areas. In recent years the construction of border barriers, walls and other tactical infrastructure built to deter human and vehicle traffic across the border has had substantial impacts on ecological processes and created an impermeable boundary with effects that reach far beyond the footprint of the border wall. Due to the Department of Homeland Security's waiver of all legal requirements along significant portions of the U.S.-Mexico border, construction of border infrastructure proceeded without the requisite environmental impact studies or input from public land managers or private landowners. With the use of Geographic Information Systems we analyzed and graphically compiled results from over-flights along the border generating photographic data of the current state and effects of infrastructure, field visits to obtain complementary information and ground-truth aerial photographs, and observations of the direct effects of barriers to wildlife movements and the flow of ecological and hydrologic processes.

From a cartographic perspective, the United States-Mexico border is often depicted as a fairly straight line, drawn to differentiate the countries to the north and south. In ecological terms, the line is far from simple. Hundreds of miles of walls, fences, and other barriers have been installed that are impacting wildlife movement, watersheds, and ecosystem health and stability. In response to these construction projects, Sky Island Alliance took the lead in developing a geodatabase and map of the border in the Sky Island region as the first steps to understand the effects of infrastructure installation and to make this information available to the public.

On October 26, 2006, President George W. Bush signed into law the Secure Fence Act. The stated goals for this act included construction of hundreds of miles of additional fencing along our Southern border; authorization of additional vehicle barriers, checkpoints, and lighting to help prevent people from entering the United States illegally; and authorization for the Department of Homeland Security (DHS) to increase the use of advanced technology like cameras, satellites, and unmanned aerial vehicles to reinforce our infrastructure at the

border. Since the passage of the Act, the installation and maintenance of border tactical infrastructure (TI) has become a central component of DHS border activities (Whitehouse 2006).

In order to accomplish TI installation, the Department of Homeland Security (DHS) relied on provisions from earlier legislation known as the Real ID act of 2005, which gave DHS authority to waive all legal requirements for building border infrastructure, and proceeded with TI construction without having to go through an environmental impact analysis required by NEPA, the National Environmental Policy Act (Ganster 2007). While this has allowed for expedient wall construction along the US/Mexico border, it has created considerable concern among the public and in conservation communities over the short and long-term impacts on ecosystems, endangered and threatened species, wildlife corridors, and watersheds. As figure 1 highlights, approximately 200 miles of TI bisects the unique and fragile Sky Island bioregion. Sky Island Alliance (located in Tucson, Arizona) has been engaged in conservation advocacy of the border region since 1991. In 2010, Sky Island Alliance (SIA) photographed the extent of existing TI in the Sky Island region, and determined that a map detailing the types of barriers and other infrastructure was needed to understand real and potential threats to the area, as well as for conservation advocacy purposes. This project represents a culmination of those efforts. The map produced from this project will be published in print and online, and will be used as a tool for future conservation activities and advocacy. It is also the first comprehensive TI infrastructure map of the region available to the public.

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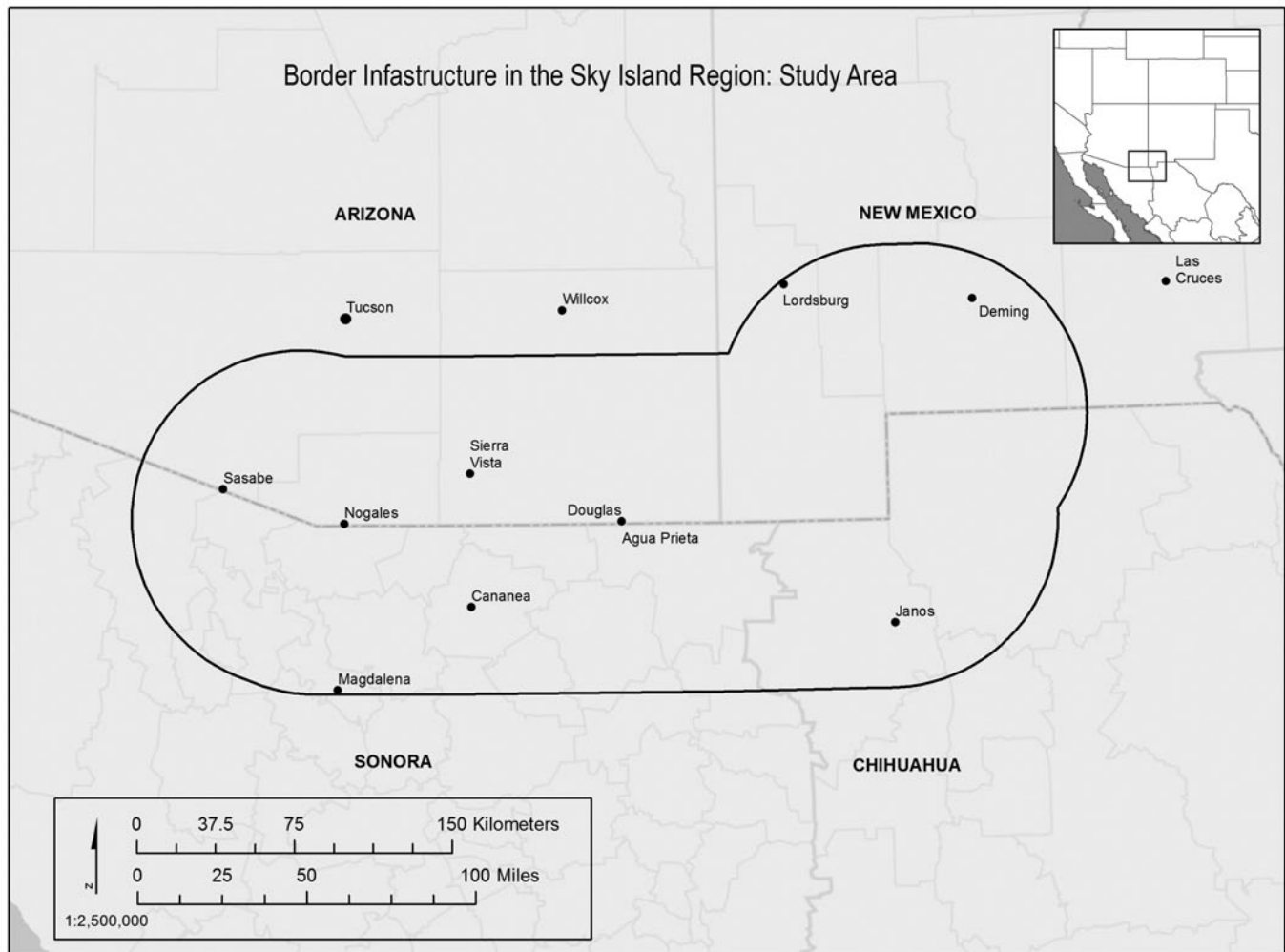


Figure 1—Project study area.

The Sky Islands: An Epicenter of Biodiversity

The Sky Island region of southeastern Arizona and southwestern New Mexico, and adjacent states in northwest Mexico (Sonora and Chihuahua), is characterized by forested mountains surrounded by intervening desert and grassland. This region hosts a high diversity of plants, animals and habitats. The region sits at the confluence of four major ecosystems: the Colorado Plateau, the Sierra Madre Occidental, and the Sonoran and Chihuahuan deserts. Because the region encompasses North America's two largest deserts and is a bridge between its two major mountain ranges, it is critically important to continental connectivity. Madrean pine-oak woodland, an important characteristic of Sky Islands, was designated a biological hotspot by Conservation International in 2005. The high number of federally protected areas along the international border—including national wildlife refuges, wilderness areas, national monuments, riparian national conservation areas, and national parks in Mexico and the United States—testify to the region's unique richness (SIA 2011).

Project Background

Creating a border infrastructure map per the needs of SIA required a multi-faceted process and an understanding of environmental and ecological factors of the region. In addition, we researched the political history of the area and how policy was developed to create the infrastructure, and the usage of land for wall construction, bridges, and easements. Because there was not a unifying source for these varied data needs, information was amassed from many sources, including printed publications, government websites, non-profit organizations including SIA, the Northern Jaguar Project and Defenders of Wildlife, border fly-over missions, and field collections. SIA began collecting data and monitoring the region in 2008, after the passage of the Real ID Act and the Secure Fence Act and the ensuing construction of the TI. Since then, it has used staff and volunteers to document wildlife corridors and monitor erosion and habitat degradation in the region as a result of construction and increased human activity.

In 2010, SIA conducted two photographic fly-over missions to capture the extent of the tactical infrastructure in the Sky Island region. The flights documented infrastructure from Sasabe, Arizona, to the eastern edge of New Mexico's "boot heel." The aircraft, equipped with

two photographers and a note-taker/navigator flew the extent of the region (approximately 200 miles) from west to east, on the south side of the border. The majority of the images were taken from the perspective of looking north, with images also captured from the southern side of the plane to assist in geo-referencing the photos based on the area's topography. As figure 2 shows, the photos from these flyovers provided an essential visual record of the extent of the TI. The note taker recorded on a topographic map the changes in the infrastructure that could be detected from the air. Although this process produced some excellent documentation of the border infrastructure, it took considerable time to geo-reference the photos to actual coordinates on the ground. This was accomplished by comparing the images to the topographic maps used during the flights and verifying the locations with Google Earth.

After compiling a profile of the TI through the aerial images, we realized that ground-truthing data collection would be needed to better understand the types of infrastructure used in areas that were either not clearly captured in imagery and/or in important conservation areas. In July and August of 2011 we visited several significant areas along the border, including the Buenos Aires National Wildlife Refuge (BANWR), the San Pedro Riparian National Conservation Area (SPRNCA), and the San Bernardino National Wildlife Refuge. As an example of the importance of these areas ecologically, the San Pedro is one of the last free flowing rivers in the desert southwest. It is also a global hotspot for bird and mammal diversity and is certainly one of the most significant wildlife corridors connecting the United States and Mexican nations. It is also important to note that the wall construction in the SPRNCA boundaries represents the first time such activities had occurred on public land that had been federally designated as a protected area (Segee and Cordova 2009).

Infrastructure Classifications

In the Sky Islands region, most of the existing TI falls into two main categories: pedestrian fencing and vehicle barriers. There are sub-categories with style/material differences within the two main categories. Table 1 outlines the different types of TI documented over the course of this project. Based on our observations, the construction goals for using different styles depended on topographical features of the area. For example, vehicle barriers were employed in certain riparian areas and other locations that the terrain presented challenges to constructing pedestrian barriers.

Cartography Goals

Once we had assembled our data, we began the task of creating a map that depicted the area and its relationship to the constructed tactical infrastructure. The goal for this map was to provide viewers a way of seeing this area as an ecological region that transcends political borders, and that the border infrastructure construction bisects the region and its important ecological processes. To accomplish this goal we did our best to downplay the state and national borders, focusing instead on the tactical infrastructure as the dividing line (fig. 3). We also made sure to include important wildlife preserves in Sonora and Chihuahua. Far too frequently, maps of the U.S./Mexico border only provide information on the northern side of the border. We did our best to rectify that approach with the information we had available.

Tactical Infrastructure Footprint

Once the data was compiled and assembled into a comprehensive map, it became possible to establish some baseline footprint data that can be used for conservation advocacy.

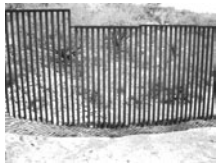
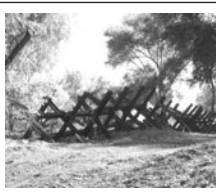
The infrastructure information compiled for this map yielded some interesting footprint statistics. Table 2 provides statistics on barrier miles in protected areas. In looking at these figures it is important to consider the following facts: (1) The mileage listed is an approximate based on GIS tools, aerial photography, and ground truthing efforts; and (2) construction is continuing on the border, and this data represents a snapshot of the situation as of July, 2011. In addition to the linear miles of federal land that the tactical infrastructure now occupies, hundreds, if not thousands, of acres of land has also been allocated and used by Custom and Border Protection (CBP) for infrastructure purposes under the auspices of the "Roosevelt Reservation." This little-known piece of legislation allows for a "public highway" to run along the U.S./Mexico border. CBP has used this to build access roads and other TI, and in several locations, have extended the easement well beyond the 60 feet to 120 feet or more. Environmental stewardship plans produced by CBP estimate a loss of 552 acres in vegetation communities from the barrier construction activities (Homeland Security 2008). Conservative estimates from this project place that figure at more than 900 acres in lost habitat, with over 500 acres on federal land.

Based on infrastructure measurements, the data collected during this project highlight the impact of the TI in federal areas. It is important to remember that this infrastructure, with an average construction cost of \$4.1 million per mile, was placed on U.S. federal land, in



Figure 2—Aerial view south to north of the San Pedro River area bisected by the international border (non-contiguous photos). On the Arizona side, the San Pedro is a riparian National Conservation Area. In addition to 6-ft high walls, a wide border road and numerous access roads fragment the land (left); Normandy-style vehicle barriers cross the San Pedro River bed (center); washes and arroyos are paved to protect the road, but water courses are blocked by pedestrian fences (right) (photos courtesy of Sky Island Alliance, Paul Condon, and LightHawk Inc.).

Table 1—Barrier classifications and characteristics (photos by Sergio Avila-Villegas and Caroline Patrick-Birdwell, 2011).

Barrier photo	Barrier type	Approximate height	Materials	Wildlife friendly	Water friendly
	Pedestrian/	15 to 18 feet	Steel, recycled helicopter landing mats	No	No
	Pedestrian/bollard	15 to 18 feet	grout-filled steel	No	No
	Pedestrian/bollard	15 to 18 feet	grout-filled steel	No	No
	Pedestrian/Water-drainage Gate	15-18 feet	grout-filled steel posts with gate housing	No	Variable; gates are only water friendly when lifted in advance of a storm event
	Pedestrian/mesh	15-18 feet	Steel with steel/wire mesh	No	No
	Vehicle/Normandy	4-6 feet	Non-reflective steel	Variable	Variable
	Vehicle/Post and Rail	4-5 feet	Non-reflective steel	Variable	Variable

highly sensitive ecological hot spots, without benefit of environmental analysis or environmental impact statements. The next phase for this project is to analyze the data more thoroughly and then use it to advocate for enlightened border security strategies that consider the environmental implications of those efforts.

Given the size and significance of the border section of the Sky Island bioregion, this project represents a starting point for further

research. With the infrastructure in place in 62% of the region's international border, biologists are already seeing signs of interruptions in wildlife corridors as well as erosion and other damage to fragile riparian ecosystems. The map and data produced for this project are important first steps for understanding the threats of the border wall on the environmental health of the region.

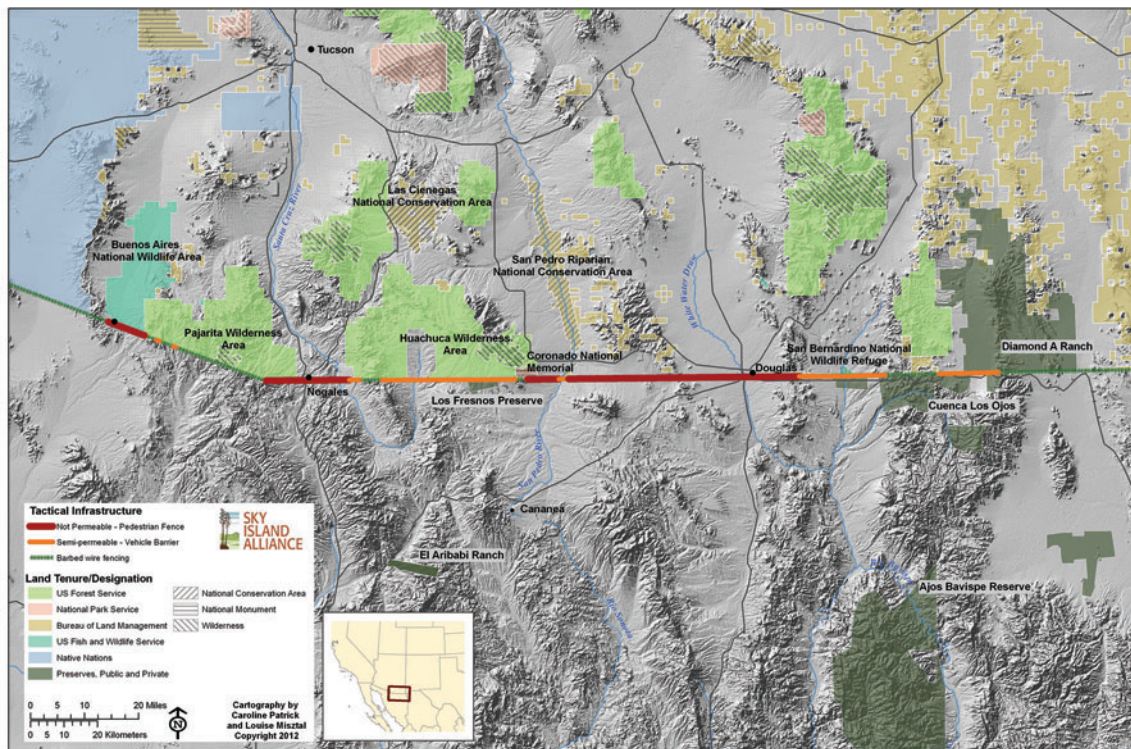


Figure 3—Infrastructure map (Cartography by Caroline Patrick-Birdwell and Louise Misztal, 2012).

Table 2—Tactical infrastructure mileage/area approximations.

	Vehicle barrier	Pedestrian barrier	Total border length	Percent covered w/barrier	Total barrier (study area)	Study area
Designated wilderness			4.18	0		
Wildlife refuges	3.06	5.44	8.5	100		
Conservation areas	1.43	0.3	1.75	100		
U.S. Forest Service	17.5	5.65	73	32		
National Park Service	0.25	1.8	3.5	58		
Other (public/private)	32.96	57.91				
Total (all land types)	55.2	71.1		62	126.3	203
Acres used in 60 ft. barrier corridors						
Federal land	516					
Total	918					
CBP predicted vegetation loss	552					

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The content of this paper reflects the views of the authors, who are responsible for the facts and accuracy of the information presented herein.