WEST Inc.

Environmental & Statistical Consultants

Wind-Wildlife Issues in Latin America: Biological Perspectives

Caleb Gordon, Ornithologist/Latin America Group Leader

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Latin American Wind-Wildlife Projects, WEST, Inc.

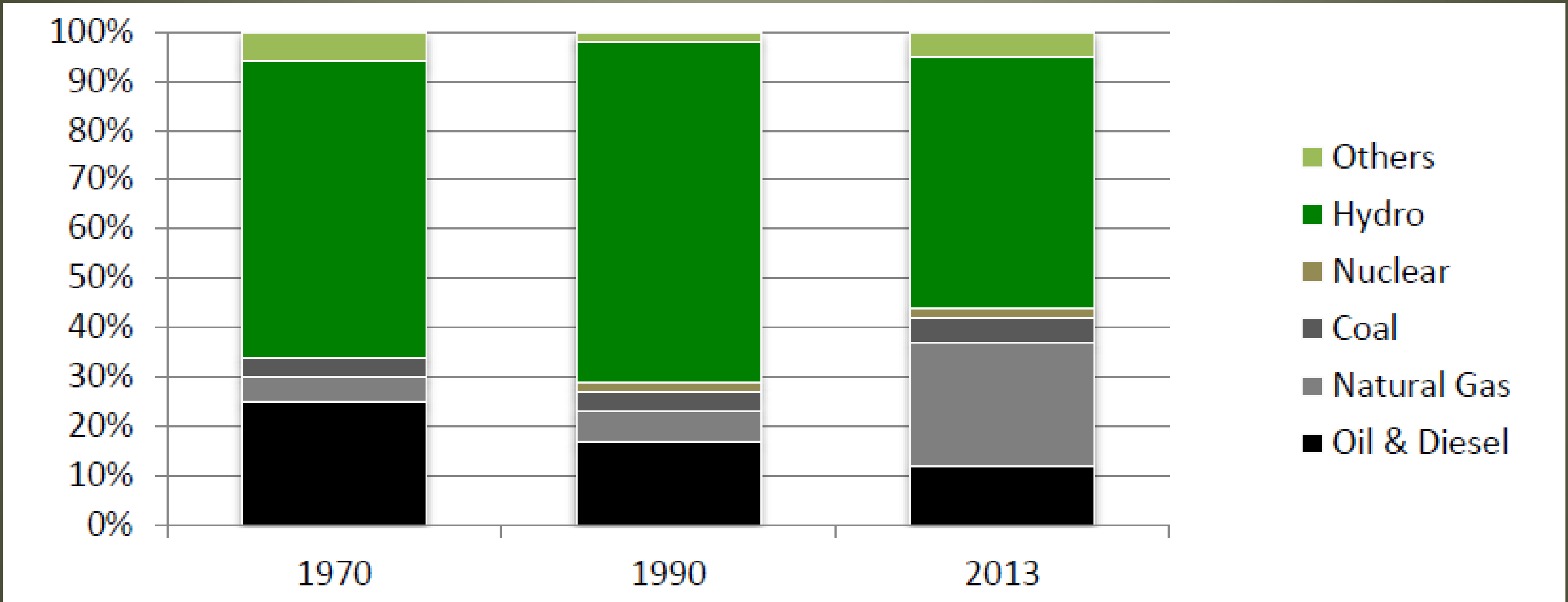
- **Leverage 20+ years working on over 500 renewable energy projects in US; very large and experienced renewable energy-wildlife impact science group**
- **Project-specific work on 15 Latin American Wind Energy Facilities in four countries**
- **Pre- and Post-construction field and desktop studies of bird and bat risk/impacts**
- **3rd party review**
- **Work for Multilateral Development Banks as well as project developers**

Talk Outline

- Overview of renewable energy development, and bird and bat diversity in Latin America
- Summary of emerging data and patterns in Latin American wind-wildlife studies
- What do we mean when we talk about "population level" effects, and how much direct mortality does it take to get there?

The Low-Carbon Latin American Energy Mix

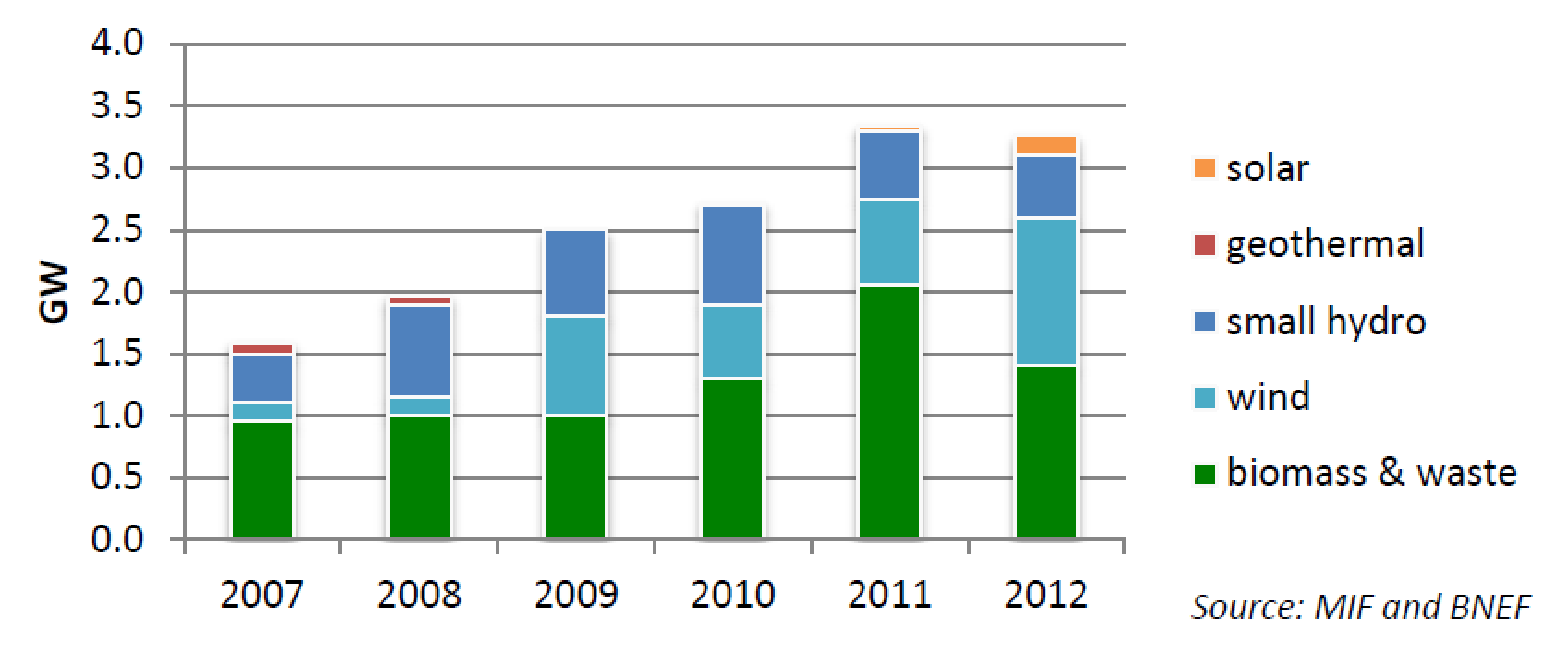
Electricity Generation By Source in Latin America (IDB Member Countries)



Source: InterAmerican Development Bank 2014, Study on the Development of the Renewable Energy Market in Latin America and the Caribbean

Recent Growth in Wind and Solar in Latin America

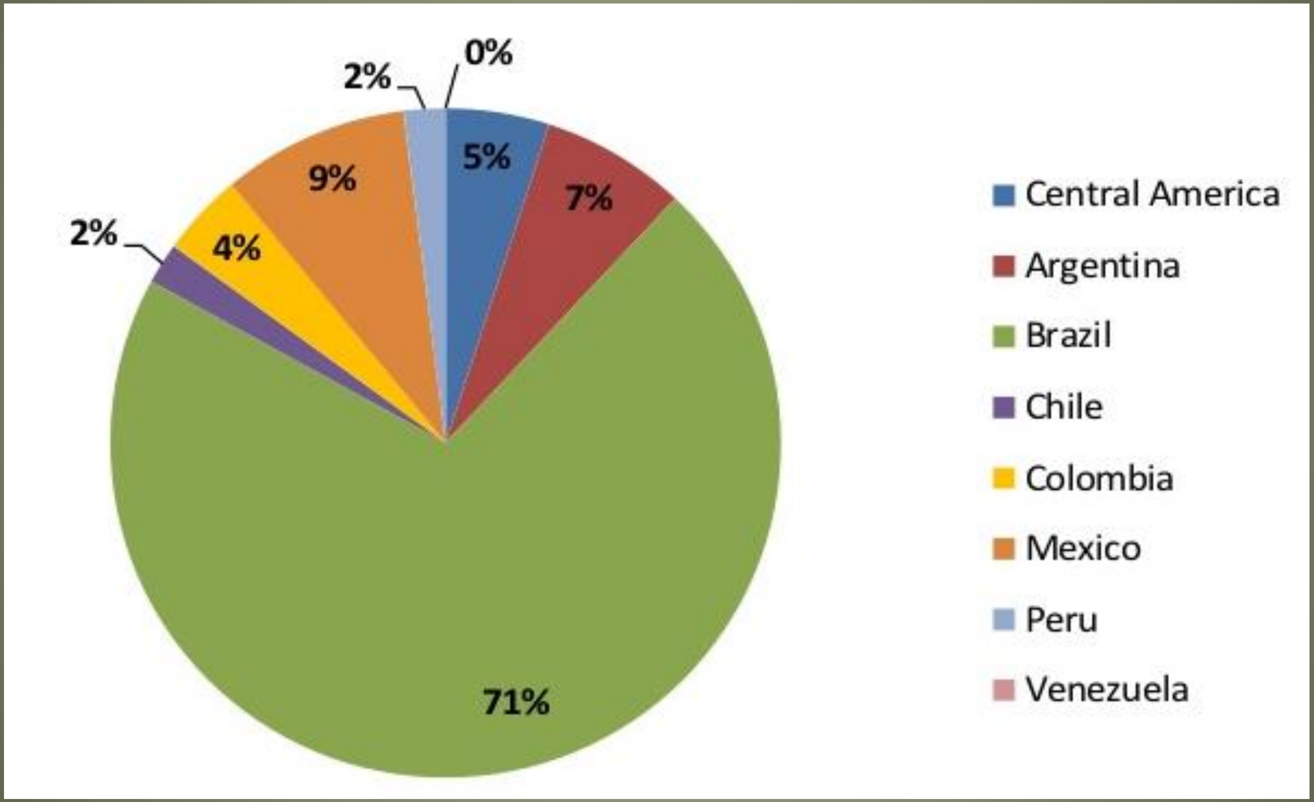
New Renewable Energy Installations By Source and by Year in Latin America (IDB Member Countries)



Source: InterAmerican Development Bank 2014, Study on the Development of the Renewable Energy Market in Latin America and the Caribbean

Geography of Latin American Renewables

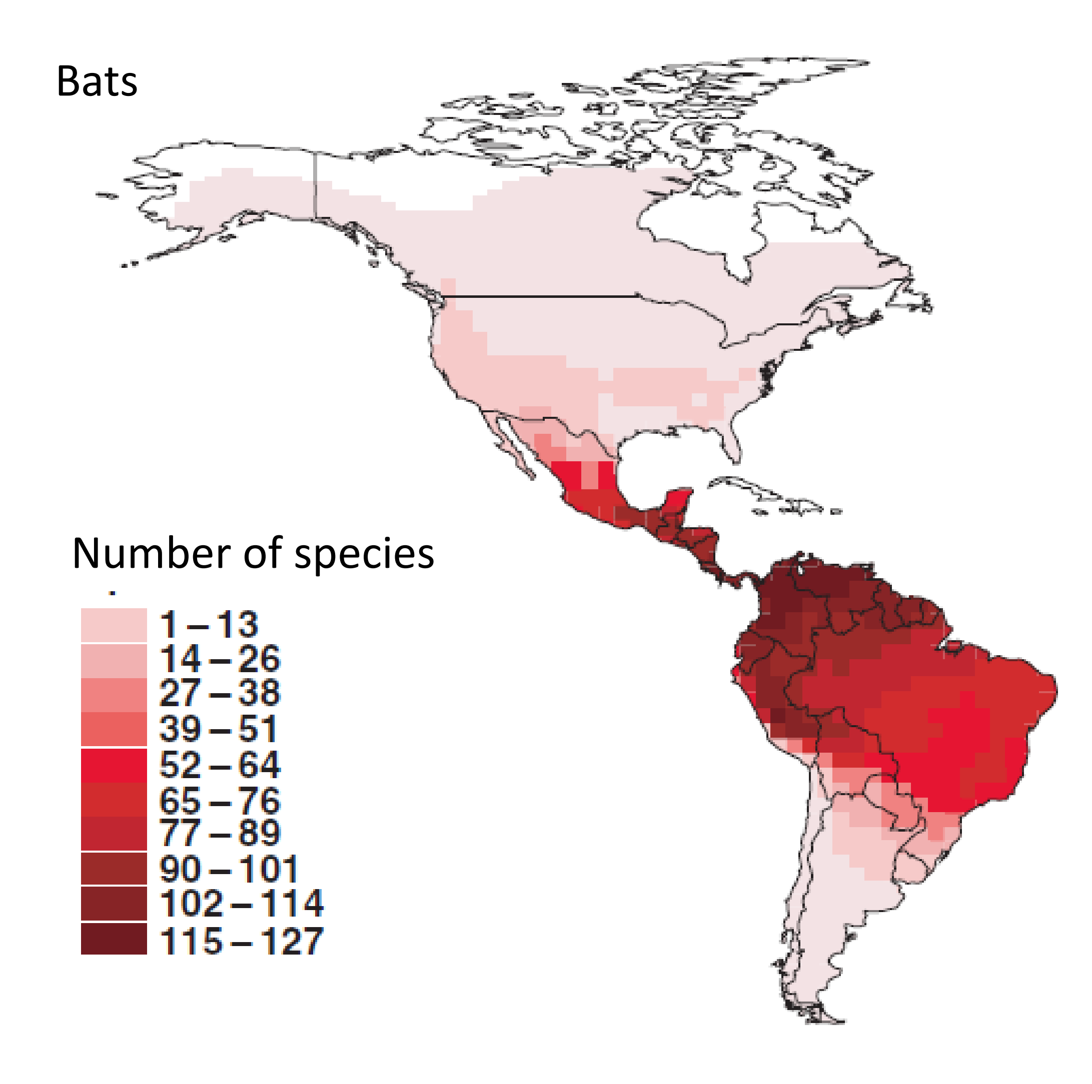
Latin American Renewable Energy Installed Capacity by Country



Source: Jannuzzi, G. M. 2011, Renewable Energy for Electricity Generation in Latin America: the market, technologies and outlook. International Energy Initiative

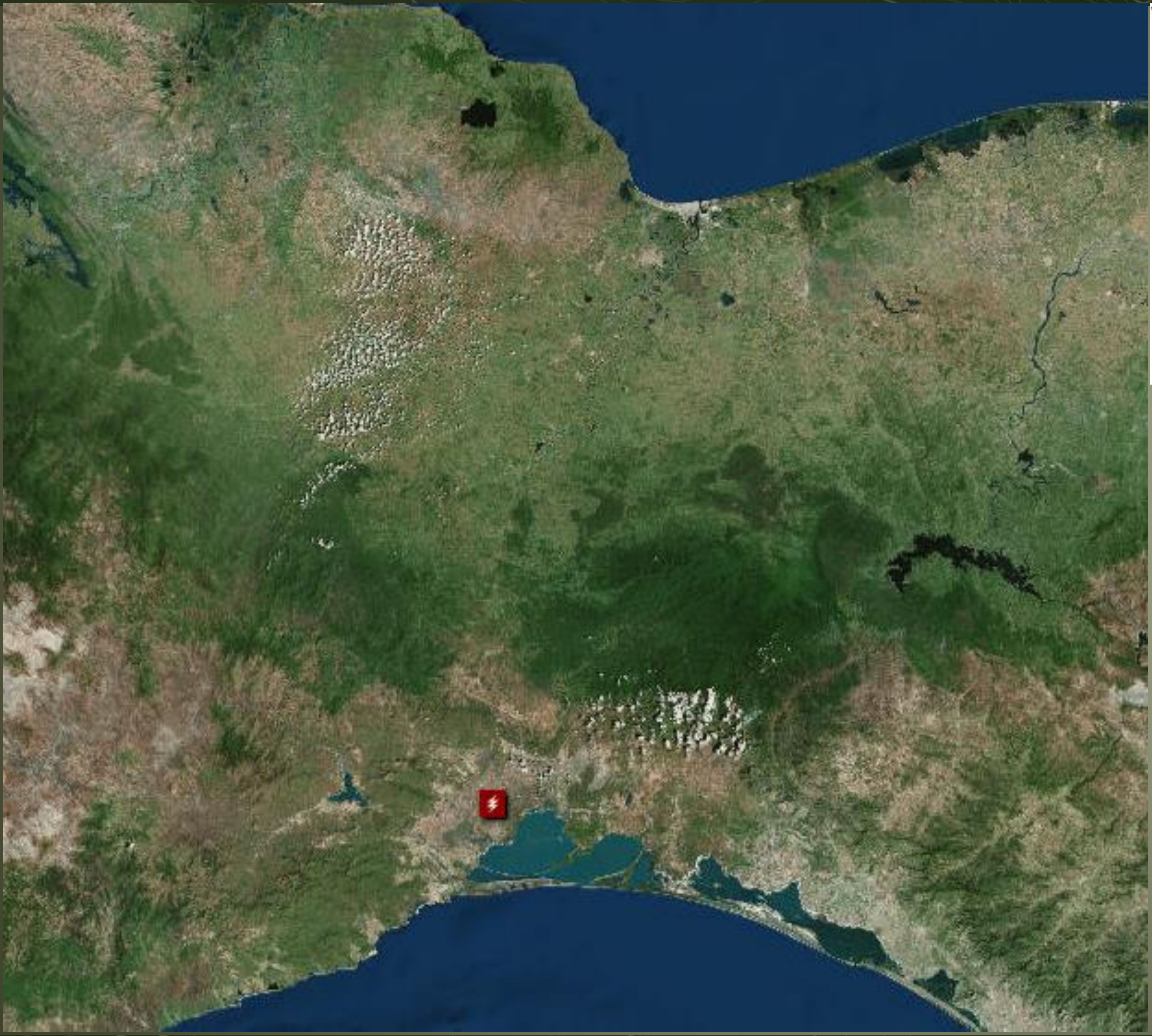
Latin America has substantially more bird and bat species than do the US and Canada

Source: Hawkins, B. A., J. A. F. Diniz-Filho, C. A. Jaramillo, and S. A. Soeller. 2006. Post-Eocene climate change, niche conservatism, and the latitudinal diversity gradient of New World birds. Journal of Biogeography 33: 770-780.



Source: Andelman, S. J., and M. R. Willig. 2003. Present patterns and future prospects for biodiversity in the Western Hemisphere. Ecology Letters 6:818-824

La Venta II Wind Project, Isthmus of Tehuantepec, Oaxaca, Mexico



- Constructed 2007 by CFE
- 83.3 MW capacity (98 turbines)
- World Bank funding, rigorous environmental requirements
- Post-construction bird and bat studies by INECOL researchers (Villegas-Patraca et al.)
    - Bird and bat fatality monitoring
    - Migratory raptor flight path studies

Bat fatalities at La Venta, Oaxaca, Mexico 2007-2010

Sources:

Comisión Federal de Electricidad. 2008. Monitoring Report Covering the First Year of the Crediting Period: July 1, 2007-June 30, 2008. Report presented to the Clean Development Mechanism (CDM), United Nations Framework Convention on Climate Change. Accessed October 14, 2009. 16 pp. Available online at: http://cdm.unfccc.int/Projects/DB/AENOR1168204945.7/view

Comisión Federal de Electricidad. 2009. Monitoring Report: La Venta II. Covering the Second Year of the Crediting Period: July 1, 2008-June 30, 2009. Available online at: http://cdm.unfccc.int/Projects/DB/AENOR1168204945.7/view

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	Carcasses					
Bat Species	Fall 2007	Spring 2008	Fall 2008	Spring 2009	Jul - Nov 2009	Jan - Nov 2010
Lasiurus cinereus			1			
Lasiurus intermedius	X		11	4	5	1
Lasiurus ega					2	1
Lasiurus spp.				1	4	
Vespertilionidae spp.			2			
Balantiopteryx plicata	X		1			
Balantiopteryx spp.			1			
Eumops bonariensis			1			
Eumops underwoodi					1	
Eumops spp.	X					
Molossus molossus	X	X	7	3	5	1
Molossus rufus			1	1	2	1
Molossus sinaloae				2	3	7
Cynomops mexicanus	X					
Tadarida brasiliensis						1
Nyctinomops macrotis						1
Molossus spp.				1	1	3
Molossidae spp.						1
Mormoops megalophylla	X	X	10	7	2	3
Pteronotus davyi	X	X	30	22	9	34
Pteronotus gymnonotus						1
Pteronotus parnellii		X		1	1	4
Pteronotus personatus				1		
Pteronotus spp.		X				
Phyllostomus discolor				1		
Artibeus jamaicensis					1	
Artibeus intermedius	X		1		1	
Artibeus tolteca						1
Centurio senex	X		2	3	1	5
Glossophaga soricina	X		1	1		1
Glossophaga morenoi			1			
Glossophaga spp.			1			
Leptonycteris curasoae						2
unidentifiable		X	14	11	14	15

Vespertilionidae
3 spp, 33 indiv.

Emballonuridae
1 spp, 3 indiv.

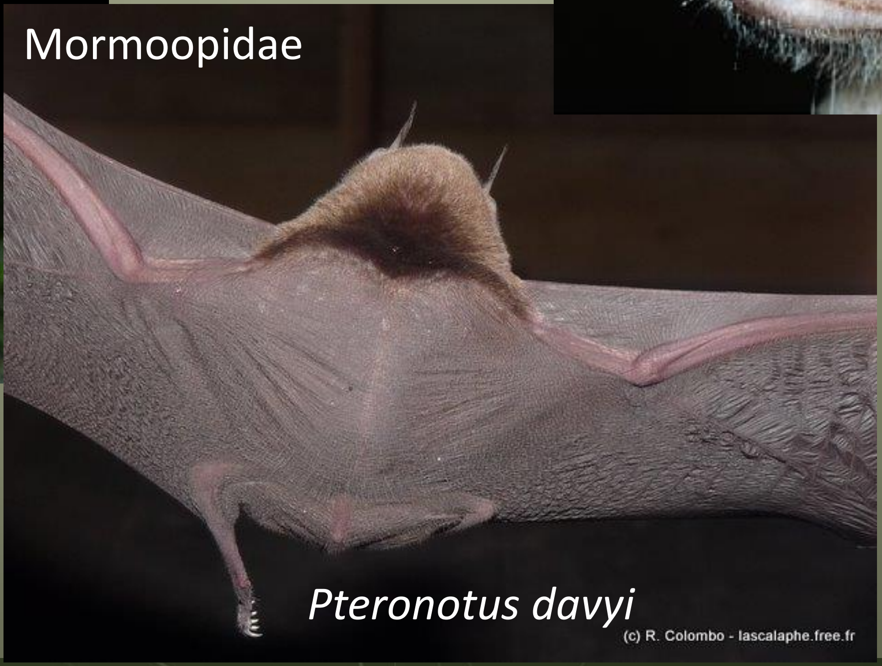
Molossidae
8 spp, 47 indiv.

Mormoopidae
5 spp, 131 indiv.

Phyllostomidae
8 spp, 26 indiv.

Latin American Bat Taxa of Interest for Wind Energy

Micronycteris microtis



Eumops perotis

Bird fatalities at La Venta, Oaxaca, Mexico 2007-2010

Sources:

Comisión Federal de Electricidad. 2008. Monitoring Report Covering the First Year of the Crediting Period: July 1, 2007-June 30, 2008. Report presented to the Clean Development Mechanism (CDM), United Nations Framework Convention on Climate Change. Accessed October 14, 2009. 16 pp. Available online at: http://cdm.unfccc.int/Projects/DB/AENOR1168204945.7/view

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Bird Species	Carcasses					
	Fall 2007	Spring 2008	Fall 2008	Spring 2009	Jul - Nov 2009	Jan - Nov 2010
Black-bellied Whistling-Duck				2		
West-Mexican Chachalaca	X					
Northern Bobwhite		X	3	1		5
Great Egret				1		
Turkey Vulture	X	X	1	4	1	2
Gray Hawk						3
White-tailed Hawk	X	X		1		
Uniform Crake			1			
Double-striped Thick-knee						1
Whimbrel	X					
Inca Dove				1		
Common Ground-Dove		X				4
White-tipped Dove	X	X	3	2	1	2
White-winged Dove			2		2	2
Yellow-billed Cuckoo	X					
Mangrove Cuckoo					1	
Groove-billed Ani						2
Lesser Nighthawk		X				
Eastern Whip-poor-will					1	
Ruby-throated Hummingbird	X					
Broad-billed Hummingbird						1
Golden-fronted Woodpecker						1
American Kestrel	5				2	
Ash-throated Flycatcher						1
Tropical Kingbird						1
Scissor-tailed Flycatcher			2			
Warbling Vireo					1	
Barn Swallow				1		
White-lored Gnatcatcher		X				
Black-and-white Warbler				1		
Blackburnian Warbler	X					
Yellow Warbler	X					
Wilson's Warbler	X	X				
Yellow-breasted Chat		X				3
Stripe-headed Sparrow	X					
Hepatic Tanager				1		
Great-tailed Grackle	X					2
Cowbird sp.	X					
Streak-backed Oriole						1
unidentified bird			2	3	3	4

- Many species, few individuals
- No migrant raptors
- Terrestrial birds
- No parrots
- Nocturnal migrants

Latin American Bird Taxa of Interest for Wind Energy

Parrots

Yellow-naped Amazon

Resident Raptors

White-tailed Hawk

Special Vultures

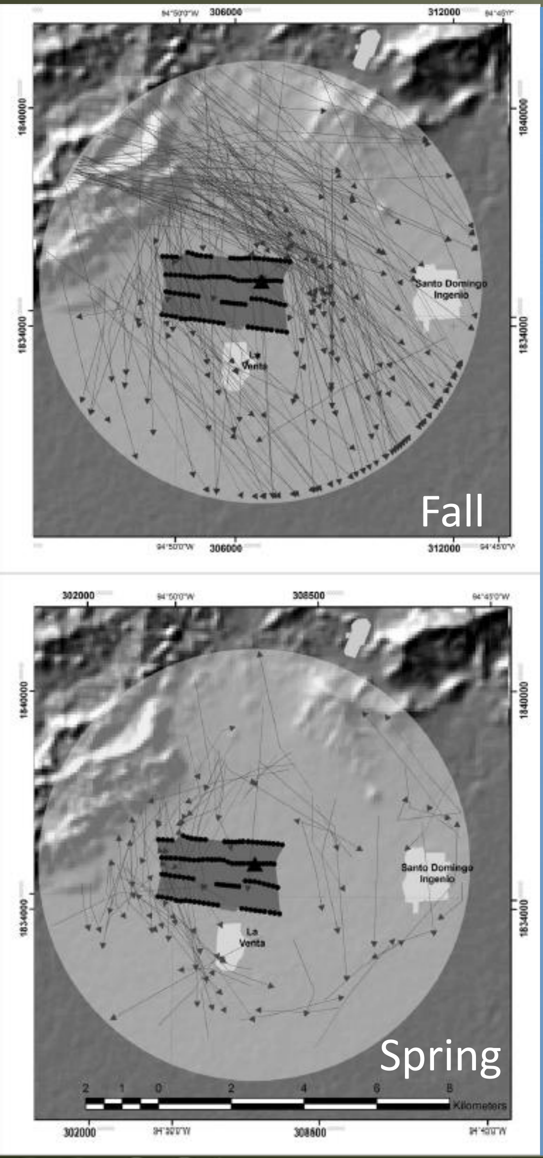
King Vulture

Andean Condor

Small Nearctic-Neotropical nocturnal migrants

Yellow-breasted Chat

Avoidance of La Venta II Wind Farm by Migrating Raptors



Source: Villegas-Patraca, R., S. A. Cabrera-Cruz, L. Herrera-Alsina, 2014. Soaring migratory birds avoid wind farm in the Isthmus of Tehuantepec, southern Mexico. PLoS ONE 9(3): e92462. doi:10.1371/journal.pone.0092462

Marine radar tracks of large soaring birds

Displacement effects

- One of the most important wind-wildlife effects in North America (e.g. prairie-dwelling grouse)
- No studies to date in Latin America (but see Villegas-Patraca et. al., 2012, Condor 114:711-719)

Red-winged Tinamou: Grassland specialist of the South American Pampas region

Population-level Effects

What do we talk about when we talk about "population-level" effects, and how much direct mortality does it take to get there?

Or

Direct Mortality: the least savory, and yet potentially most sustainable wind-wildlife effect

Population-level Effects

"Population-level" effect is key criterion for impact assessment

IFC (2012) Performance Standard #6:

"Significant conversion or degradation is…a modification that substantially minimizes the habitat's ability to maintain viable populations of its native species"

"In areas of critical habitat, the client will not implement any project activities unless…the project does not lead to a net reduction in the global and/or national/regional population of any Critically Endangered or Endangered species…"

Population-level Effects

"Population-level" effect is key criterion for impact assessment

IFC (2012) Guidance note 6 for Performance Standard #6:

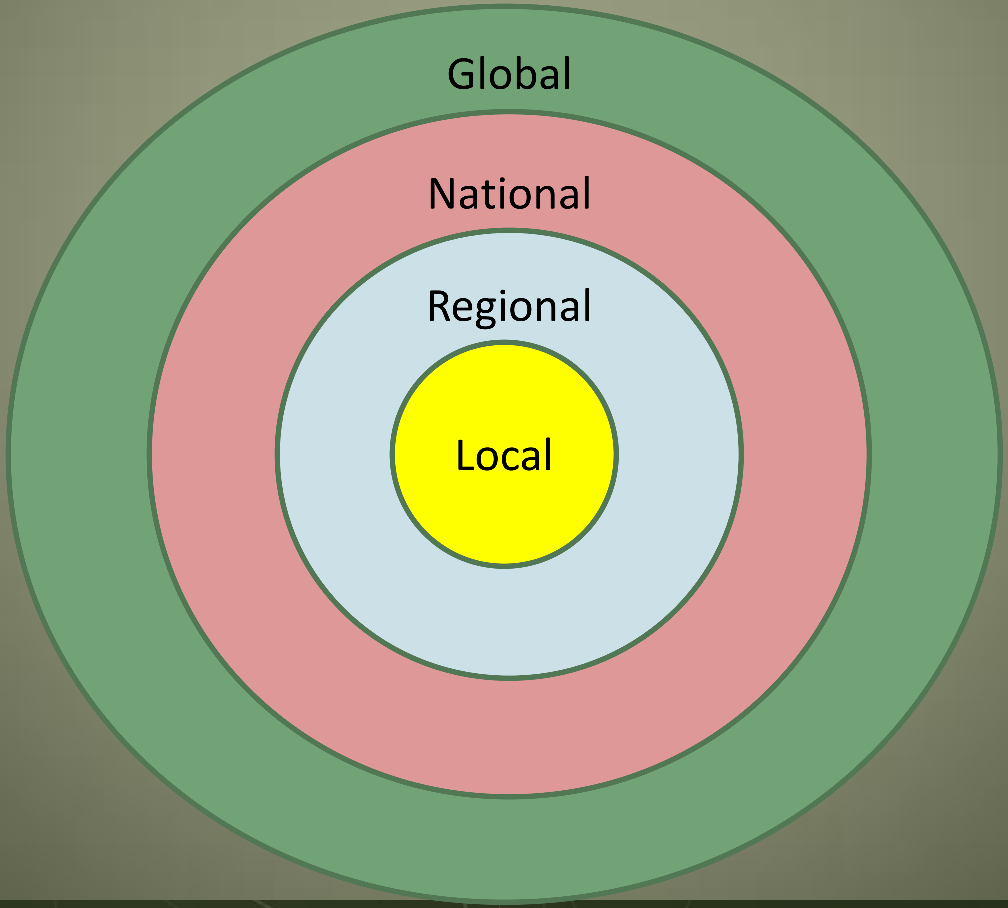
Criteria for determination of critical habitat based on fractions of global populations they contain.

Re demonstrating no net reduction in population:
"The acceptable reduction in population should also not be interpreted as the survival of every individual on-site…no net reduction is based on the species '*ability to persist at the global and/or regional/national scales for many generations over a long period of time.*' (emphasis in document)"

Population-level Effects

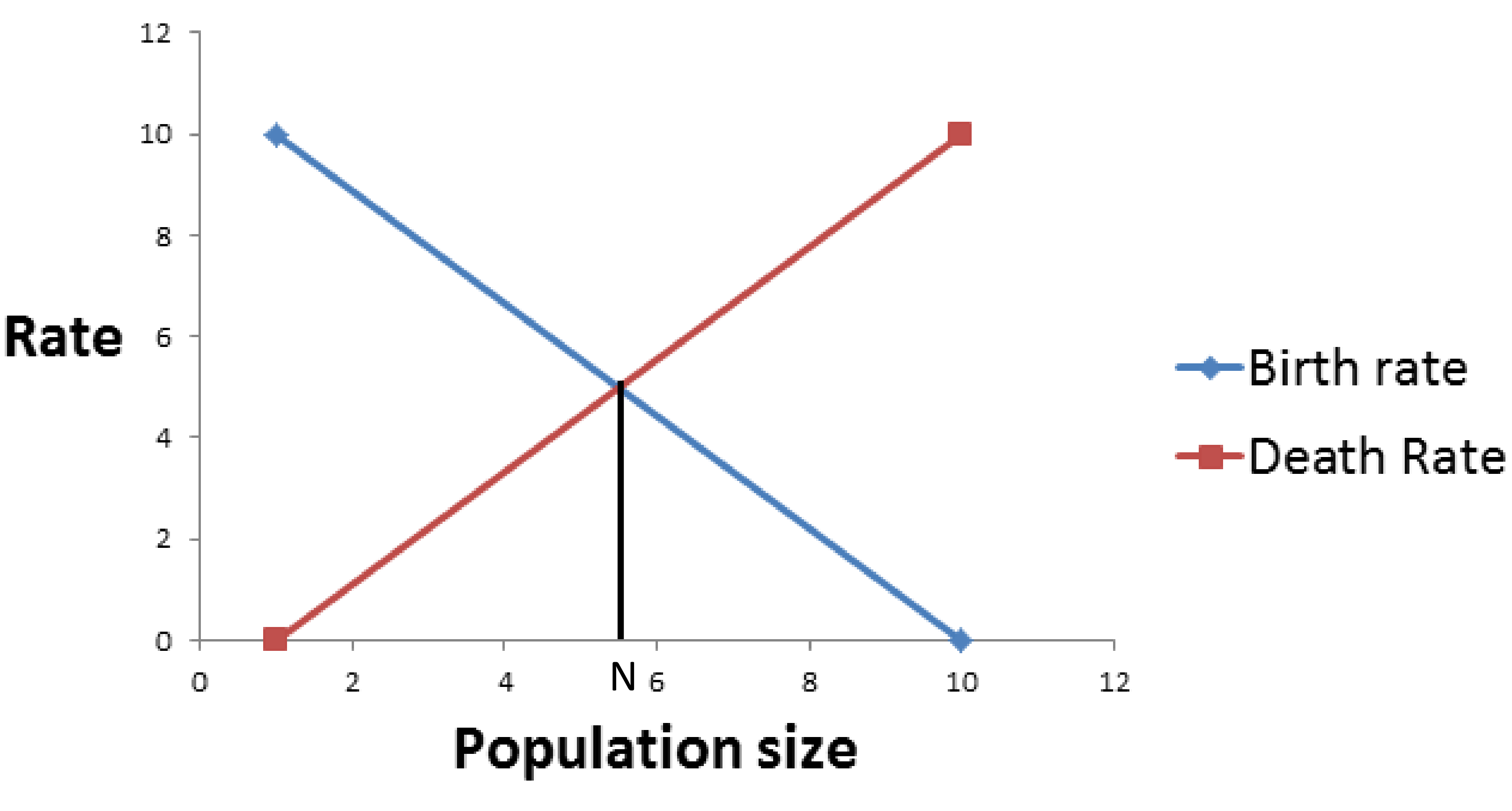
What is a population?

- Solid part: all individuals of a single species
- Fuzzy part: spatio-temporal boundaries



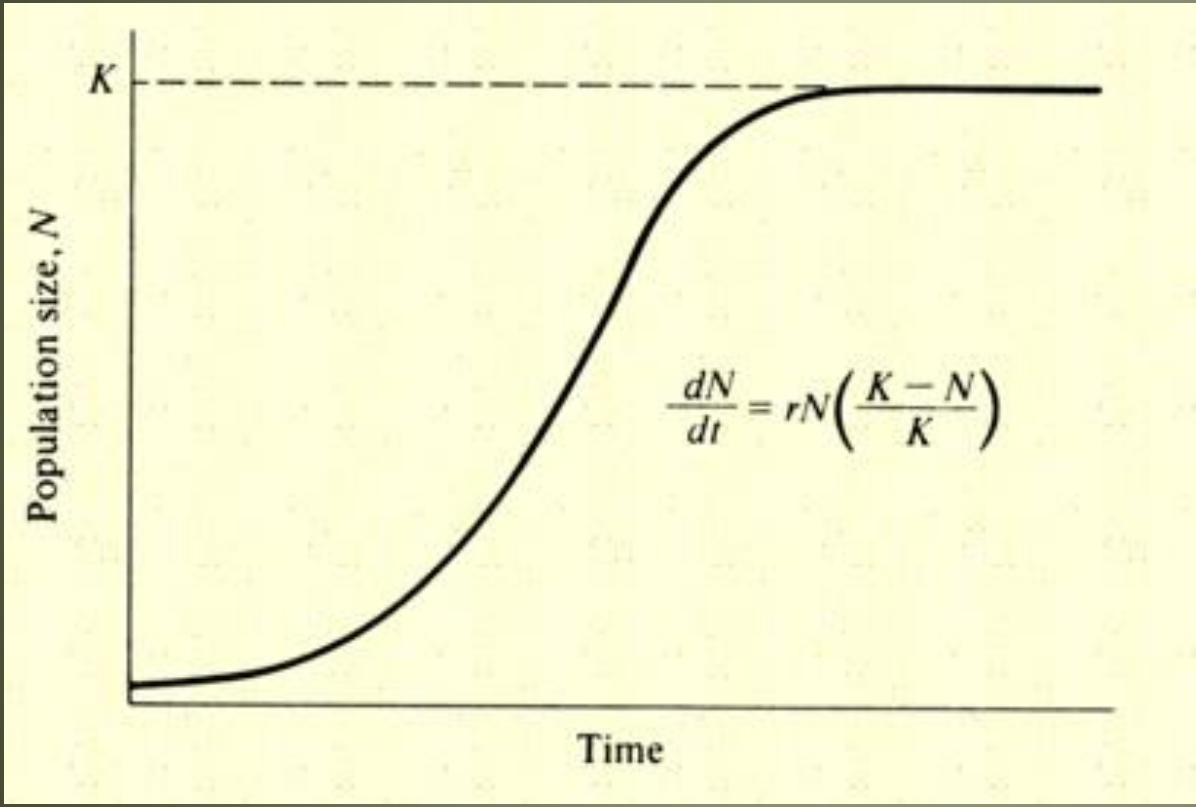
Population-level Effects

In the most basic dynamic model, population size (N) is a balance between birth and death rates



Population-level Effects

Why doesn't death rate appear in the basic ecological equation for equilibrium population size?



Take homes

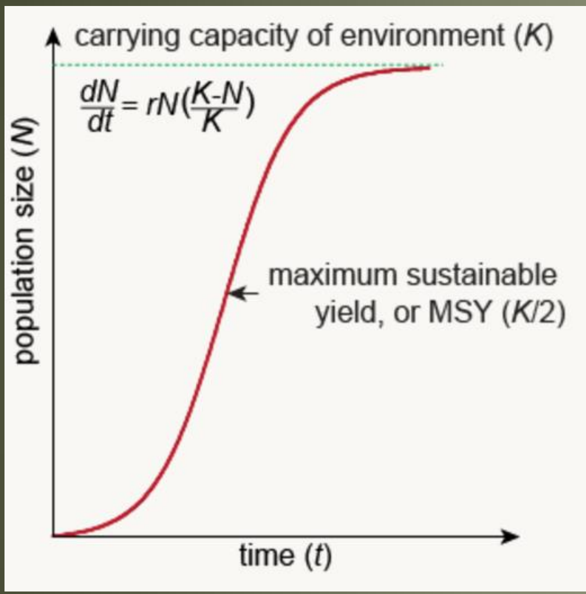
-Maintaining habitat quality and quantity is generally more important than collision fatality for sustaining pop'ns

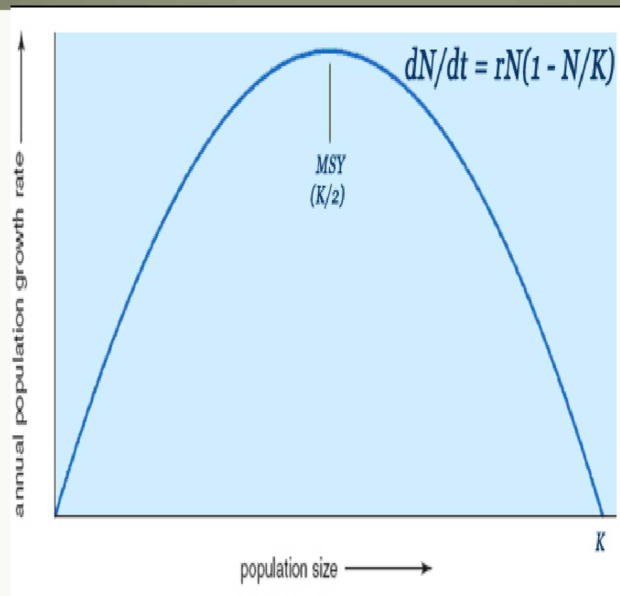
-Collision fatality is only likely to cause pop'n level effect where it is intense enough to overwhelm intrinsic growth rate (r)

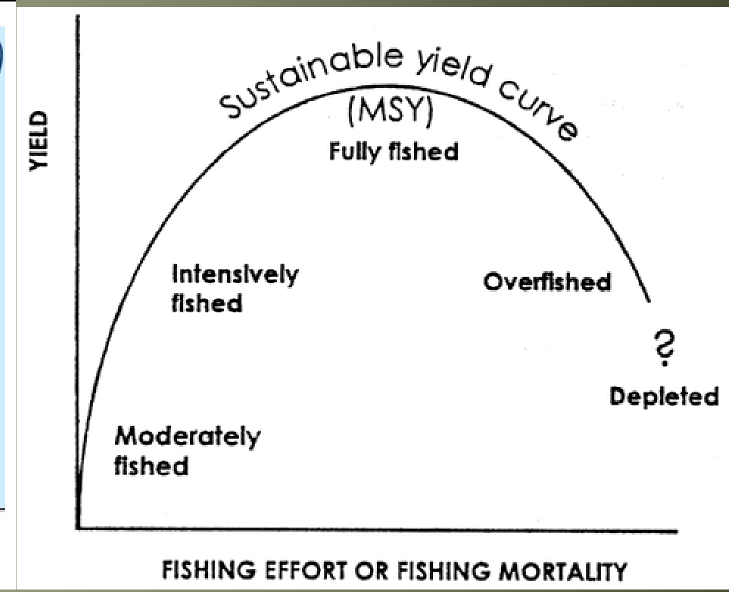
Because from an equilibrium perspective, death rate is irrelevant. Populations will always bounce back up to their equilibrium size (*N*), determined by the carrying capacity of the environment (*K*) at a speed determined by the population's intrinsic growth rate (*r*)

Population-level Effects

Concept of Maximum Sustainable Yield (MSY): in theory, a number of individuals equivalent to half of the environment's carrying capacity (K/2) can be "harvested" each generation without diminishing a population's capacity to replenish itself







Annual (2014) US waterfowl harvest numbers from USFWS

http://flyways.us/regulations-and-harvest/harvest-trends

Mallard	3,885,870
Green-winged Teal	1,745,930
Canada Goose	2,477,720
All ducks and geese combined	16,533,800

Total estimated annual bird fatality at US wind facilities, all species combined (Loss et al. 2013)

234,000

Population-level Effects

Determining sustainable fatality rates:

the challenge of estimating total population sizes

Solution for US waterfowl: Perform annual continent-wide census via aerial survey

http://flyways.us/regulations-and-harvest/harvest-trends; USFWS 2015, Waterfowl population status 2015

Species	2014 estimated US harvest	2014 total population size
Mallard	3,885,870	10,899,800
Green-winged Teal	1,745,930	3,439,900
Gadwall	1,581,570	3,811,000
American Wigeon	600,320	3,116,700
Northern Shoveler	702,000	5,278,900
Northern Pintail	465,970	3,220,300

Solution for most wildlife populations: Head-scratching, educated guesswork, and of course, statistics. Often in Latin America, or in the US for animals other than birds, we really can't make any substantiated statements about population sizes.

Population-level Effects

Determining sustainable fatality rates: the challenge of estimating total population sizes

US Breeding Bird Survey to the Rescue! Arnold and Zink (2011) compare data from building and tower bird collision studies to 44-year trend data from a continent-wide data set to ask the question, “Is collision susceptibility correlated with population trends for US bird species?”

Collision susceptibility: some species are found as collision fatalities at buildings and communication towers much more frequently than others in relation to population size. Variation across species in susceptibility to collisions with manmade structures (buildings, towers, wind turbines, power lines) is believed to be related to body size and shape, visual acuity, flight behaviors, and other factors.

“Colliders” various warblers, sparrows, brown creeper

“Avoiders” various swallows, horned lark, blue-gray gnatcatcher

Population-level Effects

Arnold and Zink 2011 Results:

-No relationship between relative vulnerability to collisions with towers and 44-year, continent-wide population trend among 188 species of US birds (p=0.83)

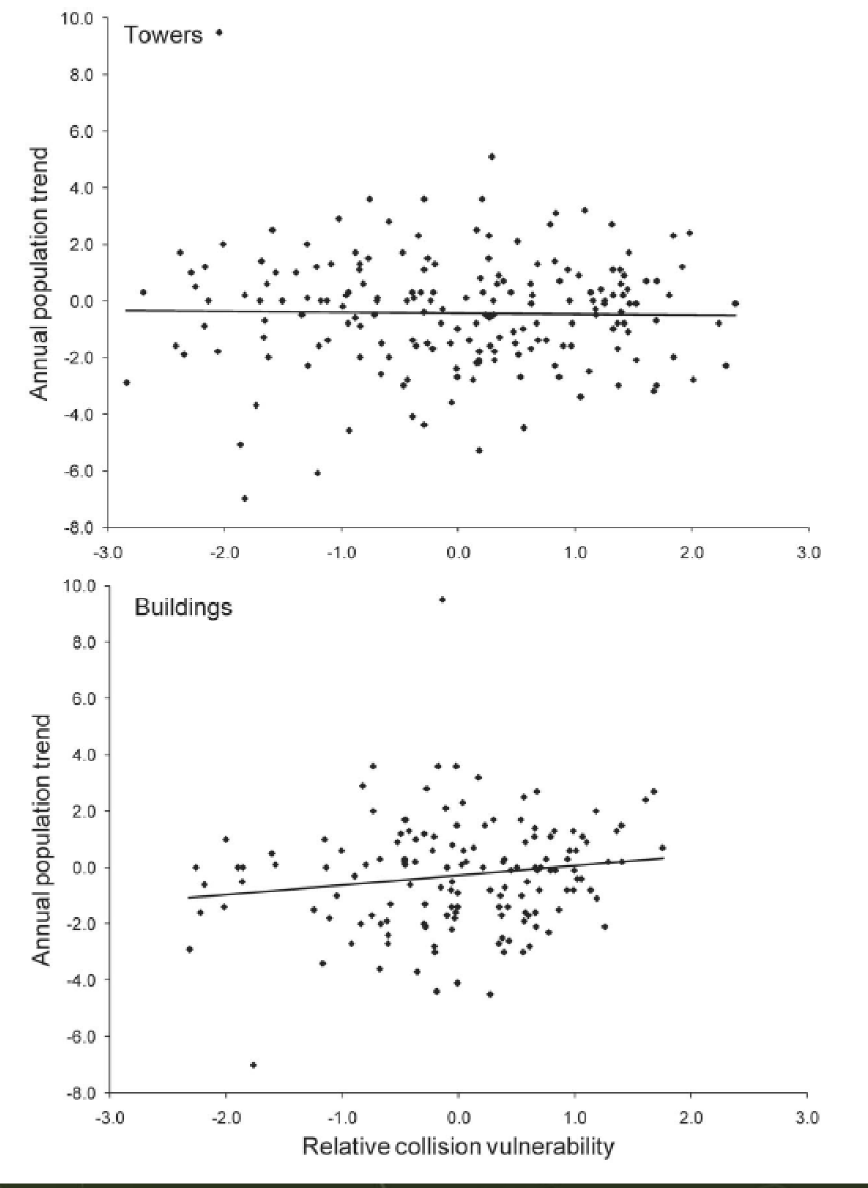
-Weak *positive* relationship between relative vulnerability to collisions with buildings and 44-year, continent-wide population trend among 147 species of US birds (p=0.06)

Conclusion: "although millions of North American birds are killed annually by collisions with manmade structures, this source of mortality has no discernible effect on populations"

but this study only looked at buildings and towers, what about wind turbines?

US collision fatality estimates from Loss et al. (2013,2014)

Wind turbines:	234,000 birds/year
Buildings	599,000,000 birds/year



Population-level Effects

So, can you remind me again why folks are concerned about flying wildlife fatalities at wind energy facilities?

- Even if generally unlikely, it is possible that wind farm fatalities could exert population-level impacts in some cases (though it has never been demonstrated)
    - Very small populations (e.g. critically endangered species)
    - Species with very slow reproduction (low *r)* e.g. bats, raptors, seabirds
    - Consideration of smaller populations scales (e.g. local pop'n) and larger impact scales (e.g. cumulative impacts) increase likelihood of pop'n impacts

- Total population size is so poorly known for most species that it's hard to be certain that populations can withstand x amount of fatality

- Population-level impact is not the only criterion for concern
    - Iconic species, bird fatality as a social issue
    - National or provincial laws that restrict or prohibit "take" (e.g. US ESA, MBTA, BGEPA)

- Collision of a bird or bat with a giant Cuisinart blade is a very tangible concept, offensive to many people with sentimental fondness for animals (also a social issue)

- It is not intuitive to understand that killing animals may not affect their populations west-inc.com

Corporate Headquarters

415 West 17th Street, Suite 200, Cheyenne, WY 82001
307.634.1756