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LONG-TERM CONSERVATION OF MIGRATORY BIRDS IN MÉXICO: THE VERACRUZ RIVER OF RAPTORS PROJECT

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Abstract. Millions of raptors and other Neotropical migratory birds are constrained to a narrow geographic corridor during migration through Veracruz, México. Over many years of work, a clearly identified list of problems has defined the agenda of a long-term conservation plan for this globally important migration stopover site. Threats to migrants include habitat loss, pesticide use, and negative human attitudes towards raptors that result in direct persecution. The Veracruz River of Raptors Project (VRR) started in 1991 as a long-term initiative to address these problems. Its adaptive conservation plan is based on three core strategic lines of work: 1) research, focused on identifying key stopover habitat sites, understanding migration ecology, and assessing conservation risk by species/habitat associations; 2) monitoring, through a long-term program to track populations based on migration counts and banding, and 3) environmental education, through an alliance to implement programs with students and teachers in rural and urban schools and permanent, year-round presence through its new Mario A. Ramos Bird Observatory. These activities are supported by three core processes for long-term sustainability: a) an international training scheme to ensure qualified human resources; b) a renewable fundraising system that includes a membership program, a private donor base, an ecotourism program, and a continuous fundraising process through foundations, and c) the formalization of partnerships and development of a network of contacts, from local to international, to support the work developed onsite. This approach to conservation implementation has sustained the VRR Project for 18 years. We anticipate utilizing these same strategies to advance the project's goals in the future.

Key Words: conservation, México, migration, raptor, Veracruz.

LA CONSERVACIÓN A LARGO PLAZO DE LAS AVES MIGRATORIAS EN MÉXICO: EL PROYECTO VERACRUZ RÍO DE RAPACES

Resumen. Millones de rapaces y otras aves migratorias Neotropicales migran por un estrecho corredor a través de Veracruz, México. Durante muchos años de trabajo en este sitio de importancia global para la migración, una lista de problemas claramente identificados ha definido su agenda de conservación. En esta región, las amenazas a las aves migratorias incluyen la pérdida de hábitat, el uso de plaguicidas y las actitudes negativas hacia las rapaces que resultan en persecución directa. El proyecto Veracruz Río de Rapaces inició en 1991 como una iniciativa de largo plazo para resolver estos problemas. Su plan de conservación está basado en tres líneas estratégicas de trabajo: 1) investigación, centrada en la identificación de sitios de hábitat críticos, el entendimiento de la ecología de la migración de las aves y la determinación del riesgo de conservación de las aves y sus hábitats; 2) monitoreo, a través de un programa de largo plazo para seguimiento de las poblaciones y que se basa en conteos de la migración y anillado, y 3) educación ambiental, a través de una alianza para implementar programas con estudiantes y maestros en escuelas rurales y urbanas, sumada a la presencia durante todo el año, a través del nuevo Observatorio de Aves Mario A. Ramos. Estas actividades están apoyadas por tres procesos centrales de sostenibilidad a largo plazo: a) un programa de entrenamiento internacional para asegurar recursos humanos calificados; b) una base de financiamiento renovable que incluye donantes privados, un sistema de membresía, un programa de ecoturismo y esfuerzos continuos de procuración de fondos a través de fundaciones, y c) la formalización de alian-

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zas y el desarrollo de una red de contactos, desde locales hasta internacionales, para apoyar el trabajo desarrollado en sitio. Esta forma de implementación de la conservación ha sostenido al proyecto VRR por 18 años y anticipamos seguir utilizando estas mismas estrategias para avanzar las metas del proyecto en el futuro.

AN INTRODUCTION TO RAPTOR MIGRATION IN VERACRUZ

The central region of the state of Veracruz, Mexico, lies at the intersection of two major mountainous systems, the Sierra Madre Oriental and the Central Volcanic Belt, which constrain the width of the Gulf Coastal Plain at about 19°N. The foothills of the Cofre de Perote volcano (4,250 masl) continue east along the Sierra de Manuel Díaz, to reach the Gulf of Mexico at the vicinity of the fishing village of Villa Rica. This reduction in the course of the Gulf lowland coastal plain forms a geographic bottleneck that funnels spring and autumn hawk migrations.

The lowlands of the Gulf coastal plain have abundant and constant thermals that allow migrating raptors and other large soaring birds to migrate with less effort and lower energy expenditure. This spectacular migration in eastern México has been documented through scattered reports since 1897 (Chapman 1898).

Jean-Marc Thiollay and his colleagues made the first counts in the spring of 1979 (Thiollay 1979, 1980), and Fred and Cathy Tilly made additional observations in 1987 and 1989, documenting over 200,000 birds during spring migration (Tilly et al. 1990).

The Veracruz River of Raptors Project (VRR) was founded in the spring of 1991 with the goal of documenting the spring migration of hawks through the region. The first field team collected data over 60 days in four localities along a transect that ran along a west-to-east axis following Federal Highway 140 between La Antigua and Xalapa, documenting over 400,000 migrants in the spring of 1991 and over 2.5 million migrants in the first autumn season(Ruelas 1992). Since then, our field crews have continued these migration counts at two sites, and we plan to continue this work over long-term.

Much has changed since those initial field seasons. VRR is now a cooperative, institutionalized effort between Pronatura Veracruz, Hawk Mountain Sanctuary, and HawkWatch International. Its mission is "the conservation of migratory raptors, wading birds, and their habitats as part of the local biodiversity, through

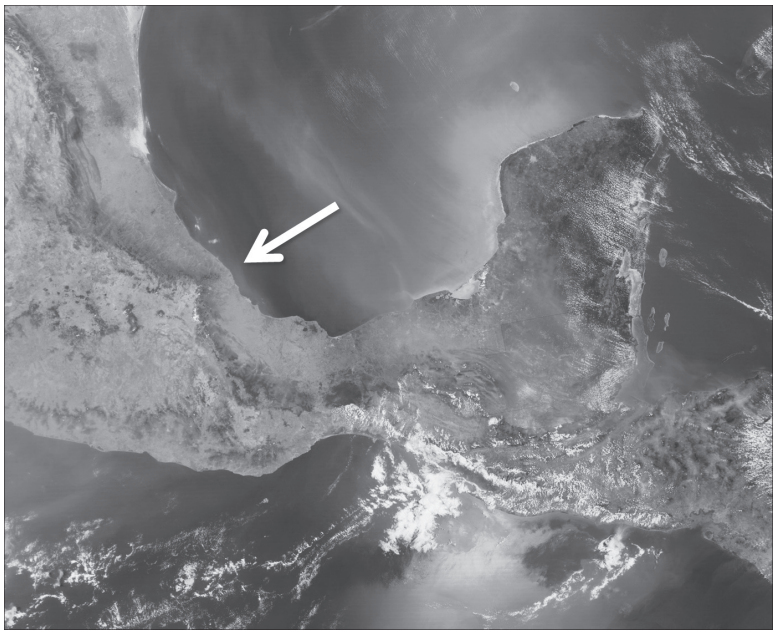

FIGURE 1. Location of Veracruz, Mexico. The spectacular hawk migration observed at the Gulf of Mexico's coastal plain in spring and autumn is a result of a geographic bottleneck that obligates migrants to a narrow passage in central Veracruz (MODIS image courtesy of NASA, http://modis.gsfc.nasa.gov/).

environmental education, research, monitoring, and habitat conservation."

In this paper, we present the threats to the conservation of migratory hawks in Veracruz and the methods VRR has used to addressed them. These results are presented as summaries of our 1) research, 2) monitoring, and 3) environmental education programs.

Sustaining a conservation project over long-term comes with a series of challenges to maintain the human and monetary resources needed. These activities have demanded a great amount of effort, and, in the original stages of the project, we did not fully envision the need to create a mechanism to sustain the project. The key elements to sustain VRR over long-term, are our international training scheme, a renewable fundraising system, and the formalization of our partnerships and collaborations.

We conclude this paper by discussing how the experiences of VRR can be useful to other projects in Mesoamerica.

THREATS TO CONSERVATION OF MIGRATORY RAPTORS IN VERACRUZ

Habitat Availability

We have identified three main problems for the conservation of migratory hawks in Veracruz. The most evident is habitat availability, because over 80% of the original forest coverage of central Veracruz has been lost to agriculture, cattle-raising, and urban development (Ruelas et al. 2005).

The region has been densely inhabited by people for over 1,500 years, and, in some locations such as the southern parts of the Totonacapan region, at higher densities than it is today (Wilkerson 1980). The area was the point of entry for cattle and sugar cane brought in by Spaniards in the 15th century, and the state of Veracruz has always been one of the most densely populated states in the country. Most of the habitat loss, however, occurred in the relatively distant past. There may actually have been a net gain in total habitat within the most recent 10 years (Sánchez-Cordero et al. 2005).

We do not have a clear understanding of the way limited forest habitat availability may be affecting roosting and foraging migrants. Over several years of field work, our observations suggest that hawks do not use traditional roosting sites. Some of the largest forest patches in the region are located in inaccessible terrain, such as the area around Chavarrillo, the area south of Río Escondido, and the Sierra de Manuel Díaz (for coordinates and elevation of localities cited in the text see Ruelas et al. 2005), show that the largest vegetation patches have a higher probability of being used as roosting habitat. Larger birds, such as Turkey Vultures (*Cathartes aura*) and Swainson's Hawks (*Buteo swainsoni*) tend to use habitats near slopes of hills and steep canyons that would presumably assist their flight take off on the following day.

Most migrants do not stay for more than a few days, as lengthy stays have only been observed during periods of inclement weather. With the exception of Turkey Vultures, the three other most common species of migrants Swainson's Hawk, Broad-winged Hawk (*Buteo platypterus*), and Mississippi Kite (*Ictinia mississippiensis*) do not overwinter in the region. *Accipiter* hawks, harriers, and falcons do overwinter in the area.

The opening of Mexico's borders for tax-free importation of high fructose and other corn products in 1994 collapsed the production of sugar cane in the region (Veracruz is the producer of ~40% of the sugar cane in the country). This has been translated into a net gain in second growth habitats that has not been precisely quantified but can be easily observed in the field (World Bank 2003). The future impact of sugar cane-based ethanol production, now that this industry is developing plans, remains as an important pending concern.

Agrochemical Contamination

A second possible threat for the conservation of migrants is contamination by agrochemicals. The region is the second most important irrigation district in Mexico for the use of agrochemicals (Botello et al. 1996). It is not clear if or how these contaminants are affecting populations of transient migrants because some species rarely forage in this area during migration. Thus, their exposure to these chemicals through the consumption of prey, at least, would seem to be low.

In the autumn of 1998, we made focal observations of foraging events in the three most common species (Turkey Vulture, Swainson's and Broad-winged Hawks) from a radius ca. 2 km around the counting stations. We documented only 13 records of foraging, all of them by Swainson's Hawk (and none for the remaining two species), which supports the hypothesis of Smith et al. (1986) that obligate-flocking species fast for a portion of their migration.

However, foraging is commonly observed in most other species, such as Mississippi Kites that prey upon migrating dragonflies and in *Accipiter* hawks and falcons. Data collected by other researchers in the region have reported DDE and other contaminants in the tissues of Peregrine Falcons (*Falco peregrinus*)

and Ospreys (*Pandion haliaetus*), but the source of these contaminants cannot be traced to their permanence in the region with certainty (Banasch et al. 1992, Elliott et al. 2007). The herbicide Monocrotophos, which caused mass mortality of Swainson's Hawks in their wintering grounds in Argentina in the mid 1990s (Woodbridge et al. 1995, Goldstein et al. 1996, 1999a, 1999b) continues to be used locally under the commercial name of Nuvacron.

Direct Persecution

One last problem that hasn't been quantified, but that may have one of the most significant impacts, is direct persecution. Shootings of hawks in White-winged Dove (*Zenaida asiatica*) hunting sites, shooting in rural areas throughout the region, and the capture of Aplomado Falcons (*Falco femoralis*) and Peregrine Falcons for trade and falconry, all need to be assessed.

MIGRATION ECOLOGY RESEARCH AT VRR

This scenario of threats provides a complex conservation context to present the exceptional raptor migration in Veracruz. Among the outstanding findings of this project, we have documented the most important migratory flyway for raptors in the world (Ruelas et al. 2000, Table 2), where an average of 5.1 million hawks can be observed each autumn field season (Table 1). These migrations are dominated by seven species of soaring birds (including pelicans, anhingas, storks, vultures, and hawks) that are constrained to the narrow passage of lowlands that provides a thermal pathway between the foothills of the Sierra Madre and the Gulf (Table 1).

Among other findings reported extensively by Ruelas (2005), we examined the spatial and temporal dynamics of migration through the area, and found a geographic distribution of the migration that is annually consistent. Seasonal timing, on the other hand, is highly variable in all species, with noticeable year effects. The variation found in the timing of migration is closely related to extrinsic variables (e.g., wind speed, precipitation, and frequency, strength, and duration of northerly weather fronts, Ruelas 2005). The extent of these temporal oscillations is different among species, with facultative, short-distance migrants experiencing higher variation than obligate, long-distance migrants. In addition to total distance of migration, the degree of the plasticity of this trait is apparently also linked to diet, body mass, and wing load (Ruelas 2005).

To understand the differential flight performance among species and migration seasons, Ruelas (2005) studied soaring behavior and quantified a) their performance in the use of thermal convection and b) wing beat frequency, as measures of energetic cost in cross country flights. Larger birds migrate with a lower energetic expenditure and use the turbulence of the boundary layer of the atmosphere in a more efficient way. He also found that spring is a migration season that demands a higher energetic expenditure for more species (Ruelas 2005).

Population Monitoring

We have monitored hawk populations using annual standardized migration counts since the spring of 1991. During the first four field seasons of work (the springs of 1991, 1994 and the autumn seasons of 1992 and 1993), we set a survey line of four or five counting stations perpendicular to the migration front, to determine the inland extent of the migration (Ruelas 2005). We found that the middle section of the coastal plain had flights of larger magnitude, and those were less variable than flights recorded near the coast or in sites farther inland, where daily totals oscillate greatly.

We selected two sites in spring (Rinconada and Cerro Gordo, located 26.2 and 38.7 km from the coast respectively) as the best localities for long-term counts. During the autumn, migration streams are restricted to locations much closer to the coast, and we selected Chichicaxtle and Cardel (located 17 and 7 km from the coast respectively) for long-term monitoring.

In comparison, the spring season (which corresponds to the dry season) has field conditions that are much harder than those of the autumn. For example, skies are hazy in the spring, and this creates a bright sky background that reduces the detectability of migrating hawks. In addition, ground temperatures are higher in the spring, and so the height of hawks above the ground is greater since thermal convection is much stronger. The combination of these conditions, and the longer distances to commute by field crew, increase observer fatigue considerably. The high cost of sustaining both a spring and autumn monitoring operation led us to select the autumn season for long-term monitoring.

We used migration count data to assess the population trends of species that met several model conditions and assumptions (Smith et al. 2008). The populations of Swallow-tailed Kite, Mississippi Kite, Cooper's Hawk, Swainson's Hawk, Zone-tailed Hawk, and Peregrine Falcon have been increasing at a rate of +1.9 to +15.7% $year^{-1}$ over the period 1995-2005. We found only one species, the Northern Harrier, showing significant declines over the same period (Table 3).

TABLE 1. Magnitude of wading bird, New World vulture, and raptor migration recorded in spring and autumn in Veracruz, México. Spring data were collected in 1991, 1994, 1995, and 2004 (n = 4 field seasons), but only 1994 and 2004 data (collected in the period 8 March–8 May) are used in the comparisons, due to differences in localities and duration of field seasons. Autumn data were collected from 1995 to 2005 and excludes the 1997 season (n = 10 field seasons, collected in the period 20 August–20 November) (source: Ruelas 2005).

	Spring			Autumn		
	Min	Max	Mean	Min	Max	Mean
Family Pelecanidae						
American White Pelican *Pelecanus erythrorhynchos*	2,260	70,533	23,511	54,507	128,757	85,679
Family Phalacrocoracidae						
Neotropic Cormorant *Phalacrocorax olivaceus*	0	3	1	29	205	97
Double-crested Cormorant *P. auritus*	0	0	0	4	95	42
Unidentified Cormorant	0	0	0	0	2	1
Family Anhingidae						
Anhinga *Anhinga anhinga*	838	14,118	4,706	18,837	41,140	31,634
Family Ardeidae						
Great Blue Heron *Ardea herodias*	1	3	1	172	2,161	646
Family Threskiornithidae						
White Ibis *Eudocimus albus*	0	6	2	230	4,693	1,469
White-faced Ibis *Plegadis chihi*	19	431	144	499	3,871	1,986
Family Ciconiidae						
Jabiru *Jabiru mycteria*	0	0	0	0	21	4
Wood Stork *Mycteria americana*	32	4,515	1,505	24,915	121,791	56,976
Family Cathartidae						
Turkey Vulture *Cathartes aura*	22,574	823,962	205,991	1,474,797	2,677,335	1,948,922
Family Accipitridae						
Osprey *Pandion haliaetus*	247	2,603	651	1,147	5,072	3,012
Hook-billed Kite *Chondrohierax uncinatus*	0	197	49	84	300	169
Swallow-tailed Kite *Elanoides forficatus*	1	25	6	90	286	167
White-tailed Kite *Elanus leucurus*	0	0	0	0	2	1
Mississippi Kite *Ictinia mississippiensis*	3,569	63,501	15,875	32,568	306,274	159,467
Plumbeous Kite[1] *I. plumbea*	0	1	0	0	17	4
Bald Eagle *Haliaeetus leucocephalus*	0	1	0	0	1	0
Northern Harrier *Circus cyaneus*	79	354	89	106	850	424
Sharp-shinned Hawk *Accipiter striatus*	447	4,515	1,129	2,137	10,462	4,073
Cooper's Hawk *A. cooperii*	140	2,034	509	932	4,019	2,416
Gray Hawk *Asturina nitida*	0	86	22	0	1,271	289
Common Black Hawk *Buteogallus anthracinus*	0	1	0	0	10	2

TABLE 1. CONTINUED.

	Spring			Autumn		
	Min	Max	Mean	Min	Max	Mean
Harris's Hawk *Parabuteo unicinctus*	0	6	2	0	12	7
Red-shouldered Hawk *Buteo lineatus*	4	76	19	1	27	10
Broad-winged Hawk *B. platypterus*	80,004	1,276,379	319,095	1,534,556	2,389,232	1,919,178
Swainson's Hawk *B. swainsoni*	14,783	421,613	105,403	388,916	1,201,484	851,326
Zone-tailed Hawk *B. albonotatus*	1	69	17	31	238	130
Red-tailed Hawk *B. jamaicensis*	13	267	67	100	352	189
Ferruginous Hawk *B. regalis*	0	0	0	0	2	<1
Golden Eagle *Aquila chrysaetos*	0	3	1	0	3	<1
Unidentified Kite	0	0	0	0	6	1
Unidentified *Accipiter* Hawk	14	215	72	24	810	171
Unidentified *Buteo* Hawk	174	17,174	4,294	1,220	256,771	70,705
Family Falconidae						
American Kestrel *Falco sparverius*	716	6,134	1,534	2,935	21,642	7,081
Merlin *F. columbarius*	10	107	27	44	383	162
Peregrine Falcon *F. peregrinus*	47	400	100	205	1,469	720
Unidentified Falcon	1	48	12	0	90	31
Season mean (all species)			686,444			5,242,907

[1] Under field conditions in Veracruz, there are notorious difficulties to positively identify Plumbeous Kites from the closely related Mississippi Kites. Although very low quantities of them are recorded every season, it is possible that more of them are included as unidentified. Due to the close proximity of our research sites to the northern limit of their breeding range, we expect this number to be low.

A banding station was established in El Palmar, nearly 3 km west of Cardel, in 1992, but that site delivered meager results and was abandoned (Ruelas 1993). In 1998, Karen L. Scheuermann founded a banding station at La Mancha (which moved later to Cansaburro) and ran its operations for several years, and in the process, she also trained numerous local field biologists to band hawks (Scheuermann and Ruelas 2003).

During the period 1998-2007, we trapped, banded, and released >3,800 hawks of 20 species. The most abundant species captured were Cooper's Hawk (~40% of all captures per season), Sharp-shinned Hawk (~30% per season), and Peregrine Falcon (10% per season). In the first 10 years of operation, nineteen hawks banded in La Mancha and Cansaburro, or banded elsewhere and re-trapped here, were recovered (Table 4). These results indicate that most Veracruz *Accipiter* hawks originate in the upper Midwestern region of the United States and south-central Canada, but also illustrate a broad range of localities of geographic origin. Our banding station has also contributed blood samples for contamination research (Elliott et al. 2007) and feather samples for geographic origin/phylogenetic analyses of migrants (Hull and Girman 2005). Such data are important for understanding the populations being sampled with the migration counts.

ENVIRONMENTAL EDUCATION

Our environmental education programs started out in the form of a simple brochure, illustrated by Scott Weidensaul, that field biologists distributed onsite to visitors during the spring 1991 field season. The importance of this locality and the urgent need to develop educational programs was raised by Evodia Silva Rivera, who developed the first education materials for teachers and elementary school children in the autumn of 1992, in cooperation with Sharon Gaughan and other Hawk Mountain education staff.

In 1994, VRR was brought under the umbrella of conservation activities of Pronatura Veracruz. In 1995, Sandra L. Mesa Ortiz, Sharon M. Gaughan, and Liliana Coronado Limón rede-

TABLE 2. MAXIMUM NUMBER OF BIRDS RECORDED AT MIGRATION BOTTLENECKS OF GLOBAL IMPORTANCE.

Locality	Wading birds[1]	New World Vultures	Raptors	Notes
Veracruz, Mexico	128,757 pelicans 121,791 storks	2,677,355	4,120,356	Records for 33 species tallied from two localities between 1991-2007 (this study, Ruelas et al. 2000, and Castillejos and Rodríguez 2002)
Talamanca, Costa Rica	n/a	1,367,200	1,611,902	Records of 17 species tallied from two localities in falls of 2000-2001, Porras-Peñaranda et al. (2004)
Isthmus of Panama	n/a	1,399,847	1,725,639	Records of 15 species tallied from a survey line of nine sites in fall of 2004 (Batista et al. 2005)
Israel	301,048 pelicans 76,909 storks	n/a	1,193,751	Records for 35 species tallied from a survey line of max. 20 sites between 1977 and 1990 (Leshem and Yom-Tov (1996)

[1]Includes only counts of pelicans and storks. In Veracruz, records pertain to American White Pelican and Wood Stork; In Israel, records pertain to White Pelican (*Pelecanus onocronatus*) and White Stork (*Ciconia ciconia*).

TABLE 3. RATE OF CHANGE IN THE AUTUMN COUNTS OF MIGRATING HAWKS FROM VERACRUZ, MÉXICO, 1995-2005 (MODIFIED FROM SMITH ET AL. 2008). SCIENTIFIC NAMES ARE GIVEN IN TABLE 1.

Species	Annual rate of change (±95% confidence intervals)	Statistical significance
Turkey Vulture	+5.7 (± 5.9)	$P \leq 0.10$
Osprey	+2.8 (± 6.5)	$P \leq 0.50$
Hook-billed Kite	+3.3 (± 6.1)	$P \geq 0.50$
Swallow-tailed Kite	+7.3 (± 4.2)	$P \leq 0.01$
Mississippi Kite	+15.4 (± 11.5)	$P \leq 0.05$
Northern Harrier	-8.4 (± 8.2)	$P \leq 0.05$
Sharp-shinned Hawk	-7.5 (± 9.3)	$P \leq 0.10$
Cooper's Hawk	+1.9 (± 6.2)	$P \geq 0.50$
Broad-winged Hawk	+3.1 (± 9.5)	$P \leq 0.50$
Swainson's Hawk	+13.6 (± 12.2)	$P \leq 0.05$
Zone-tailed Hawk	+15.7 (± 7.2)	$P \leq 0.01$
Red-tailed Hawk	-3.3 (± 5.6)	$P \leq 0.50$
American Kestrel	-0.0 (± 7.3)	$P \geq 0.50$
Merlin	+0.4 (± 7.4)	$P \geq 0.50$
Peregrine Falcon	+3.2 (± 6.5)	$P \leq 0.50$

signed all the education materials with support from the National Fish and Wildlife Foundation and other donors and launched a very ambitious environmental education program that, to this date, runs parallel to our monitoring work. They also coined the motto "Veracruz River of Raptors"© for our project (Fig. 2).

The program is targeted at fourth grade students of rural and urban elementary schools in School District No. 5 of the Ministry of Education and Culture of Veracruz (Mesa et al. 2003). The program consists of a 13-week-long, formal environmental education curriculum that uses our teacher's manual as its backbone (Mesa et al. 2005). Each chapter of the manual contains a background section, a presentation of the unit's theme, and a series of activities for students to develop with their teacher.

Pronatura educators visited schools once a week and worked with teachers to cover the week's theme. Each unit had a quantitative evaluation questionnaire that students filled at the end of the session and allowed educators to track progress along the duration of the program. Students gained information on general concepts such as food chains and ecosystem functions using raptors and raptor migration in the region as model examples (Mesa et al. 1997).

INTERNATIONAL TRAINING SCHEME

People and money are two basic ingredients needed for a successful conservation project. The importance of a system to recruit, train, and retain human resources is an aspect that we did not fully consider in the early stages of the

TABLE 4. Recoveries of hawks originally banded in La Mancha (N = 10) and foreign birds banded elsewhere and recaptured in La Mancha (N = 9), 1998–2006. Codes for age classes: HY = hatching year, SY = second year, AHY = after hatching year, ASY = after second year, U = unknown.

Species	Sex	Age at banding date	Banding date	Recovery date	How recovered?	State or province	Country	Distance (km)
Originally banded in La Mancha:								
Sharp-shinned Hawk	♀	HY	8 October 1999	2 May 2000	Retrapped and released alive	New York	United States	3,190
	♀	HY	24 September 1999	6 May 2001	Found as skeleton	Michigan	United States	3,120
	♀	AHY	23 October 2002	Spring 2004	Retrapped and released alive	Michigan	United States	U
	♀	HY	25 October 2002	11 April 2006	Found dead	Iowa	United States	U
	U	U	1 October 2004	U	U	U	U	U
Cooper's Hawk	♀	SY	25 September 2002	1 December 2003	Found as skeleton	U	Nicaragua	U
	♀	AHY	14 October 2000	7 October 2004	Retrapped and released alive	Iowa	United States	U
	♂	AHY	20 October 2002	25 October 2005	Found dead	U	Guatemala	U
	♀	HY	29 October 1998	June 1999	Found dead	Saskatchewan	Canada	3,750
Peregrine Falcon	♀	HY	21 October 1999	22 April 2002	Found dead	Alberta	Canada	4,410
Banded elsewhere and retrapped in La Mancha:								
Sharp-shinned Hawk	♀	HY	28 August 1998	28 September 1998	Thunder Cape Bird Observatory	Ontario	Canada	3,250
	♀	HY	27 August 2000	15 October 2000	U	Wisconsin	United States	2,810
	♀	SY	11 May 2000	27 October 2000	Independent banders	Michigan	United States	3,170
	♀	ASY	17 September 1999	13 October 2001	Hawk Cliff Banding Station	Ontario	Canada	2,960
	♀	SY	9 April 2002	22 October 2002	U	Michigan	United States	760
	♀	HY	16 September 2002	7 October 2005	Holiday Beach Migration Observatory	Ontario	Canada	U
Cooper's Hawk	♀	ASY	5 July 2000	6 October 2001	Lostwood National Wildlife Refuge	North Dakota	United States	3,270
	♀	ASY	6 December 2002	11 October 2005	U	Wisconsin	United States	U
Peregrine Falcon	♀	HY	14 October 2001	25 October 2001	Padre Island Peregrine Falcon Study	Texas	United States	760

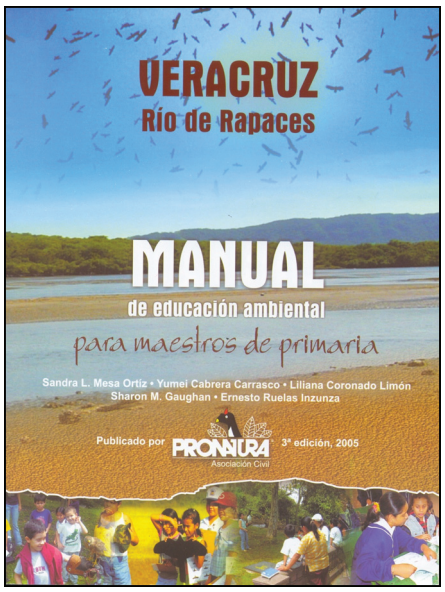

FIGURE 2. The Veracruz River of Raptors teachers' manual. The formal environmental education programs take place in elementary schools in Cardel and Chichicaxtle, Veracruz, every autumn. VRR educators have given similar programs in many other localities across central Veracruz and trained dozens of teachers to use the manual with their fourth grade students.

project. Consider these facts: a) a field assistant collecting migration count data requires at least two field seasons of work and a training internship before becoming a fully trained field biologist capable of running the field protocol at the current standards of data quality, b) educators take at least one season as a trainee before being able to conduct programs in schools, and c) VRR has had over 150 people in its field operations over the years.

How and where do you recruit people? VRR has recruited personnel among Universidad Veracruzana undergraduate students of biology, pedagogy, and education. A good portion of the personnel have also come from our field operations. People from the villages and locations where we work frequently volunteer in our field operations, and, at a later time, may become capable of running different aspects of our project such as banding hawks, collecting migration count data, or conducting education programs and training workshops for teachers.

On-the-job training, however, does not replace the role of participation in a formal program. VRR partners Hawk Mountain and HawkWatch International have international internship programs available for students of hawk migration and conservation. VRR has sent more than 20 trainees to our partners' internship programs over the years, in aspects such as field operations, environmental education, research, and monitoring.

One important limitation for retaining those trained human resources is that VRR is a project that expands and contracts seasonally. The number of full-time, year-round employees of VRR is three. During the autumn field season, we have nine staff members conducting migration counts, up to five in education programs, and up to five running the banding station. In some exceptionally well-funded field seasons, we have had as many as 25 paid personnel. At the end of each field season, some of these staff face unemployment and leave to continue their studies, go back to other jobs, return home, or otherwise move on.

An offer of internships and collaboration in other Pronatura projects has helped us retain some of these personnel for some time, but the turnover in personnel remains higher than what would be desired. Training project personnel in field sites in the US also has challenges, because trainees have to overcome language barriers and cumbersome immigration procedures to travel to training sites. Our efforts to help share these qualifications among similar projects has had some success: VRR has trained more than 10 colleagues now operating similar projects in Guatemala, Costa Rica, Panama, El Salvador, and elsewhere in Mexico.

A Renewable Fundraising System

Funding, particularly originating from renewable sources, is a resource difficult to secure for Mesoamerican projects. Laurie Goodrich and Sharon M. Gaughan brought the first Hawk Mountain birding group in the autumn of 1994, and with this tour they inaugurated our ecotourism program to help raise funds for VRR. The itineraries, organizational mechanisms, and many other details, operate to this date in basically the same way since this original tour. Robert Straub recently formalized much of this experience in his regional guide for birding sites in the state, published by Pronatura Veracruz in Spanish and English (Straub 2006).

Tours are fully organized or co-organized by a staff person in Pronatura, who sets itineraries, estimates costs, and makes all the logistical arrangements (such as transportation, housing, and meals), and provides a knowledgeable bilingual guide for the group. In many cases, the contact person in the co-organizing group in the US recruits most or all the tour participants, collects trip fees, and co-leads the tour group while in Veracruz. After tour expenses are paid

for, the net profits are shared among the two organizations. This has been an effective fundraiser for the project and covers nearly 30% of the annual budget of the project.

In 1995, Laurie Goodrich laid out the basics of another private, renewable fundraising mechanism: a membership program. "Amigos del Río de Rapaces" is a membership system directed to tour attendants that donate annually and receive a semiannual newsletter. Most tour attendees that have been exposed to VRR and Pronatura's work respond favorably to a follow-up membership request, and donate annually for a period typically ranging from 2-4 years. Some exceptionally loyal members have donated funds for over 10 years at the same or at an increased level. Membership dues account for 15-20% of the annual budget of VRR. Members receive a newsletter that gives them updates on VRR and other Pronatura programs. Such communication is important to maintain their interest. Within-country membership support has been low and could be expanded.

The private, renewable, funding base is augmented by grant money. Grants compose the second half of the budget, and, over the years, the National Fish and Wildlife Foundation, the U.S. Fish and Wildlife Service, Lannan Foundation, and the Fondo Mexicano para la Conservación de la Naturaleza have been the most notable funding partners (other sources are listed in the acknowledgments section).

VRR has been particularly successful in securing grants, and this fact has been critical in sustaining the project over the years. Professional donors, however, expect that over time grantees will move from a position of grant money dependence to a funding base from sustainable sources. VRR is aware of this fact and has made great efforts to increase non-grant funding over time, but some benchmarks (e.g., "new" private foundations covering large portions of the project, an increased participation of in-country donors) have remained virtually unchanged over many years, as opposed to reducing the grant-originated proportion of the total budget.

Private funding has never exceeded 50% of the annual project budget, and grant funding has largely originated from professional funding sources from the US for over 90% of the remaining needs. The annual budget of VRR ranges between $85, 000 and 100, 000 dollars a year (2008 figures). A net reduction in the budget, transforming cash needs into in-kind support, extending the partnership to more cooperators, and other strategies have only partially succeeded. Long-term funding continues to be one of the most important challenges facing VRR and the long-term conservation of raptors in this region.

Partnerships In Conservation

VRR has reached in many directions for formal partnerships to implement its conservation programs and to maintain its human and monetary resources. In many long-term projects, these aspects have received less attention than its conservation activities per se, and external support networks revolve around the personal affinities and connections of one or several individuals in the project. VRR has formalized collaboration agreements in written form (as MOUs or formal agreements) with a wide range of partners from local to international. These formalized agreements, which may at some point seem an unnecessary burden, have enabled the project to secure long-term continuity and to transcend the individuals working or leading VRR at a given time.

CONCLUDING REMARKS, LESSONS LEARNED, AND THE FUTURE OF VRR

Pete Marra and Scott Sillet recently stated in a meeting of the MIGRATE group in Ithaca NY: "assume yours will be a long-term project and take the necessary provisions" (MIGRATE is an NSF-funded network of scientists pursuing an integrated understanding of animal migration, http://www.migrate.ou.edu/). This piece of advice cannot be underestimated and even though it sounds logical, it is rarely taken into consideration by individuals running conservation projects and is not acknowledged by donors and other partners.

Before adding more adjectives of emphasis to these "necessary provisions" (and indentifying what they are), we would like to comment on some features of conservation projects that would increase the likelihood of effective long-term impact.

The first comes from our own problem of adjusting the "standard" North American migratory bird conservation tool kit to the conditions we found in Veracruz. In short, we have found that simple "translations" and "blue-print copies" of successful programs elsewhere do not suffice. Over time, we discovered that in order to develop a robust suite of conservation tools - one that is culturally, socially, and economically consistent with its regional context - it is necessary to innovate and experiment with novel approaches, in many cases through a trial and error system.

At the risk of sounding repetitive, we must stress that conservation at a local scale is a problem that has to be addressed at a local level.

Generalized solutions do not always fit well with local problems, and it often results in projects that deviate significantly from the standard concept.

One example of this is in the areas of emphasis of VRR: our project has been criticized for not addressing habitat conservation sufficiently or as a top priority. Over time, we have discovered that stopover habitat may not be the most acute problem for migratory raptor conservation in Veracruz, because the use of local patches of vegetation is ephemeral and, to some extent, unpredictable (Duncan et al. 2002). Moreover, the region has been gaining habitat, particularly within the last 10 years, due to the aforementioned large-scale economic policy overhaul of 1994 (but one that may soon change in the opposite direction due to the prospect of using local staple crops to generate biofuels).

In turn, we have devoted a significant amount of time and effort to population monitoring, because we have demonstrated that VRR data has the capacity to illustrate the demographic change of many raptor species at a continental scale (Bildstein et al. 2008). This is, in our perspective, the most important global contribution of our project.

Contrary to what the statistics of agrochemical use in this irrigation district may suggest, we have little evidence that contamination plays a major role limiting transient raptor populations. Raptor and other top-predator loss may not always be a habitat functionality problem, but one of direct persecution (Bildstein 2008). Because direct persecution may be an issue of higher importance, we believe education is a task that will help reduce it and contribute to lower other pressures.

One of the most important lessons that VRR has taught us, and one we would like to share with our colleagues operating conservation projects in Mesoamerica, is that the amount of effort that goes into sustaining a long-term project should not be underestimated, and that the costs of the support systems have to be factored in as part of standard operations. Fundraising, diversifying income sources, recruiting, training, planning, and organizing are tasks that will consume a large portion of a long-term conservation project. (In a calculation of hours of labor to maintain VRR made in 1999, we estimated that nearly 40% of our efforts went into sustaining its operations.)

This paper, reporting on a local case study, has particular significance when put into a broader context. VRR proudly belongs to a cohort of long-term bird conservation projects in Mesoamerica that started in the late 1980s and early 1990s, responding to the concerns over declines of Neotropical migratory birds raised by scientists (Robbins et al. 1989, Terborgh 1989).

These population declines prompted an energetic response of the conservation community in general, and coalitions such as Partners in Flight in particular have launched (and have successfully helped to sustain) independent, vigorous projects run primarily by not-for-profit conservation organizations.

Almost 20 years after these warning signs were raised, Neotropical migratory bird conservation outside North America is only starting to thrive, fueled by a generalized view that conservation of migratory birds is a shared international responsibility, one that must consider population limitations during the breeding, migration, and winter periods (Kirby et al. 2008). The tasks ahead for those projects are not simple are or easy to undertake, but we expect that this culture of collective commitment will help VRR to continue over the long-term.

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We should explicitly mention the sustained and incredibly generous contribution of Jennifer P. and Randolph C. Speers, George and Nancy Perkins, and the late Nancy Claflin over the years. Hawk Mountain Sanctuary has managed a system to process donations for VRR at zero cost. Robert Templeton has contributed significantly to VRR through his *Education Intern Resource Manual*, financial contributions, and in many other ways. The University of Missouri and John and Janice Faaborg supported the senior author during the analysis of VRR data.

It is impossible to personally thank all the field biologists, educators, and other people that have served VRR in different capacities,

but we would like to mention some individuals that have played critical roles "stabilizing" VRR work over time and sustaining its quality. Efraín Castillejos Castellanos, Octavio G. Cruz Carretero, Jorge E. Montejo Díaz, Zachary N. Smith, and Ruth Tingay worked diligently as field crew leaders for the monitoring team; James Dion and Larry D. Maynard carried on ecotourism and membership programs; and L. Fernando Rincón Ramos, Alexaldo García Miranda, and Julio Lobato coordinated the raptor banding station.

Pronatura Veracruz honors the significant contributions of Dr. Mario A. Ramos to ornithology and conservation in México by dedicating the Migratory Bird Observatory in Chichicaxtle on his memory. This is Hawk Mountain Sanctuary contribution to conservation science No. 180.

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