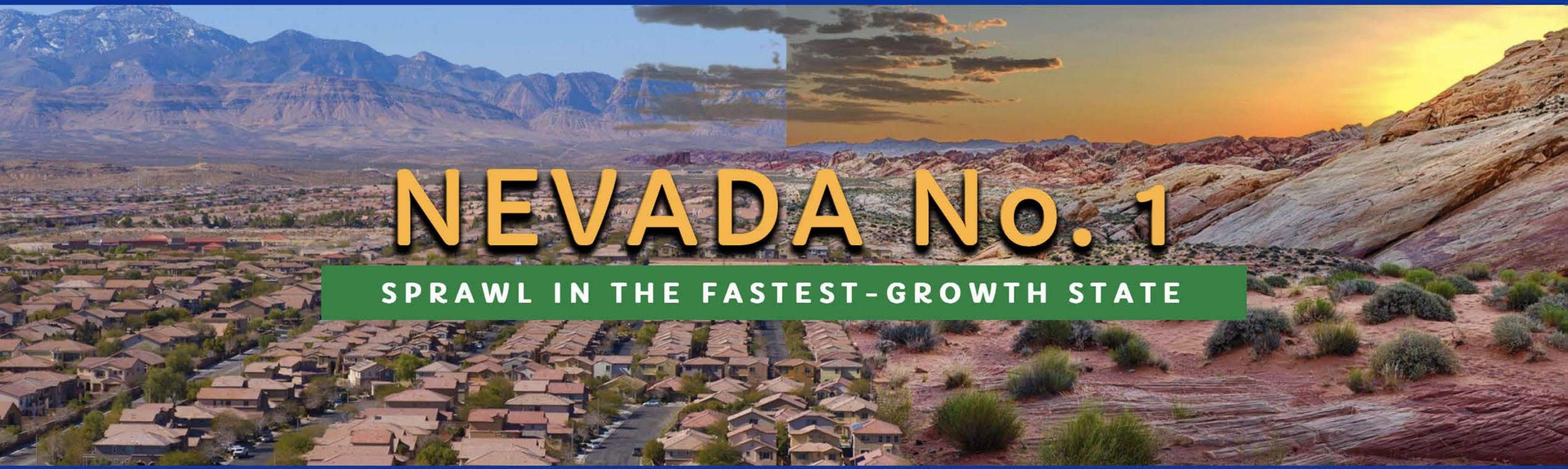
May 2024

NEVADA No. 1

SPRAWL IN THE FASTEST-GROWTH STATE

NumbersUSA
For sensible immigration

A Report by Leon Kolankiewicz and Roy Beck, with Eric A. Ruark



FINDINGS

www.NVSprawl.com

VOTER POLL RESULTS

www.NVSprawl.com/voter-poll/

NumbersUSA
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(A) POPULATION AND SPRAWL IN EACH NEVADA COUNTY (1982-2017)

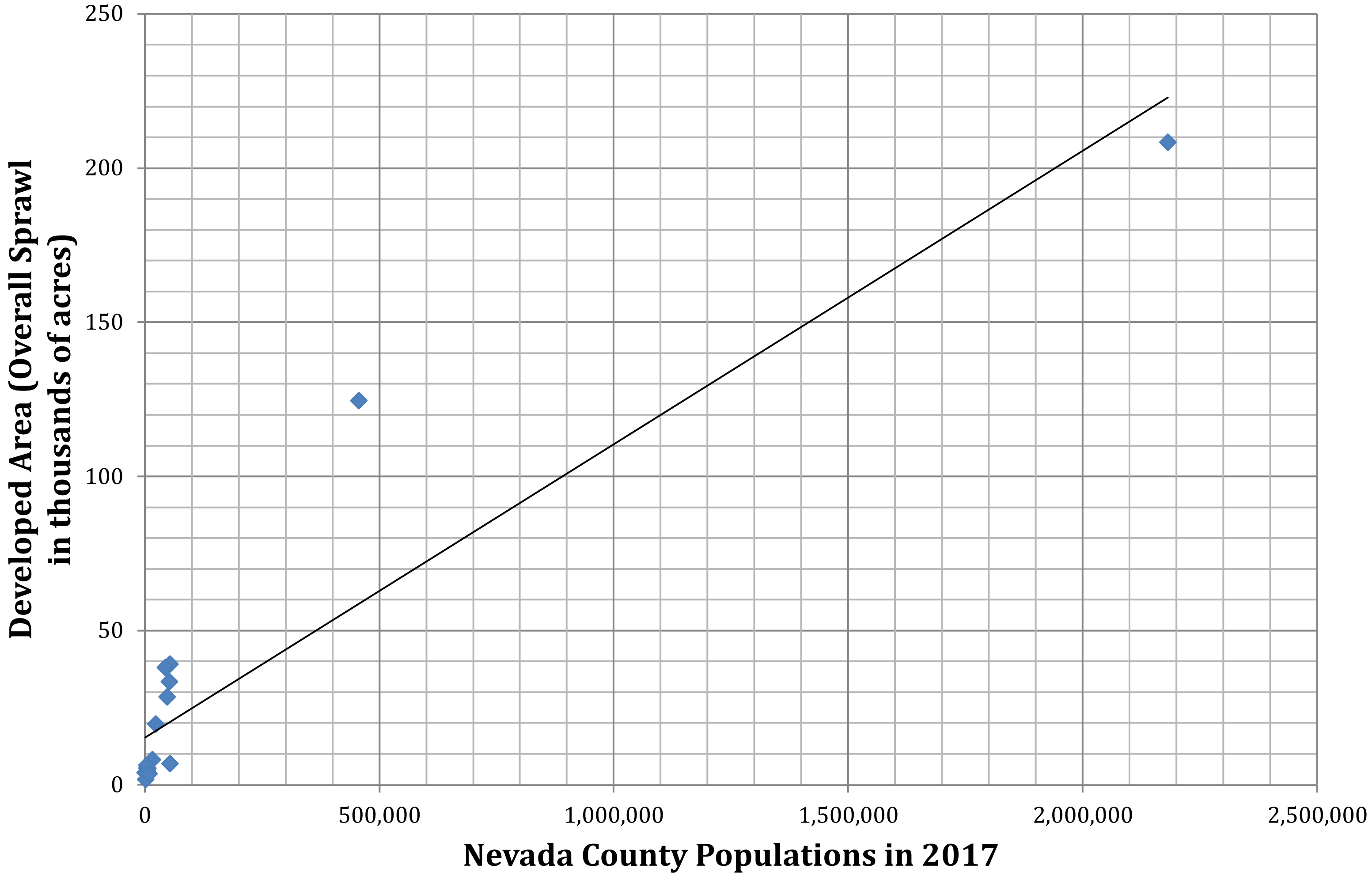
Nevada

Nevada County	1982 Population	2017 Population	Pop Change 1982 to 2017	% Pop Change 1982 to 2017	Developed Land 1982 (1,000's of acres)	Developed Land 2017 (1,000's of acres)	Change in Developed Land (Sprawl in square miles)	% Change In Developed Land	% Sprawl Related to Population Growth
Churchill Co.	14,178	24,021	9,843	69	10.2	19.8	15.0	94	79
Clark Co.	513,708	2,181,635	1,667,927	325	80.6	208.5	199.8	159	100
Douglas Co.	20,348	48,030	27,682	136	14.0	28.6	22.8	104	100
Elko Co.	19,687	52,357	32,670	166	26.4	33.5	11.1	27	100
Esmeralda Co.	1,213	843	-370	-31	2.2	4.0	2.8	82	0
Eureka Co.	1,350	1,946	596	44	1.8	1.9	0.2	6	100
Humboldt Co.	11,220	16,719	5,499	49	4.6	8.2	5.6	78	69
Lander Co.	4,871	5,579	708	15	4.1	5.0	1.4	22	68
Lincoln Co.	3,753	5,191	1,438	38	2.5	4.5	3.1	80	55
Lyon Co.	14,901	53,895	38,994	262	9.1	39.2	47.0	331	88
Mineral Co.	6,125	4,455	-1,670	-27	3.9	5.5	2.5	41	0

(A) POPULATION AND SPRAWL IN EACH NEVADA COUNTY (1982-2017)

Nevada County	1982 Population	2017 Population	Pop Change 1982 to 2017	% Pop Change 1982 to 2017	Developed Land 1982 (1,000's of acres)	Developed Land 2017 (1,000's of acres)	Change in Developed Land (Sprawl in square miles)	% Change In Developed Land	% Sprawl Related to Population Growth
Nye Co.	13,090	43,977	30,887	236	12.3	38.1	40.3	210	100
Pershing Co.	3,683	6,469	2,786	76	5.2	5.6	0.6	8	100
Storey Co.	1,786	3,976	2,190	123	1.9	6.5	7.2	242	65
Washoe Co.	208,577	456,629	248,052	119	29.6	124.6	148.4	321	55
White Pine Co.	8,724	9,651	927	11	2.4	3.6	1.9	50	25
Carson City	34,324	54,532	20,208	59	4.4	6.9	3.9	57	100
Totals	**881,538**	**2,969,905**	**2,088,367**	**237**	**215.2**	**544.0**	**513.8**	**153**	**100**
Weighted Average									**83**

(A) POPULATION AND SPRAWL IN EACH NEVADA COUNTY (1982-2017)



Scatter Plot for Nevada County Populations versus Developed Land Area (Cumulative Sprawl) in 2017

R-value: 0.93

(B) HOW NEVADA COMPARES WITH OTHER STATES

Population Change in 49 States, 1982-2017, Ranked By Percentage Growth

State	1982 Population	2017 Population	% Population Growth, 1982-2017
Nevada	**881,538**	**2,969,905**	**237%**
Arizona	2,889,860	7,044,008	144%
Florida	10,471,405	20,963,613	100%
Utah	1,558,314	3,101,042	99%
Texas	15,331,408	28,295,273	85%
Georgia	5,649,788	10,410,330	84%
Colorado	3,061,562	5,611,885	83%
Idaho	973,719	1,717,715	76%
Washington	4,276,551	7,423,362	74%
North Carolina	6,019,108	10,268,233	71%
Delaware	599,148	956,823	60%
California	24,820,007	39,358,497	59%
South Carolina	3,207,611	5,021,268	57%
Oregon	2,664,919	4,143,625	55%
Virginia	5,492,785	8,463,587	54%
New Mexico	1,363,822	2,091,784	53%
Tennessee	4,646,043	6,708,799	44%
Hawaii	993,780	1,424,393	43%
New Hampshire	947,720	1,348,787	42%
Maryland	4,282,923	6,023,868	41%
Minnesota	4,131,450	5,566,230	35%
Montana	803,984	1,052,482	31%
Arkansas	2,294,254	3,001,345	31%

(B) HOW NEVADA COMPARES WITH OTHER STATES

State	1982 Population	2017 Population	% Population Growth, 1982-2017
South Dakota	690,597	872,868	26%
Alabama	3,925,263	4,874,486	24%
Missouri	4,929,456	6,106,670	24%
Oklahoma	3,206,129	3,931,316	23%
Wisconsin	4,728,862	5,790,186	22%
Indiana	5,467,918	6,658,078	22%
Kansas	2,401,207	2,908,718	21%
Nebraska	1,581,776	1,915,947	21%
Kentucky	3,683,449	4,452,268	21%
Vermont	519,108	624,344	20%
New Jersey	7,430,970	8,885,525	20%
Massachusetts	5,771,222	6,859,789	19%
Maine	1,136,683	1,334,612	17%
Mississippi	2,556,776	2,988,510	17%
Wyoming	506,400	578,931	14%
Connecticut	3,139,014	3,573,297	14%
North Dakota	668,972	754,942	13%
Illinois	11,423,413	12,778,828	12%
New York	17,589,737	19,589,572	11%
Rhode Island	954,170	1,055,673	11%
Michigan	9,115,196	9,973,114	9%
Iowa	2,888,190	3,141,550	9%
Ohio	10,757,085	11,659,650	8%
Pennsylvania	11,845,146	12,787,641	8%
Louisiana	4,352,609	4,670,560	7%
West Virginia	1,949,605	1,817,004	-7%
Entire USA*	**230,580,652**	**323,550,933**	**40%**

Source: U.S. Census Bureau population estimates
***Note**: Includes all states except Alaska; does not include territories

Per Capita Sprawl vs. Overall Sprawl
49 U.S. States – 1982 to 2017

State	% Change in Per Capita Land Consumption, 1982-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 1982-2017 (OVERALL SPRAWL)
Alabama	44.0%	78.9%
Arizona	-12.4%	113.6%
Arkansas	18.0%	54.3%
California	-3.2%	53.4%
Colorado	-10.4%	64.2%
Connecticut	13.3%	28.9%
Delaware	17.0%	86.8%
Florida	-0.6%	99.0%
Georgia	15.3%	112.4%
Hawaii	6.7%	53.0%
Idaho	-5.6%	66.5%
Illinois	18.3%	32.4%
Indiana	17.5%	43.1%
Iowa	10.1%	19.7%
Kansas	1.6%	23.1%
Kentucky	56.7%	89.4%
Louisiana	50.7%	61.7%

(B) HOW NEVADA COMPARES WITH OTHER STATES

State	% Change in Per Capita Land Consumption, 1982-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 1982-2017 (OVERALL SPRAWL)
Maine	48.1%	73.9%
Maryland	12.1%	57.6%
Massachusetts	34.4%	59.7%
Michigan	37.2%	50.2%
Minnesota	5.7%	42.5%
Mississippi	42.5%	66.6%
Missouri	12.4%	39.3%
Montana	0.2%	31.2%
Nebraska	-4.4%	15.8%
Nevada	-25.0%	152.8%
New Hampshire	29.0%	83.6%
New Jersey	32.4%	58.3%
New Mexico	24.4%	90.8%
New York	23.0%	37.0%
North Carolina	22.2%	108.4%
North Dakota	3.1%	16.4%
Ohio	36.8%	48.3%
Oklahoma	21.4%	48.8%

(B) HOW NEVADA COMPARES WITH OTHER STATES

State	% Change in Per Capita Land Consumption, 1982-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 1982-2017 (OVERALL SPRAWL)
Oregon	-6.7%	45.1%
Pennsylvania	49.7%	61.6%
Rhode Island	23.9%	37.0%
South Carolina	27.8%	100.1%
South Dakota	-5.2%	19.8%
Tennessee	32.7%	91.6%
Texas	-2.3%	80.3%
Utah	-1.2%	96.5%
Vermont	28.4%	54.4%
Virginia	14.1%	75.9%
Washington	-9.5%	57.1%
West Virginia	96.3%	83.0%
Wisconsin	14.9%	40.7%
Wyoming	13.7%	30.0%
Entire USA*	**14.8%**	**61.1%**

(C) THE THREAT TO NEVADA WILDLIFE

Despite its desert image (based largely on reality), Nevada is a cornucopia of biological diversity that is staring into the headlights of the vehicles of the state's speeding population expansion. The Center for Democratic Culture at the University of Nevada, Las Vegas (UNLV) has provided several reasons why Nevada is important to national and global species protection:

- **Only California, Florida, and Hawaii among U.S. states have more than the 3,800 plant and animal species identified in Nevada.**
- **More than 300 of the species (67 of them aquatic) exist in no other state and in no other country.**
- **Nevada has more endangered fish than any other state.**
- **Among the most threatened species is the desert tortoise, listed as "threatened" under the Endangered Species Act.**

Nevada's special geography and climate has created the habitat conditions for such stunning biological and botanical diversity. The UNLV center describes this colorfully: "The numerous mountain ranges are relatively isolated from one another by the arid, treeless basins that divide them. As the Nevada Department of Wildlife explains, this has created isolated islands of habitat, called sky islands. These isolated islands have produced the evolution of new species and subspecies of flora and fauna. Many of these species are traceable to the Pleistocene period with large lakes covered much of the state. As the climate changed, the lakes dried up, leaving isolated pockets of wetlands and springs. Many organisms that thrived in the lakes, now persist in these isolated areas, evolving and adapting to ongoing ecological change." Nevada's wildlife is nurtured by a broad range of habitat types in four major eco-regions:

- **The Mojave Desert:** creosote scrub, succulents, and yucca-blackbrush species in southern Nevada, with atypical desert habitats in higher elevations.
- **The Great Basin:** salt desert scrub and sagebrush, conifer forests, and alpine areas with isolated aquatic habitats in central Utah.
- **The Sierra Nevada:** ecoregion conifer forests mixed with sagebrush, pinion-juniper stands and alpine areas at high elevations located on the western edge of the Great Basin.
- **The Columbia Plateau:** volcanic plains and valleys in north central Nevada.

Until recent decades, Nevada's wildlife and their habitats were relatively unthreatened by human populations which did not accumulate in large numbers because of the arid conditions; as the driest state, Nevada has far less water resources than the rest of the country. But in the late 20th century, it was made habitable for millions of newcomers through the invention and widespread availability of air conditioning and the extraordinary exploitation of its scarce surface water and groundwater resources.

Snowmelt from the Rocky Mountains pouring into the Colorado River and the Rio Grande, as well as snowmelt in the Sierra Nevada flowing into the Central Valley and the Owens Valley, were effectively "re-plumbed" with a vast network of dams, reservoirs, aqueducts, pumps, and canals.

That exploitation is beginning to crash into limits that are likely to require some combination of diverting water from the state's farmlands, further over-pumping aquifers, draining rivers below their ability to sustain wildlife that depend on them, or greatly reducing the number of additional people moving into Nevada.

Falling water tables, dried up rivers, shrinking lakes and wetlands are the signs of natural water limits being encountered. Artesian wells in the Las Vegas area "have long overextended groundwater supplies found in the large aquifer beneath Las Vegas," states the UNLF center. "This has led to increased draws on the Colorado, which threatens to turn it into what hydrologists call a 'deficit river' where more water is allotted for its users and is used each year than is annually replenished through the natural cycle."

Open space, parks, green spaces, natural areas – including wetlands, riparian corridors, farmland, beaches, rivers, lakes, the ocean, fields and forests – provide demonstrable mental and physical health benefits. They have proven to be preventative measures that can actually lower health care costs and reduce the need for health interventions. Exploring or even just gazing upon natural areas – such as a swamp or mangrove-fringed estuary next to a city – gives human beings a sense of perspective, continuity in a changing world, spiritual renewal, well-being, and a feeling of harmony with the world around us. The presence of open space within and adjacent to our urban areas – and the assurance that this open space will outlast us – serves to counter-balance the stress and strain of modern life.

Contact with nature and open space provides both physiological and psychological benefits. Research on the physiological benefits of open space has centered on how direct or indirect (vicarious) experience with vegetated and/or natural landscapes reduces stress, and anxiety.[*] A series of studies spanning nearly 20 years in the seventies and eighties linked photo simulations of natural settings to reduced stress levels as measured by heart rate and brain waves. One study revealed that subjects experienced more "wakeful relaxation" in response to slides showing vegetation only and vegetation with water compared to urban scenes without vegetation. These data were corroborated by attitude measures which indicated lower levels of fear and sadness when experimental subjects observed nature-related slides, as opposed to urban slides.104 In studies of hospital patients, recovery was faster, there were fewer negative evaluations in patient reports, and there was less use of anesthetic medication among post-surgery patients with views of exterior greenery than among control group patients with views of buildings.[**]

In new research published in 2023 in the peer-reviewed journal Science Advances, epidemiologists found that long-term exposure to more greenery can increase life expectancy by up to 2.5 years. "Our study shows that being near green space caused some biological or molecular changes that can be detected in our blood," said the study's principal investigator Lifang Hou, a preventive medicine professor at Northwestern University's Feinberg School of Medicine. Apparently, exposure to nature, and living near or in greener spaces can actually modify how genes are expressed (epigenetics), in effect, "getting under our skin" in a positive way.[***]

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[*] Rubenstein, N.R. The Psychological Value of Open Space. Chapter 4 in *The Benefits of Open Space*. The Great Swamp Watershed Association. 1997. Available on the World Wide Web at: http://www.greatswamp.org.

[**] Ulrich, R. 1979. Visual landscapes and psychological well-being. *Landscape Research*, 4(1): 17-23. 105 Ulrich, R. 1983. Aesthetic and affective response to natural environment. Chapter 3 in I. Altman, & J. F. Wohlwill (Eds.), Human Behavior and Environment: Volume 6 (pp. 85-126). New York: Plenum Press; Ulrich, R. 1984. Views through a window may influence recovery from surgery. Science, 224, 420-421.

[***] Allyson Chiu. 2023. Living near green spaces could add 2.5 years to your life, new research finds. Washington Post. June 28. Available online at: https://www.washingtonpost.com/climate-solutions/2023/06/28/aging-green-spaces-nature-health/; Kyeezu Kim et al. 2023. Inequalities in urban greenness and epigenetic aging: Different associations by race and neighborhood soicioeconomic status. Science Advances. 28 June. Vol. 9, Issue 26. Available online at: https://www.science.org/doi/10.1126/sciadv.adf8140.

In other research, breast cancer survivors who engaged in personally enjoyable and nature-related "restorative activities" showed dramatic effects on their cognitive process and quality of life.* At the end of three months, the experimental group showed significant improvements in attention and self-reported quality of life measures; they had begun a variety of new projects. Control group members, meanwhile, who had been given no advice regarding nature exposure activities, continued with deficits in measures of attention, had started no new projects, and had lower scores on quality of life measures. This research underscored that difference between nature as an amenity and as a human need. As one reviewer of the study observed:

> “People often say that they like nature; yet they often fail to recognize that they need it...Nature is not merely 'nice.' It is not just a matter of improving one's mood, rather it is a vital ingredient in healthy human functioning."**

There is an important distinction between nature as amenity and nature as need. As one book affirms:

> “Viewed as an amenity, nature may be readily replaced by some greater technological achievement. Viewed as an essential bond between human and other living things, the natural environment has no substitutes.”***

While there are many anecdotal reports linking the natural environment or open space to everything from increased self-esteem to stress reduction, there are few studies attempting to categorize the many phrases used to identify the worth of a walk in the woods or a day bird-watching beside a marsh. Few studies track long-term longitudinal effects on changed attitudes and behavior. While it is difficult to characterize and quantify the long-term, intangible manner in which lives are modified, it is easy to acquire narrative accounts about the effect of a favorite overlook, trail, or patch of woods on one’s psyche. One of the best known of such testimonials is from pioneering naturalist-conservationist John Muir:

> “Climb the mountains and get their good tidings. Nature's peace will flow into you as sunshine flows into trees. The winds will blow their own freshness into you, and the storms their energy, while cares will drop away from you like the leaves of Autumn.”

Natural settings are unparalleled in their ability to furnish solitude, privacy, and tranquility. They also have “existence value,” that is, there is value to knowing that they are simply there and to the very idea that we *could* get away into them, if we so chose; this is a value in and of itself, which provides for a psychological "time-out" and a sense of wellbeing.

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* Cimprich, B. E. 1990. Attentional fatigue and restoration in individuals with cancer. Unpublished Doctoral Dissertation, University of Michigan.

** Kaplan, S. (1992). The Restorative Environment: Nature and human experience. In D. Relf (ed.), *The Role of horticulture in human well-being and social development: A National Symposium* [Proceedings of Conference Held 19-21 April 1990, Arlington, VA] (pp. 134-142). Portland, OR: Timber Press.

*** Kaplan, R., & Kaplan, S. (1989). *The Experience of nature: A Psychological perspective*. New York: Cambridge University Press.

FAMILY SIZE: The population growth causing most of the lost habitat and farmland in Nevada has little to do with recent decisions of Nevadans about family size. Their **Total Fertility Rate** (TF) of births per woman has been below the "replacement level" of 2.1 since 2009, and was 1.56 in 2022. (See: **States by Fertility Rate**.)

FEDERAL IMMIGRATION POLICIES loom as the biggest single factor in the nation's current population growth, **accounting for nearly 90%**. Demographic projections made in 2015 by the Pew Research Center indicated that future immigration would comprise some 88% of the projected U.S. population growth to 2060. (See **Pew Research Center**.)

CALCULATING DIRECT IMMIGRATION EFFECT IN NEVADA: Our estimate of immigration's direct impact on Nevada's population growth between 1982 and 2017 is based primarily on an analysis of the public use files of the 2017 American Community Survey (ACS) and 2017 Current Population Survey Annual Social and Economic Supplements (CPS ASEC).

We also use the 2002 ACS to estimate the total foreign born in Nevada in that year. It is well established that these Census Bureau surveys capture both legal and illegal immigrants, though some modest fraction is missed. We also use the 2002 ACS to estimate the total

We also use the number of immigrants living in the Sagebrush state in the 1980 and 1990 Censuses to estimate the state immigrant population in 1982. The immigrant or foreign-born population in Census Bureau Surveys includes everyone who is not a citizen at birth.

The 2017 ACS shows 594,400 immigrants living in Nevada. This represents an increase of 529,041 compared to an estimated 65,359 in 1982. The growth represents the number of foreign-born people who arrived in the state from abroad or relocated to the state from another part of the United States. [There is no Census Bureau survey that shows the foreign born in Nevada in 1982. However, the 1980 Census shows 56,020 and the 1990 Census showed 102,713. Assuming a linear growth in the intercensal period then there were 65,359 foreign born residents in the state in 1982.]

In addition to the growth in the foreign born, there are also children born to immigrants after they arrived in the Sagebrush state. The 2017 CPS ASEC shows 284,084 U.S.-born people in the state who based on their age were born 1982 to 2017 and who also reported their mother was foreign born. [We are counting those with two foreign born parents or those with only a foreign-born mother, but not those with only a foreign-born father to avoid double counting.] However, some of these individuals could have been born to an immigrant living in the state prior to 1982. As such we assume that 89 percent (252,847) of these second-generation individuals were born to an immigrant who arrived in the state in 1982 or later. We make this assumption because growth in the total immigrant population of 529,041 since 1982 is equal to 89 percent of the total immigrant population in the state in 2017. Finally, there are grandchildren of immigrants who arrived in the state in 1982 or later. In 2017 there were 31,389

U.S.-born children living with a parent who was 35 years old or younger and the parent reports having an immigrant mother. Again, we assume that 89 percent (27,938) of these children were the grandchild of an immigrant who arrived in the state in 1982 or later.

- In total, we estimate there were 809,826 post-1982 immigrants, their children and grandchild living in Nevada in 2017.
- The state's total population was 881,000 in 1982 and 2.972 million in 2017.
- **Immigration therefore accounted for 39 percent of the 2.091 million increase in the state's population 1982 to 2017.**

Looking at the period 2002 to 2017 is a simpler calculation as we do not need to consider the U.S.-born grandchildren of immigrants as the children of post-1982 immigrants would not have time to grow to adulthood.

The state's immigrant population grew from 364,690 in 2002 to 594,400 in 2017, an increase of 229,710.

In 2017 there were 159,203 U.S.-born children with a foreign-born mother ages 0 to 15. Since the growth (2002 to 2017) of 229,710 in the state's foreign-born population was equal to 39 percent of the total foreign born in the state in 2017, we estimate that 39 percent or 61,525 of these children were the result of immigrants who arrived in the state 2002 to 2017. Adding these two numbers together means that:

- Immigration added 291,235 people to the state's population between 2002 and 2017.
- The state's population grew 806,269 from 2002 to 2017 -- 2.972 million to 2,166 million.
- Immigration therefore accounted for 36 percent of population growth from 2002 to 2017.

TOP SENDING STATES: The biggest contributor to Nevada's rapid population growth is the migration of native-born and foreign-born residents from other states, particularly ones with higher numbers of direct immigration and population growth, increased congestion, and elevated cost of living.

Most recently, 2022 data of people relocating into Nevada showed the most additions coming from California, Texas, and Arizona, with **38% coming from the single state of California** as they leave their coastal home in even larger numbers than the hundreds of thousands of foreign immigrants who continue to settle there. (See **USNews** and **Slacker**.)

Over the past few decades, dozens of diverse factors have been suggested as causes of America's relentless, unending sprawl, defined here as the expansion of urban land at the expense of rural land.

1. One factor is population growth.
2. All the other factors combine to increase per capita land consumption.

This study examines the relative importance of those two overall factors.

The word "sprawl" is not a precise term. But we do indeed use the term "Overall Sprawl" in a precise way in this study – it is the amount of rural land lost to development.

Fortunately, it is easy to measure the amount of Overall Sprawl because of two distinct, painstaking processes conducted by two unrelated federal agencies: the U.S. Census Bureau (Census) and the Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture (USDA). Using data from decennial censuses, Census has tabulated changes in the size and shape of the nation's Urbanized Areas (UAs) every 10 years for more than a half a century (since 1950), while the NRCS has estimated changes in the size and shape of America's Developed Lands in National Resources Inventories (NRIs) developed every five years or so for almost 40 years (since 1982). This study, unlike others we have prepared over the past 20 years, uses only the NRI data (in conjunction with Census population estimates for each county in the 49 states covered).

The NRCS uses remote sensing, survey, and statistical techniques to derive NRI's estimates of changes in land use on the nation's non-federal lands. Built-up or developed lands are one of the categories of land use NRCS delineates.

County-by-county Developed Land data from the 1982-2017 National Resources Inventories served as the main data source for our current study of sprawl in the United States. While the Census data pertain to a discrete list of designated cities, the NRI data furnish a portrait that also includes development in places in counties around the country that are outside of the boundaries of the Census Bureau's UAs. Therefore, we were able to assess and include traditional sprawl and development within American cities as well as the more diffuse development and sprawl dispersed across the entire state, as evidenced in the NRI data. The NRI refers to these areas of more dispersed development as "Small Built-up Areas." In 2015, Small Built-up Areas comprised 7.4 million acres or about six percent of the total of 116.3 million acres of Developed Land in the contiguous United States.

This study quantifies the amount of sprawl over the most recent periods for which the most comprehensive government data are available: 1982-2017. Available NRI Developed Land estimates span an uninterrupted 35-year period from 1982-2012 in seven 5-year intervals (1982-1987, 1987-1992, 1992-1997, 1997-2002, 2002-2007, 2007-2012, 2012-2017). These estimates quantify how much rural land was converted into developed or built-up land over these discrete time intervals, as well as over the 35- year time period in its entirety.

The NRI is based on rigorous scientific and survey protocols. The U.S. Department of Agriculture's NRCS began developing the NRI in 1977 in response to several Congressional mandates. The first NRI published in 1982 used most of the survey methodology and protocols utilized by earlier inventories. However, the scope and sample size of the 1982 NRI were expanded to meet the demands of the Soil and Water Resources Conservation Act (RCA) of 1977, as well as to better address emerging issues like the permanent loss of agricultural lands to nonagricultural uses, such as transportation, industry, commercial and residential land uses.[*]

The NRI covers the entire surface area (both land and water) of the United States, including all 50 states, Puerto Rico, the U.S. Virgin Islands, and certain Pacific Basin islands. The sample includes all land ownership categories, including federal lands (e.g., national parks, national wildlife refuges, national forests, Bureau of Land Management lands, military installations), although NRI data collection activities have historically focused on non-federal lands. Sampling is conducted on a county-by-county basis, using a stratified, two-stage, area sampling scheme. The two-stage sampling units are nominally square segments of land and points within these segments. The segments are typically half-mile-square parcels of land equal to 160-acre quarter-sections (a section is a square of territory one mile on each side, and comprising one square mile or 640 acres in area) in the Public Land Survey System, but there are a number of exceptions in the western and northeastern U.S. Three specific sample points are selected for most segments, although two are selected for 40-acre segments in irrigated portions of some western States, and some segments originally contained only one sample point.[*]

The 1997 NRI sample contained about 300,000 sample segments and 800,000 sample points. Whereas the NRI was conducted every five years up to 1997, an annual or continuous approach was begun in 2000. Each year a subset of between 71,000 and 72,000 segments from the 1997 sample is selected for observation. The subset is selected using a "supplemented panel rotation" design, meaning that a "core panel" of about 40,000 segments is observed each year along with a different supplemental or rotation panel chosen for each year.

[*] U.S. Department of Agriculture. 2009. *Summary Report: 2007 National Resources Inventory*, Natural Resources Conservation Service, Washington, DC, and Center for Survey Statistics and Methodology, Iowa State University, Ames, Iowa. 123 pages. http://www.nrcs.usda.gov/technical/NRI/2007/2007_NRI_Summary.pdf.

The NRI survey system uses points as the sampling units rather than farms or fields, because land use and land unit boundaries often change in some parts of the country. Utilizing points has allowed the survey process to generate a database with dozens of factors or data elements that are properly correlated over many years. Thus, analyses and inferences based on these data are using proper combinations of longitudinal data. Data for the initial 1982 NRI were collected by thousands of field staff of the Soil Conservation Service (SCS – precursor agency to NRCS), whose efforts were supplemented by contractors and employees of other agencies working under SCS supervision. Data collection began in the spring of 1980 and ran for more than two years, finishing in the autumn of 1982. For the 1987 NRI, data were also collected by teams of trained personnel. Remote sensing techniques (via aircraft or satellite) were used to update 1982 conditions for about 30 percent of the sample sites. Reliance upon remote sensing increased during the 1990s. Beginning in 2000, special high-resolution imagery was obtained for each NRI sample site.

In 2004, NRCS established Remote Sensing Laboratories (RSLs) in Greensboro, NC; Fort Worth, TX; and Portland, OR. These three labs were designed, equipped, and staffed to take advantage of modern geospatial technologies, enabling efficient collection and processing of NRI survey data. The RSLs are now staffed with permanent employees whose full-time job is NRI data collection and processing.

A number of quality control and quality assurance (QC/QA) processes are conducted by NRCS and contract staff as well as by the Statistical Unit and NRCS resource inventory specialists. Many of these QC/QA processes are embedded within the survey software developed by NRCS and the Statistical Unit. The QC/QA processes ensure that differences in the data over time reflect actual changes in resource conditions, rather than differences in the perspectives of two different data collectors, or changes in technologies and protocols.

One of the special features of the NRI is its genuine longitudinal nature, that is, its reliability and consistency through time, so that users of this dataset can be confident that, for example, differences in the area of developed land shown for 2007 and 1997 accurately reflect true differences "on the ground" or in reality. Even though many operational features of the NRI survey program have evolved over the years, processes have been implemented to ensure that data contained within the 2007 NRI database are longitudinally consistent. Data collection protocols always include review and editing of historical data for the particular NRI sampling units being observed.

NRI's broadest classification divides all U.S. territory into three categories: federal land, water areas, and non-federal land. Non-federal land is divided into developed and rural. Rural lands are further subdivided into cropland, Conservation Reserve Program (CRP) land, pastureland, rangeland, forestland, and other rural land. In the present study we are concerned only with developed land.

NRI's category of Developed Land differs from that used by other federal data collection entities. While other studies and inventories emphasize characteristics of human populations (e.g., Census of Population) and housing units (e.g., American Housing Survey), for the NRI, the intent is to identify which lands have been permanently eliminated from the rural land base. The NRI Developed Land category includes: (a) large tracts of urban and built-up land; (b) small tracts of built-up land less than 10 acres in size; and (c) land outside of these built-up areas that is in a rural transportation corridor (roads, interstates, railroads, and associated rights-of-way).

Per capita land consumption statistics are a useful way to understand the combined power of numerous land use and consumption choices that can lead to urban sprawl. In general, around the United States, the increase in per capita land consumption (Per Capita Sprawl) is an important cause of Overall Sprawl in many cities and counties. The NRI combined with Census data on the nation's Developed Land allow us to track trends in per capita land consumption from decade to decade.

At a minimum, the **per capita land consumption figure reflects the combined outcome of all the following individual and institutional choices and factors**:

- **Development**
    - Consumer preferences for size and type of housing and yards
    - Developer preferences for constructing housing, offices and retail facilities
    - Governmental subsidies that encourage land consumption, and fees and taxes that discourage consumption
    - Quality of urban planning and zoning
    - Level of affluence
    - Areal extent of the entire built-up urbanized land area comprised of non-residential land uses, such as industrial, institutional, government, commercial, etc.
- **Transportation**
    - Governmental subsidies and programs for highways, streets and mass transit
    - Consumer preferences favoring the mobility and flexibility offered by using private vehicles rather than public transit
    - Price of gasoline (cheap gas encourages sprawl)
- **Quality of existing communities and ability to hold onto their residents**
    - Quality of schools
    - Reality and perceptions concerning crime and safety
    - Ethnic and cultural tensions or harmony
    - Quality of government leadership
    - Job opportunities
    - Levels of pollution
    - Quality of parks, other public facilities and infrastructure
- **Number of people per household**
    - Marriage rate and average age for marriage
    - Divorce rate
    - Recent fertility rate
    - Level of independence of young adults
    - Level of affluence enabling single people to live separately

A methodology for quantifying the respective contributions of population growth and changes in per capita consumption of any type of resource use was outlined in a 1991 paper by physicist John Holdren ("Population and the Energy Problem." *Population and Environment*, Vol. 12, No. 3, Spring 1991). Although Dr. Holdren's 1991 paper dealt specifically with the role of population growth in propelling the increase in U.S. energy consumption, the same methodology can also be applied to many types of population and resource consumption analyses.

In the case of sprawl, the resource under consideration is rural land, namely the expansion over time in the total acreage of rural land urbanized or converted into developed land and subsequently used for urban purposes, such as for housing, commerce, retail, office space, education, light and heavy industry, transportation, and so forth.

As stated in Appendix B, the total land area developed in a city (urbanized area), county, or state can be expressed as:

(1) $A = P \times a$

Where*:*

A = Area of total are (in acres or square miles) of development in city or state
P = Population of that city or state
a = area of city or state used by the average resident (per capita land use)

Following the logic in Holdren's paper, if over a period of time Δt (e.g., a year or a decade), the population grows by an increment ΔP and the per capita land use changes by Δa, the total urbanized land area grows by ΔA, expressed as:

(2) $A + \Delta A = (P + \Delta P) \times (a + \Delta a)$

Subtracting eqn. (1) from eqn. (2) and dividing through by A to compute the relative change (i.e., $\Delta A/A$) in urbanized land area over time interval Δt yields:

(3) $\Delta A/A = \Delta P/P + \Delta a/a + (\Delta P/P) \times (\Delta a/a)$

Now equation (3) is quite general and makes no assumption about the growth model or time interval. On a year-to-year basis, the percentage increments in P and a are small (i.e., single digit percentages), so the second order term in equation (3) can be ignored. Hence following the Holdren paradigm, eqn. (3) states that the percentage growth in an urbanized land area or developed area of a country (viz., 100 percent x $\Delta A/A$) is the sum of the percentage growth in the population (100 percent x $\Delta P/P$) plus the percentage growth in the per capita land use (100 percent x $\Delta a/a$). Stated in words, equation (3) becomes:

(4) *Overall percentage land area growth = Overall percentage population growth + Overall percentage per capita growth*

In essence, this apportioning methodology quantifies population growth's share of total land consumption (sprawl) by finding the ratio of the overall percentage change in population over a period of time to the overall percentage change in land area consumed for the same period. This can be expressed as:

(5) $$\textit{Population share of growth} = \frac{\textit{(Overall percentage population growth)}}{\textit{(Overall percentage land area growth)}}$$

The same form applies for per capita land use:

(6) $$\textit{Per capita land use share of growth} = \frac{\textit{(Overall \% per capita land use growth)}}{\textit{(Overall \% land area growth)}}$$

The above two equations follow the relationship based on Prof. Holdren's equation (5) in his 1991 paper. A common growth model follows the form (say for population):

(7) $P(t) = P_0 (1 + g_p)t$

Where $P(t)$ is population at time t, P_0 is the initial population and g_p the growth rate over the interval. Solving for g_p the growth rate yields:

(8) $\ln (1 + g_p) = (1/t) \ln (P(t)/P_0)$

Since $\ln (1 + x)$ approximately equals x for small values of x, equation (8) can be written as:

(9) $g_p = (1/t) \ln (P(t)/P_0)$

The same form of derivation of growth rates can be written for land area (A) and per capita land use (a)

(10) $g_A = (1/t) \ln (A(t)/A_0)$

(11) $g_a = (1/t) \ln (a(t)/a_0)$

These three equations for the growth rates allow the result of equation (4) to be restated as:

(12) $gP + g_a = g_A$

Substituting the formulae (equations 9 through 11) for the growth rates and relating the initial and final values of the variables P, a and A over the period of interest into equation (12), the actual calculational relationship becomes:

(13) ln (*final population / initial population*) + ln (*final per capita land area / initial per capita land area*) = ln (*final total land area / initial total land area*)

In other words, the natural logarithm (ln) of the ratio of the final to initial population, plus the logarithm of the ratio of the final to initial per capita land area (i.e., land consumption per resident), equals the logarithm of the final to the initial total land area.

In the case of the United States (49 states) from 1982 to 2017, this formula would appear as:

(14) ln (323,550,993 *residents* / 230,580,652 *residents*) + ln (*0.358 acre per resident / 0.312 acre per resident*) = ln (*115,726,400 acres / 71,847,500 acres*)

Computing the ratios yields:

(15) $\ln(1.403) + \ln(1.148) = \ln(1.611)$

$0.339 + 0.138 = 0.477$

Then, applying equations (5) and (6), the percentage contributions of population growth and per capita land area growth are obtained by dividing (i.e., normalizing to 100 percent) each side by 0.54381:

(16) $$\frac{0.339}{0.477} + \frac{0.138}{0.477} = \frac{0.477}{0.477}$$

Performing these divisions yields:

(17) $0.71 + 0.29 = 1.0$

Thus, we note that in the case of the 49 states of the USA (all except Alaska) from 1982 to 2015, the share of sprawl due to population growth was 71 percent [100 percent x (0.339 / 0.477)], while declining density (i.e., an increase in land area per capita) accounted for 29 percent [100 percent x (0.138 / 0.477)]. Note that the sum of both percentages equals 100 percent.

In the main body of this report we modify this gross state-wide percentage of sprawl related to population growth by using a county-by-county weighting approach. This approach accounts for the sprawl that occurs in each county and applies a proportionately greater weight to those counties with greater amounts of sprawl. In essence, sprawl in counties around Flagstaff, Arizona for example, should not be attributed to population growth in counties around Phoenix or Tucson.

In this method, the amount of sprawl related to population growth in each county is summed for all of the counties each of the states. This sum or aggregate is then divided by the total amount of sprawl in the state. Using this procedure, by way of example, 92 percent of the sprawl in Texas between 1982 and 2015 was shown to be related to population growth, which the authors believe is a more accurate rendering of population growth's role than 113 percent, which

exaggerates population's role, and implies that all sprawl (and then some) in Texas during that period was related to population growth, which was not the case.
However, the opposite can also occur. That is, hypothetically, the weighted average for a state can also be greater than the gross state-wide percentage.

This is best illustrated by the State of West Virginia (p. D-293 in Appendix D), where the population did not grow from 1982 to 2017, but actually fell by seven percent. Because there was no population growth – indeed there was population decline instead – by our own terminology and procedures, population growth cannot have been related to any sprawl at all in West Virginia in the 1982 to 2017 time period. All sprawl in the state must have been associated with growth in per capita land consumption (i.e., declining population density).

Indeed, this is what is shown on p. D-293. The 827.3 square miles of sprawl in West Virginia from 1982-2017 was all related to declining per capita land consumption, or what we call Per Capita Sprawl. The right-most column, labeled "% Sprawl Related to Population Growth" shows "0", as it should according to our methodology.

However, it seems a bit absolutist or extreme to conclude that no sprawl at all in the state was related to population growth. How could this be, when individual county results for West Virginia show that population growth did account for some of their own sprawl?

For example, Berkeley County, WV sprawled by 83.4 square miles from 1982 to 2017, a 215% increase in the area of Developed Land. Its population also grew by 66,545, a 137% increase. Our calculations estimate that 75% of the sprawl in Berkeley County was due to population growth. However, if we examine West Virginia's counties only in the aggregate, these more "granular" results vanish, and that leads to an inaccurate and extreme conclusion that no sprawl at all in the entire state was related to population growth.

But if we add up the counties one by one, weighting them proportionately by how much sprawl and population growth occurred in each county individually, we can obtain a more accurate result for the state as a whole. This is shown in the bottom row of the table for West Virginia (p. D-293 in Appendix D), and indicates that approximately 18 percent of the sprawl (increase in area of Developed Land, or 827.3 square miles) in the state from 1982 to 2017 was related to population growth.

FEDERAL CONSERVATION AND POPULATION POLICIES AT ODDS

In May 2021, the Biden Administration formally released its grand "30x30" plan in a report called "Conserving and Restoring America the Beautiful." Co-authored by the U.S. Departments of Interior, Commerce, and Agriculture, along with the White House Council on Environmental Quality, the document characterizes itself stirringly as a "preliminary report to the National Climate Task Force recommending a ten-year, locally led campaign to conserve and restore the lands and waters upon which we all depend, and which bind us together as Americans."

The elevated public attention to habitat preservation is a welcome change from the basic disinterest shown during most of our two decades of publishing these sprawl studies. Among many threats to wildlife, including pollution, toxics, invasive species, road mortality, overhunting, or poaching, various studies have found habitat loss is the single most critical threat to the preservation of species.

Preserving natural areas is also important for the quality of life of humans. The presence of open space within and adjacent to our urban areas – and the assurance that this open space will outlast us – serves to counterbalance the stress and strain of modern life. Contact with nature and open space provides both physiological and psychological benefits.

Nonetheless, many of the same politicians and groups who are ambitiously calling for protecting 30 percent of the United States land area from development by 2030 are also advocating large increases in immigration that would swell the U.S. population even further.

Most fail to even recognize that U.S. population growth is a major factor in causing the loss of open space and natural habitat in the United States. The White House "30×30" plan, for example, does not have a single reference to U.S. population growth.

That approach doesn't work, according to Joseph Chaimie, former director of the United Nations Population Division. Writing in early 2022 in *The Hill,* a favorite publication for those who work in and around Congress, he stated: "If the United States intends to address climate change, biodiversity loss, pollution, etc., it must consider how its population affects each issue."

He lamented that federal officials for a half-century have ignored the recommendations of a bi-partisan federal commission in 1972 to stabilize the U.S. population to reduce pressures on the environment. That failure has had global demographic and environmental consequences. But the United States has a chance to redeem itself: “Gradually stabilizing America’s population will provide an exemplary model for other countries to emulate. Rather than racing to increase the size of their respective populations in a world with 8 billion humans and growing, nations would see America moving away from the unsustainable demographic strategy,” Chamie wrote.

Congress missed a similar opportunity a quarter-century ago, Gary Wockner wrote in the *Las Vegas Sun*. The Colorado-based, self-proclaimed “river warrior” recognized for efforts to save wild waterways in many countries decried the failure of federal officials to heed the conclusion in 1996 of President Clinton’s Task Force on Population and Consumption that U.S. population stabilization is essential for environmental sustainability. “Time is running out, but we can make sure the next three decades don’t mirror the past 30 years of population growth and environmental destruction,” he wrote. "President Joe Biden has an opportunity to follow in Clinton's footsteps and finally implement the council's recommendations. Our most pristine and breathtaking places are worth protecting. But we won't be able to save them if our country keeps growing by leaps and bounds."

The United States has lost well over 20,000 square miles of natural habitat and farmland to development since we at the NumbersUSA Education and Research Foundation began our long series of sprawl studies in the year 2000. The losses have exceeded 35,000 square miles since 1996 when the economic, government, private sector, and environmental leaders on the Clinton task force called on the country to “move toward stabilizing the U.S. population.”

At the time of the report, the U.S. population had exceeded **281 million**. The task force warned that if the country did not heed its recommendations, “U.S. population is likely to reach **350 million** by the year 2030; a level that would place even greater strain on our ability to increase prosperity, clean up pollution, alleviate congestion, manage sprawl, and reduce the overall consumption of resources.”

Unfortunately, the task force's dismal warning is turning out to be largely precise. U.S. population has already exceeded **332 million** in 2022 and is headed for **355 million** by 2030, according to the Census Bureau. The imperiled natural habitat, species, and human communities are reviewed in the opening chapters of our study.

Today's urgent national efforts, such as the 30x30 movement, are based on changing the trajectory of open-space loss by 2030 without changing the trajectory of population growth. Echoing the conclusions of the Clinton task force, our latest national sprawl study finds that formula is highly unlikely to be successful.

The outlook for open-space conservation could be much more positive, however, if Congress Simply would follow the Clinton task force recommendation to adopt annual immigration numerical caps consistent with the goal of stabilizing the country's population size.

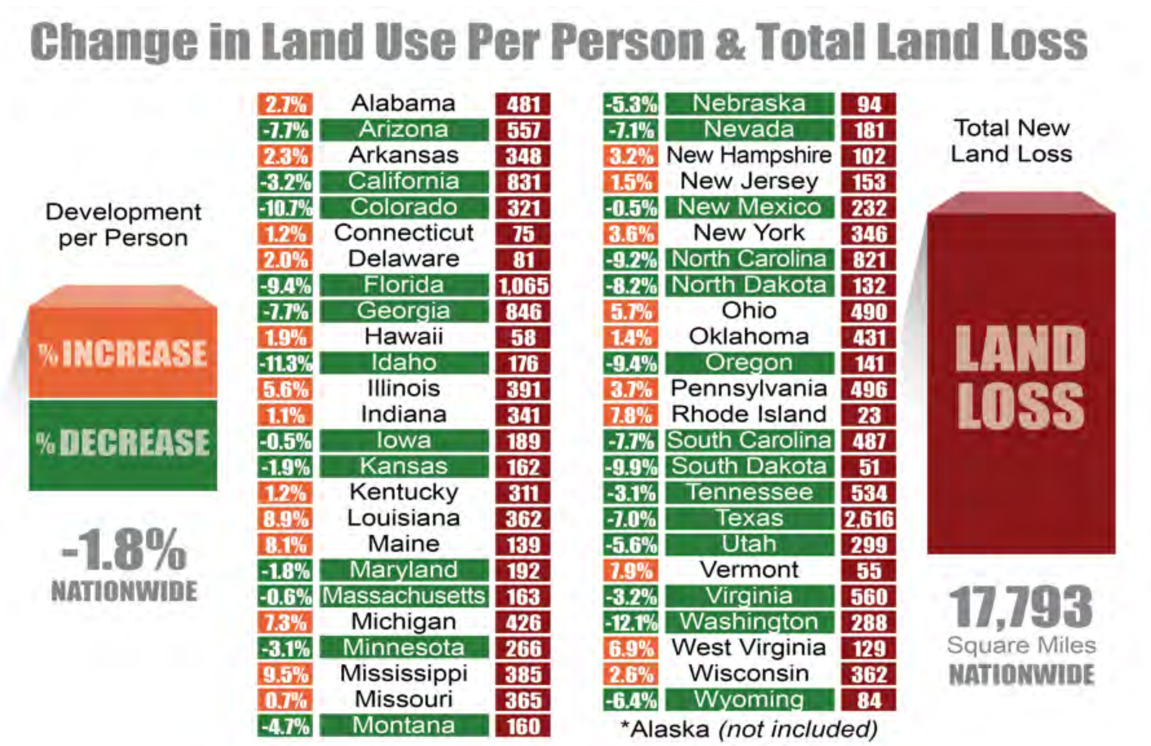
(J) DENSER LIVING DIDN'T STOP LOSS OF OPEN SPACE

In the United States, nearly all government efforts to combat sprawl have focused on strategies which primarily seek to create denser settlement by changing land use practices.

Our findings, however, indicate that approach will have limited success in saving rural land from development because it fails to address the key reason for current sprawl – population growth and its overwhelming driver, federal immigration policies. **Twenty-six states with declining development per resident** in the 2002-2017 period provided case studies for that proposition. The residents of those states lived, worked and shopped more densely than prior to 2002. How did that happen? Certainly, some role was played by so-called Smart Growth planning efforts, higher gasoline prices, fiscal and budgetary constraints (limiting new road-building, for example), the increasing popularity of denser city living (pre-Covid pandemic) and its cultural amenities, and the recession-inducing mortgage meltdown in 2008.

The extent to which any of those and still other unforeseen factors and events – such as the COVID-19 pandemic of 2020-2022 – may affect the rate of per capita sprawl in the coming decades is unknown and unpredictable. It may well be, for example, that concerns about high density residential living in the face of pandemics could increase sprawl pressures by raising the preference of consumers for lower-density suburban neighborhoods.

The 26 states with declining development per person are shown in the chart below with negative percentage numbers in green-shaded boxes. As you can see in the column next to them containing the square miles of lost rural land, all 26 states still sprawled over additional large areas of natural habitat and farmland. **The population growth in these states simply erased any land-conservation benefit of denser living and better planning.**



Change By State in Land Use Per Person & Total Land Loss (2002-2017)

Even if all new population could somehow be added to cities without the cities expanding over any new ground, the additional people would still greatly increase the overall **ecological footprint** of the cities into rural areas. For example, U.S. residents in 2017 on average used or "consumed" 0.356 acre – a little over one-third of an acre – of developed land per resident. But that 0.356-acre/resident metric does not include relatively unpopulated rural lands – farmlands (cropland, pasture, and rangeland), forests, reservoirs, and mines – that furnish crucial raw materials and products used by every consumer/resident, namely for food, fiber, fuels, water, energy, metals, and minerals. Nor does the 0.356-acre of developed land include the forestlands needed to absorb each American resident's carbon dioxide (CO_2) emissions from fossil fuel combustion to produce electricity and propel our vehicles.

All of these ecologically productive lands not covered with pavement and buildings, but used indirectly by each and every U.S. resident (and all human consumers), contribute to the average per capita ecological footprint of each American. This entails approximately 20 acres per person, according to the Global Footprint Network.

https://www.youtube.com/watch?v=eb7L9j48IKot

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ROY BECK was one of the nation's first environment-beat newspaper reporters in the 1960s. A graduate of the University of Missouri School of Journalism, he won national recognition for his coverage of urban expansion issues. A former Washington bureau chief for a chain of daily newspapers, he is the author of five public policy books, including *Recharting America's Future*, and the latest, *Back of The Hiring Line: a 200-year history of immigration surges, employer bias, and depression of Black wealth*. His articles have appeared in scores of magazines, newspapers and journals. He has lectured widely on the ethical aspects of U.S. population issues and testified before Congress on many occasions. He has co-authored more than a dozen studies on sprawl in the last two decades. He founded NumbersUSA in 1996 to educate the public on the recommendations of two federal commissions on population and environmental sustainability and on economic justice.

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