Twenty Years of Herping: Updated Visual Representation of Species Richness in New Mexico

Author(s): Vinicius Ortega-Berno, William A. Parish, and Ivana Mali
Source: The Southwestern Naturalist, 62(3):215-220.
Published By: Southwestern Association of Naturalists
https://doi.org/10.1894/0038-4909-62.3.215
URL: http://www.bioone.org/doi/full/10.1894/0038-4909-62.3.215

northern Great Plains (United States) paddlefish stocks within frameworks of Acipenseriform life history and the metabolic theory of ecology. Reviews in Fisheries Science 19:279–298.

Schwemm, M. R., A. A. Echelle, and J. D. Schooley. 2015. Fine-scale genetic structuring of American paddlefish populations in Oklahoma. Oklahoma Department of Wildlife Conservation, Oklahoma City, Final Report F14AF00156.

Zigler, S. J., M. R. Dewey, B. C. Knights, A. L. Runstrom, and M. T. Steingraeber. 2004. Hydrologic and hydraulic factors affecting passage of paddlefish through dams in the upper Mississippi River. Transactions of the American Fisheries Society 133:160–172.

Submitted 21 April 2017. Accepted 26 June 2017.
Associate Editor was Ingo Schlupp

The Southwestern Naturalist 62(3): 215–220

TWENTY YEARS OF HERPING: UPDATED VISUAL REPRESENTATION OF SPECIES RICHNESS IN NEW MEXICO

Vinicius Ortega-Berno, William A. Parish, and Ivana Mali*

Department of Biology, Eastern New Mexico University, Portales, NM 88130
Present address of VOB: Federal University of Paraná, Curitiba, PR, Brazil
**Correspondent: ivana.mali@enmu.edu*

Abstract—Based on herpetofaunal records, New Mexico is one of the most diverse states in the American Southwest. We visually summarized reptile and amphibian diversity in New Mexico using occurrence data from the past 20 years. We also identified patterns of species richness by county and discuss survey bias as a factor. In general, northwestern counties had the lowest number of species while central and southwestern regions had the highest numbers of species. We also recognized species-rich counties with few to no new county records in the past 20 years as areas that potentially reached survey saturation.

Resumen—Con base en registros de herpetofauna, Nuevo México es uno de los estados más diverso del suroeste de USA. Usando datos de ocurrencia de los últimos 20 años, resumimos visualmente la diversidad de anfibios y reptiles en el estado. También identificamos patrones de riqueza de especies por condado y discutimos posibles errores en los muestreos. En general, los condados al noroeste tuvieron el menor número de especies, mientras que las regiones del centro y suroeste presentaron los mayores números de especies. También reconocimos condados ricos en especies que poseen pocos o ningún registro de nuevas especies en los últimos 20 años como áreas en las que los muestreos han llegado a un nivel de saturación.

The effort to locate and record herpetofauna from previously unknown localities (i.e., Battaglia et al., 2015; Folt et al., 2015; Hudson et al., 2015) is an ongoing process. Making these new species distribution records public helps fill gaps in distributions and identify range expansions and species introductions. Unfortunately, differential survey strategies and efforts may introduce collecting biases. For example, survey sites are often chosen based on ease of access, which can be influenced by road availability because road survey is a commonly used technique in herpetofaunal studies (Langen et al., 2007). The data from even intensely surveyed states show that some regions might have been overlooked or undersurveyed (Brown et al., 2012; Price and Dimler, 2015). New Mexico is home to ≥123 species of reptiles and amphibians (Degenhardt et al., 1996), and has the second-highest diversity of lizard species in the southwestern United States (Jones and Lovich, 2009). Unfortunately, of these 123 species, 32 reptile and 15 amphibian species are listed as Species of Greatest Conservation Need by the New Mexico Department of Game and Fish. Furthermore, 6 amphibians and 16 reptiles are considered state threatened or endangered, 1 amphibian and 3 reptile species are federally threatened, and 1 amphibian species is federally endangered. Given these concerns, the scientific community should continue to monitor, record, and update the geographic distributions of herpetofauna in New Mexico.

Several guides serve as references of herpetofaunal diversity in New Mexico. Degenhardt et al. (1996) is the foundational guide, providing taxonomic keys, illustrations, and county records. More recently, Bartlett and Bartlett (2013) published a field guide with updated taxonomy, but more generalized taxonomic keys and distribution maps of lower resolution compared with Degenhardt et al. (1996). Our primary goal was to update the distribution maps and county records provided by Degenhardt et al. (1996) using new records from the literature. We used these data to create a visual summary of overall species richness per county and we summarized the county records within the past 20 years, to highlight recent changes. We purposefully used county record information to identify areas that are generally species-rich or -poor. Presentation of these data on the county map provides a visual illustration of where survey efforts should be focused in order to fill in distribution gaps in the future.

We compiled the amphibian and reptile county records in tabular Excel (Microsoft Corporation, Redmond, Washington) format using maps provided by Degenhardt et al. (1996). Based on these maps, we identified the counties occupied by each species. We also updated current records using *Herpetological Review* distribution records published from 1995 to 2016. *Herpetological Review* publishes new county records in the Geographic Distribution section and represents the most current data reference. We decided to use publications in *Herpetological Review* as the primary source of information because these data are publicly accessible, repeatable, and provide a conservative estimation of specimens recorded throughout the state. We combined these sources of information and calculated total number of species reported in each county.

We used a Geographic Information System (ArcMap 10.2.2) to visually represent species richness per county in three different ways. First, we downloaded a Topographically Integrated Geographic Encoding and Referencing shapefile of New Mexico counties from the web portal of the Sevilleta Long Term Ecological Research Program (http://sev.lternet.edu/). We modified the layer's attribute table to add the total number of species per county, the total number of species per county per unit area, and the number of new records per county in the past 20 years. Based on these attributes, we created three thematic maps that visually represent species richness. For the total number of species per county, we used natural breaks method (Jenks, 1967) to classify the data into eight categories: 23–28, 29–35, 36–42, 43–47, 48–51, 52–64, 65–75, and 76–87. However, when we normalized the data by the county size, we depicted Los Alamos County as an outlier. Los Alamos County is approximately 34 times smaller than the average of all counties in New Mexico, and therefore we excluded it from normalization process. For the number of new records in the past 20 years, we also used natural breaks method, but classified the data into five categories: 0–1, 2–3, 4–5, 6–7, and 8–10.

There were 1,634 records among the 33 counties of New Mexico. The total number of species per county ranged from 23 (Taos County) to 87 (Hidalgo County), with a mean of 49.5. Species richness of herpetofauna was the highest in the southern and southwestern regions (Fig. 1A), especially in Hidalgo County ($n = 87$) and Grant County ($n = 75$). Northern counties showed the lowest species richness, ranging from 23 (Taos County) to 34 (Rio Arriba County). Northeastern (i.e., Union County) and southwestern (i.e., Sierra County) regions had higher species richness per unit area, as did the northcentral region (i.e., Santa Fe and Bernalillo counties; Fig. 1B).

In the past 20 years, *Herpetological Review* published 103 new county records for 23 amphibians and 80 reptiles (see Appendix). Cibola ($n = 7$), Lincoln ($n = 9$), and Otero ($n = 10$) counties had the highest number of records (Fig. 1C). Bernalillo and Colfax had no new county records. Scientists reported five new county records for desert massasauga (*Sistrurus catenatus*), which is the highest number of new county records for any species. False map turtle (*Graptemys pseudogeographica*) in Sierra County, Yaqui black-headed snake (*Tantilla yaquia*) in Hidalgo County, and spotted chorus frog (*Pseudacris clarkii*) in Quay County represent new state records.

There is an increasing need for species distribution data across various taxa to monitor biodiversity changes; however, such data can often be survey-biased (Reddy and Dávalos, 2003; Boakes et al., 2010; LaDuc and Bell, 2010). In this article, we visually represent overall herpetofaunal species richness in New Mexico. However, the observed species-richness variation could be related to potential biases in survey effort. For example, the northwestern counties have the lowest numbers of species reported and there were few new records in these counties, potentially demonstrating an undersurveyed area. In support of our speculation, this region is underdeveloped and has a high proportion of reservation land in comparison with the rest of the state. Furthermore, northwestern counties are surrounded by counties with an above-average number of species reported, calling for further investigation of the northwest.

Therefore, our data suggest that the species-poor counties in the northwestern region of New Mexico are undersurveyed and actually have more species than what is currently known. We should recognize that land use may be affecting species diversity. For example, eastern New Mexico is known for agricultural practices, private land ownership, and limited state and federal lands in comparison with the rest of the state. Similarly, lower species richness was also recorded in counties of the Texas panhandle (Ward et al., 1990; Brown et al., 2012) that also are highly used for agricultural practices. Nonetheless, it could be appealing to herpetologists from both Texas and New Mexico to determine if these areas are truly species-poor or are an artifact of reduced effort.

Brown et al. (2012) pointed out that Texas species

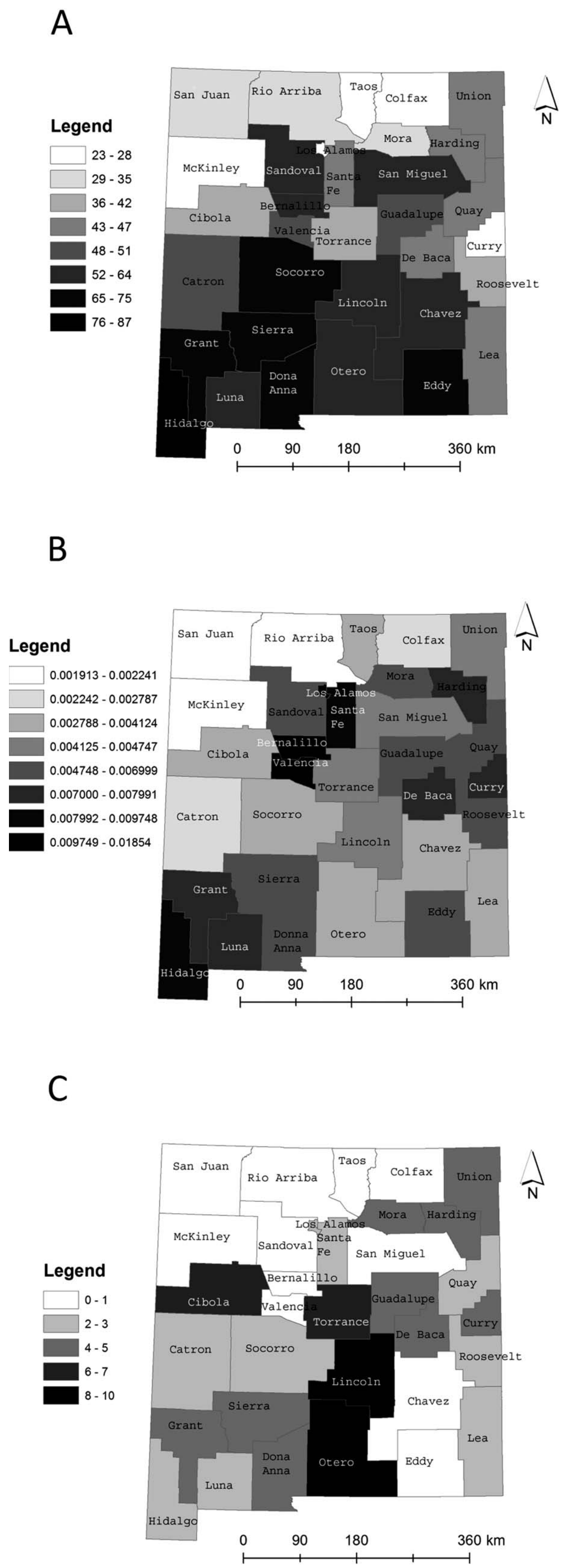

Fig. 1—Herpetofaunal species richness in New Mexico presented as the number of species per county (A), herpetofaunal species richness in New Mexico presented as the number of species per square kilometer per county (B), and number of herpetofaunal county records in New Mexico published from 1995 to 2016 (C).

richness per county correlated with distance from large universities. We identified similar trends in the data from New Mexico. For example, University of New Mexico and New Mexico State University are located in particularly species-rich counties, Bernalillo ($n = 56$) and Dona Ana ($n = 69$), respectively. Not surprisingly, Los Alamos and Santa Fe counties that surround University of New Mexico are also species-rich. In addition, Western New Mexico University is in Grant County, the second-most species-rich county ($n = 75$). New county records have not been reported in Bernalillo County, potentially suggesting that survey efforts have reached saturation, with the major driver for surveys in this county being the Museum of Southwestern Biology. However, just to the west, there were seven new records in Cibola County. The large disparity between the two counties might reflect urbanization and county size, given that Bernalillo County is smaller and highly urbanized in comparison with Cibola County.

Reptiles and amphibians are key indicators of ecosystem health and provide an important role in maintaining biological diversity. Despite their importance, reptiles and amphibians are often underrepresented in the scientific literature (Christoffel and Lepczyk, 2012). Reports on distributional records represent valuable information about the regional diversity of ecosystems, especially for rare and endangered taxa. It is worth pointing out that 24 of the recent county records in New Mexico represent species of "greatest conservation need." Our method of visually representing species richness can be useful to researchers, private land owners, and conservation and management agencies when conducting research, constructing new infrastructure developments, or implementing regional management regimes.

We thank D. I. Thompson for her help with data organization. We also thank L. J. S. Pierce, D. J. Brown, and M. W. Vandewege for reviewing the manuscript and providing useful comments and all herpetology enthusiasts who continue to update species distributions.

Literature Cited

Bartlett, R. D., and P. P. Bartlett. 2013. New Mexico's reptiles and amphibians: a field guide. University of New Mexico Press, Albuquerque.

Battaglia, C. D., C. R. Faidley, A. N. Hudson, M. D. Brown, T. M. Pardue, M. L. Reid, A. A. Bass, C. L. Townsend, and J. L. Carr. 2015. Distribution records for Louisiana amphibians and reptiles. Herpetological Review 46:579–581.

Boakes, E. H., P. J. K. McGowan, R. A. Fuller, D. Chang-qing, N. E. Clark, K. O'Connor, and G. M. Mace. 2010. Distorted views of biodiversity: spatial and temporal bias in species occurrence data. PLoS Biology 8(6):e1000385. doi:10.1371/journal.pbio.1000385.

Brown, D. J., J. R. Dixon, and M. R. J. Forstner. 2012. Visual summary of herpetofaunal diversity in Texas. Southwestern Naturalist 57:465–467.

Christoffel, R. A., and C. A. Lepczyk. 2012. Representation of herpetofauna in wildlife research journals. Journal of Wildlife Management 76:661–669.

Degenhardt, W. G., C. W. Painter, and A. H. Price. 1996. Amphibians and reptiles of New Mexico. University of New Mexico Press, Albuquerque.

Folt, B., D. Laurencio, J. M. Goessling, R. D. Birkhead, J. Stiles, S. Stiles, A. T. Harris, and S. Belford. 2015. One hundred two new county records for amphibians and reptiles in Alabama, USA. Herpetological Review 46:591–594.

Hudson, B. D., Z. I. Felix, J. Oguni, B. Wilson K. D. McEntire, T. Stratmann, D. D. Duff, and Z. Seymour. 2015. New geographical distributional records of amphibians and reptiles in Georgia, USA. Herpetological Review 46:595–596.

Jenks, G. F. 1967. The data model concept in statistical mapping. International Yearbook of Cartography 7:186–190.

Jones, L. L. C., and R. E. Lovich. 2009. Lizards of the American Southwest: a photographic field guide. Rio Nuevo Publishers, Tucson, Arizona.

LaDuc, T. J., and C. J. Bell. 2010. Educating students on the importance of spatial and temporal bias in museum collections: an example using *Sonora semiannulata* from Texas. Herpetological Review 41:292–297.

Langen, T. A., A. Machniak, E. K. Crowe, C. Mangan, D. F. Marker, N. Liddle, and B. Roden. 2007. Methodologies for surveying herpetofauna mortality on rural highways. Journal of Wildlife Management 71:1361–1368.

Price, M. S., and T. M. Dimler. 2015. New distributional records for herpetofauna of Texas. Herpetological Review 46:605–607.

Reddy, S., and L. M. Dávalos. 2003. Geographical sampling bias and its implications for conservation priorities in Africa. Journal of Biogeography 30:1719–1727.

Ward, R., E. G. Zimmerman, and T. L. King. 1990. Multivariate analyses of terrestrial reptilian distribution in Texas: an alternate view. Southwestern Naturalist 35:441–445.

Submitted 18 September 2016. Accepted 20 July 2017.
Associate Editor was Geoffrey Carpenter.

Appendix—Specific county records published in *Herpetological Review* from 1995 to 2016.

Year	Volume	Issue	Species	County
1995	26	1	*Anaxyrus punctatus*	Roosevelt
1995	26	4	*Elaphe guttata emoryi*	Socorro
1996	27	4	*Lampropeltis triangulum celaenops*	Grant
1996	27	4	*Sistrurus catenatus edwardsii*	Otero
1996	27	4	*Sistrurus catenatus edwardsii*	Torrance
1997	28	1	*Diadophis punctatus*	Otero
1997	28	1	*Heterodon nasicus nasicus*	Cibola
1997	28	1	*Kinosternon flavescens flavescens*	Socorro
1997	28	1	*Scaphiopus couchii*	Cibola
1997	28	3	*Pseudacris triseriata*	Cibola
1998	29	1	*Arizona elegans*	Guadalupe
1998	29	1	*Aspidoselis uniparens*	Cibola
1998	29	1	*Anaxyrus speciosus*	Otero
1998	29	1	*Lampropeltis getula californiae*	San Juan
1998	29	1	*Lampropeltis triangulum celaenops*	Guadalupe
1998	29	1	*Salvadora grahamiae*	Torrance
1998	29	2	*Holbrookia maculata bunkeri*	Dona Ana
1998	29	2	*Lampropeltis getula splendida*	Lincoln
1998	29	2	*Masticophis flagellum*	Los Alamos
1998	29	2	*Elaphe guttata emoryi*	Otero
1998	29	4	*Crotalus atrox*	Union
1998	29	4	*Crotalus molossus*	Torrance
1998	29	4	*Thamnophis sirtalis*	Chaves
1999	30	1	*Masticophis bilineatus*	Catron
1999	30	2	*Sceloporus undulatus speari*	Dona Ana
1999	30	4	*Hypsiglena torquata*	Harding
1999	30	4	*Leptotyphlops dulcis*	Otero
2000	31	1	*Gastrophryne olivacea*	Union
2000	31	1	*Sistrurus catenatus edwardsii*	Hidalgo
2000	31	2	*Aspidoscelis tigris*	Lincoln
2000	31	2	*Aspidoscelis velox*	Mora
2000	31	2	*Aspidoselis uniparens*	Otero
2000	31	2	*Eumeces obsoletus*	Harding
2000	31	2	*Leptotyphlops dulcis dissectus*	Mora
2000	31	2	*Leptotyphlops humilis*	Lincoln
2000	31	2	*Rhinocheilus lecontei*	Lincoln

Appendix—Continued.

Year	Volume	Issue	Species	County
2000	31	2	*Salvadora grahamiae*	Harding
2000	31	2	*Sceloporus magister*	Lincoln
2000	31	2	*Uta stansburiana*	Lincoln
2000	31	3	*Tantilla yaquia*	Hidalgo
2000	31	4	*Crotalus oreganus cerberus*	Grant
2000	31	4	*Diadophis punctatus*	Guadalupe
2000	31	4	*Heterodon nasicus*	Mora
2000	31	4	*Trachemys scripta*	Union
2001	32	1	*Sceloporus undulatus tedbrowni*	Roosevelt
2001	32	2	*Chrysemys picta bellii*	Santa Fe
2001	32	3	*Chelydra serpentina*	Debaca
2001	32	3	*Diadophis punctatus*	Debaca
2001	32	3	*Masticophis taeniatus*	Debaca
2002	33	1	*Hemidactylus turcicus*	Sierra
2002	33	1	*Leptotyphlops dulcis*	Lincoln
2002	33	1	*Trimorphodon biscutatus*	Grant
2002	33	3	*Aspidoscelis neomexicana*	Debaca
2003	34	2	*Craugastor augusti*	Dona Ana
2003	34	2	*Eumeces multivirgatus*	Mora
2003	34	2	*Hemidactylus turcicus*	Otero
2003	34	3	*Hyla arenicolor*	Union
2003	34	4	*Anaxyrus debilis insidior*	Sierra
2003	34	4	*Anaxyrus punctatus*	Rio Arriba
2003	34	4	*Chelydra serpentina*	Torrance
2003	34	4	*Crotalus lepidus*	Socorro
2003	34	4	*Salvadora deserticola*	Otero
2003	34	4	*Thamnophis marcianus*	Lincoln
2003	34	4	*Trachemys gaigeae*	Dona Ana
2004	35	4	*Aspidoscelis neomexicana*	Lincoln
2005	36	1	*Hyla eximia*	Cibola
2005	36	1	*Hypsiglena torquata*	Cibola
2005	36	1	*Phrynosoma modestum*	Torrance
2005	36	1	*Tropidoclonion lineatum*	Curry
2005	36	2	*Anaxyrus punctatus*	Torrance
2006	37	4	*Coluber constrictor flaviventris*	Guadalupe
2006	37	4	*Phrynosoma cornutum*	Sandoval
2007	38	1	*Anaxyrus woodhousii woodhousii*	Lea
2007	38	1	*Lampropeltis triangulum celaenops*	Luna
2007	38	1	*Scaphiopus couchii*	Guadalupe
2007	38	2	*Lithobates blairi*	Dona Ana
2008	39	1	*Sistrurus catenatus edwardsii*	Santa Fe
2008	39	4	*Hyla arenicolor*	San Miguel
2008	39	4	*Lithobates catesbeianus*	Mora
2008	39	4	*Elaphe guttata emoryi*	Sierra
2009	40	1	*Sceloporus jarrovii*	Grant
2010	41	3	*Hyla wrightorum*	McKinley
2010	41	4	*Anaxyrus debilis insidior*	Curry
2010	41	4	*Scaphiopus couchii*	Curry
2010	41	4	*Tropidoclonion lineatum*	Otero
2011	41	3	*Aspidoscelis teselata*	Lea
2011	41	4	*Nerodia erythrogaster*	Quay
2011	42	2	*Sistrurus catenatus*	Debaca
2011	42	4	*Aspidoscelis neomexicana*	Roosevelt
2011	42	4	*Crotalus molossus*	Valencia
2012	43	1	*Graptemys pseudogeographica*	Sierra
2012	43	1	*Lithobates catesbeianus*	Taos
2012	43	1	*Pseudacris clarkii*	Quay
2012	43	4	*Anaxyrus microscaphus*	Luna

Appendix—Continued.

Year	Volume	Issue	Species	County
2012	43	4	*Cophosaurus texanus*	Cibola
2012	43	4	*Sceloporus poinsettii*	Luna
2012	43	4	*Spea bombifrons*	Catron
2013	44	2	*Tropidoclonion lineatum*	Eddy
2014	45	3	*Trachemys scripta elegans*	Lea
2015	46	1	*Arizona elegans*[a]	Los Alamos
2015	46	1	*Crotalus atrox*	Curry
2015	46	1	*Crotalus viridis*	Harding
2016	47	3	*Lampropeltis alterna*	Otero

[a] This specimen was later reexamined and determined to be *Elaphe guttata emoryi* county record (*Herpetological Review*, 2017, Vol. 48, No. 2).

The Southwestern Naturalist 62(3): 220–225

TOURISM, WASTEWATER, AND FRESHWATER CONSERVATION IN PALENQUE NATIONAL PARK, MEXICO

Krista A. Capps,* María Mercedes Castillo, Allison A. Pease, Aarón Jarquín-Sánchez, and Rocío Rodiles Hernández

Odum School of Ecology, University of Georgia, Athens, GA 30602 (KAC)
Savannah River Ecology Laboratory, Aiken, SC 29802 (KAC)
Departamento de Ciencias de la Sustentabilidad, El Colegio de la Frontera Sur, Villahermosa, Tabasco, CP 86280, México (MMC, AJS)
Department of Natural Resources Management, Texas Tech University, Lubbock, TX 79409 (AAP)
Departamento de Conservación de la Biodiversidad, El Colegio de la Frontera Sur, San Cristóbal de las Casas, Chiapas, CP 29290, México (RRH)
**Correspondent: kcapps@uga.edu*

Abstract—As human population densities grow around the boundaries of protected areas in lower-income economies, there are frequently concomitant increases in environmental degradation. The purpose of this study was to examine water chemistry and the isotopic signatures of primary consumers in streams in and around a national park in the tropics to document whether park watersheds were affected by untreated wastewater. Three of the six study sites had concentrations of soluble reactive phosphorus >39 μg/L. Additionally, there was a strong, positive correlation between δN^{15} values of grazing snails and phosphorus concentrations of the water, suggesting that sewage effluent is influencing trophic ecology in the protected aquatic habitats. The results from this study lend support to recent calls for management beyond riparian buffers for conservation of freshwater ecosystem integrity in protected areas.

Resumen—A medida que las densidades de población humana crecen alrededor de las fronteras de las áreas protegidas en las economías de bajos ingresos, con frecuencia hay aumentos concomitantes en la degradación ambiental. El propósito de este estudio fue examinar la química del agua y las firmas isotópicas de los consumidores primarios en arroyos dentro y alrededor de un parque nacional en los trópicos para documentar si las cuencas del parque fueron impactadas por aguas residuales no tratadas. Tres de los seis sitios de estudio tenían concentraciones de fósforo reactivo soluble >39 μg/L. Además, hubo una fuerte correlación positiva entre los valores de δN15 de los caracoles de pastoreo y las concentraciones de fósforo del agua, lo que sugiere que el efluente de las aguas residuales está influyendo en la ecología trófica en los hábitats acuáticos protegidos. Los resultados de este estudio dan apoyo a las recientes convocatorias de