Bird class people: See the article ("A Century of Change…"), p. 26.

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A Century of Change in Birds and Climate

The great California ornithologist Joseph Grinnell set out with a collecting party in May 1911 on a historic trek to the crest of the Sierra Nevada. His aim was to document the ranges of the mountains' wildlife at every elevation.

By railroad, automobile, stagecoach, pack mule, hiking, and climbing, Grinnell achieved the goal. In so doing, he left an unparalleled record enabling today's biologists to measure a century of bird species' distributional change.

In transects from the floor of the San Joaquin Valley to the peak of Mount Langley at nearly 14,000 feet, he listed all the birds and other animals he found. The results helped Grinnell to formulate his concept of the biological "niche"—the combination of environmental and behavioral factors governing species' distribution. More treks were to come, but early on he judged that temperature and precipitation are ultimate regulators of species' complex niches.

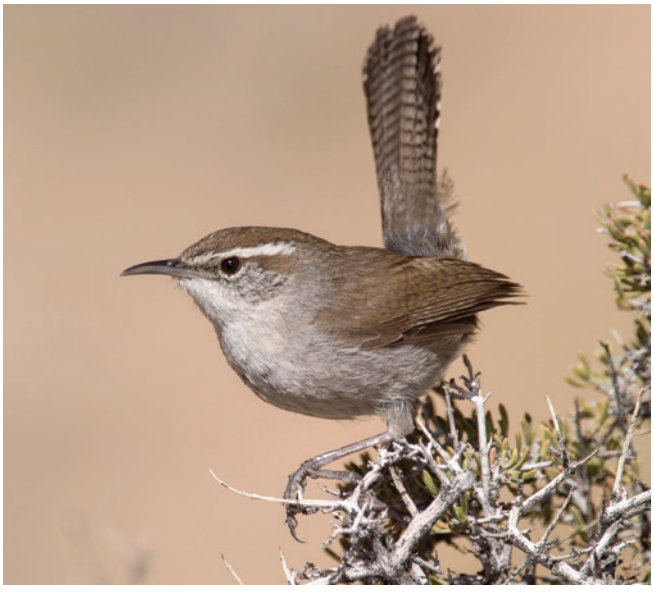
A century later, researchers at the University of California–Berkeley Museum of Vertebrate Zoology, where Grinnell had been the founding director, began to revisit three of his transects. Named the Grinnell Resurvey Project <mvz.berkeley.edu/Grinnell>, the study had two goals: first, to determine whether species' present-day elevational ranges have changed; second, to tease apart how any observed changes may be related to modern climate change.

Grinnell's detailed dataset proved to be an ample source for achieving the goals. The researchers found that high proportions of the bird species surveyed have evidently adjusted their distributions in accord with climatic factors. The findings appear in three studies by Morgan W. Tingley and colleagues.

First, Tingley, William B. Monahan, Steven R. Beissinger, and Craig Moritz compared the elevations of 53 species in Grinnell's surveys in 1911–1929 and resurveys of his transects in 2003–2008. Ranges of 48 of the species tracked changes in temperature, or precipitation, or both. Between the periods 1910–1930 to 1986–2006, average breeding-season temperatures at the transect sites increased from 15.2° C to 16.0° C (59° F to 61° F) and average precipitation increased from 19.0 mm to 24.9 mm (0.75 in to 0.98 in).

The authors reported in 2009 (*Proceedings of the National Academy of Sciences* 106:19637–19643) that relatively high-el-

Joseph Grinnell (1877–1939) prepares a specimen in a field tent, circa 1922, during one of his pioneering wildlife surveys in California. *© Image courtesy of The Bancroft Library, University of California–Berkeley.*



Resurveying routes taken by Joseph Grinnell a century ago, researchers have found that many bird species, such as the **Bewick's Wren,** have altered their distributions. Some of the distributional changes are correlated with long-term changes in temperature and/or precipitation. *Kern County, California; February 2004. Photo by © Bob Steele.*

evation birds such as Mountain Chickadees and Cassin's Finches have tended to track changes in temperature—but some shifted toward warmer and others toward cooler conditions. Relatively low-elevation birds, such as Western Kingbirds and Bewick's Wrens, generally tracked precipitation toward wetter locations. Meanwhile, five species—Anna's Hummingbird, Nuttall's Woodpecker, Black Phoebe, Western Scrub-Jay, and California Thrasher—did not track either factor.

Second, although the Sierra climate warmed in general during the past century, many changes in range did not conform to the conventional assumption that warming temperatures should push species upslope. Reality is not so simple.

In a 2012 paper (*Global Change Biology* 18:3279–3290), Tingley, Moritz, and Beissinger, along with Michelle S. Koo and Andrew C. Rush, further emphasize the diversity of species' responses. Comparing range limits of 99 species in Grinnell's records with the limits today, the authors found what they call a "push and pull": Rising temperatures pushed some species upslope and increasing precipitation pulled others downslope. Combined across all three transects, only 51% of species' range shifts were upslope; however, when temperature and precipitation were analyzed separately, 82% of the shifts were upslope or downslope in a direction predicted for either factor. Among species that moved upslope are Savannah Sparrow, Red-winged Blackbird, and Western Meadowlark. Those that moved downslope include low-elevation species, such as Ash-throated Flycatcher and Western Scrub-Jay, and high-elevation species, such as Red-breasted Nuthatch and Cassin's Finch.

Third, Tingley and Beissinger focused in a 2013 paper (*Ecology* 94:598–609) on species richness and turnover in entire avian communities. They found that richness (the number of species in an ecological community) decreased across the entire Sierra Nevada gradient during the past 80–100 years.

At 77 sites where historical and current richness were compared, 21 sites lost species and only seven sites gained species. Significant declines in estimated richness ranged from 4.6 to 15.0 species per site, and the declines were at the low and high extremes of elevation. One well-surveyed avian community, in Lassen National Forest, lost an estimated 12 or 13 ecologically diverse species, including Sooty Grouse, Calliope Hummingbird, Western Wood-Pewee, Hammond's Flycatcher, and Black-headed Grosbeak.

The authors noted that no study is likely to attribute declines entirely to climate change because many other factors could be involved. Nevertheless, Tingley and Beissinger consider the changes in richness to be at least partly due to shifting climatic patterns.

The question now, of course, is whether any or all of the changes will continue to expand and intensify. Regardless, the immense value of Grinnell's baseline is already obvious. In a 1910 essay in *The Popular Science Monthly* (77:163–169), Grinnell prophesied that its importance would not be realized "until the lapse of many years, possibly a century." How prophetic he was!

Cars and Cliff Swallows

It was 1928, the first full year of the Ford Model A. It was also the year when ornithologist Frederick C. Lincoln told American Ornithologists' Union members at their annual meeting, "The latest hazard for birds, as well as for men, appears in the automobile."

Instead of "appears *in* the automobile," we moderns might say "appears *to be* the automobile." Yet one of Lincoln's anecdotes did justify *in*. He told of an occasion when "a banded Catbird flew through an open window of an automobile and

Could natural selection be responsible for a trend toward shorter wings in **Cliff Swallows** that fly low over highways? Two authors suggest that shorter-than-average wing length might improve swallows' odds of survival by helping them to avoid colliding with vehicles. *Boulder County, Colorado; June 2013. Photo by © Bill Schmoker.*

was killed upon striking the closed window on the opposite side."

Lincoln's data on bird–vehicle collisions, published in 1931 (*Auk* 48:538–546), showed that most accidents at that time occurred in the breeding season. He suggested two reasons. First, "birds lose much of their customary caution and in their fervid pursuit of one another dash back and forth across the highways…" Second, "newly fledged young frequently congregate along the roads, where, lacking the skill and experience of their elders, they are not able to avoid the swift-moving traffic."

Since Lincoln's report, scores of ornithologists and ecologists have studied birds' collisions with vehicles, not only in the U.S. and Canada, but also in such far-flung places as Brazil, Sweden, and Tasmania. Clearly, cars are a worldwide concern. Other analyses have supported Lincoln's idea that birds "lacking the skill and experience of their elders" could explain why young birds are statistically more likely to be victims.

Now comes a proposition that natural selection may be offering Cliff Swallows a remedy. In a widely reported 2013 paper (*Current Biology* 23:233–234), Charles R. Brown and Mary Bomberger Brown described results of a 30-year study of Cliff Swallow social behavior and coloniality in southwestern Nebraska. Among their findings was a substantial decline in the frequency of road kills between 1983 and 2012.

The authors also found two factors correlated with the decline. During that period, the wing length of road-killed swallows was gradually averaging longer than the average in the overall local population. At the same time, wing length in the overall population was not merely stable; it was gradually averaging shorter and shorter.

It is an oft-cited aerodynamic effect that relatively short wings provide greater maneuverability in flight, enabling birds to change direction more quickly than birds with relatively long wings. Could natural selection be removing longer-winged swallows from the population and favoring shorter-winged individuals that are more likely to avoid collisions?

Not necessarily. Jeremy M. V. Rayner, an expert in the biomechanics of vertebrate flight, noted in his classic 1988 review, "Form and Function in Avian Flight" (*Current Ornithology* 5:1–66), that the aerodynamic effect refers primarily to wing shape, not to wing length alone. Short, rounded wings characterize small passerines requiring maneuverability within the "dense clutter" of woodlands; long, pointed wings are characteristic of "agile, open-air species," such as swallows, which rely on this wing design for fast, prolonged aerial pursuit of prey.

In any case, could such selection for shorter wings take place so quickly? The Browns are circumspect in their interpretation. They discuss factors that could compromise their data and factors other than wing length that might be involved. They suggest only that the pattern of mortality should prompt researchers to consider the possibility of natural selection.

How different their circumspection is from headlines in popular media proclaiming cause and effect as if it were a known fact—and, even if true, that it represents evolution.

Consider three examples from nonscientific publications on the internet, which are both laughable and lamentable: "No More Road Kill: Evolution Helped Swallows Avoid Car Crashes," from *Die Welt*/Worldcrunch <tinyurl.com/Evolution-Helped>; "Birds Evolve Shorter Wings to Escape Traffic Crush," from Science Friday <tinyurl.com/BirdsEvolve>; "Birds Grow Shorter Wings to Help Avoid Car Collisions," from UK News <tinyurl.com/BirdsGrow>.