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Zoning for Sustainability: A Review and Analysis of the Zoning Ordinances of 32 Cities in the United States

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Edward J. Jepson, Jr., and Anna L. Haines

Problem, research strategy, and findings: To understand how communities use zoning ordinances to achieve sustainability goals, we identify nine sustainability principles and 53 associated regulatory items that might be included in a zoning ordinance to achieve sustainable development and then examine the zoning ordinances of 32 randomly selected communities to determine if they included these principles and their associated items. We find both wide variation and some consistency in how zoning ordinances address sustainability goals, independent of city size or location in the country. Some of the identified principles and regulatory items are found in many ordinances; others appear in only a few. However, there is an inverse relationship between the age of the ordinance and the extent to which it includes sustainability principles. As ordinances are updated, it is likely that they will address more topical sustainability concerns. We study only ordinance content, not implementation; moreover, sustainability can be achieved in ways other than zoning. However, zoning ordinances that directly address sustainability in many dimensions are more likely to achieve these goals. We conclude that planners can more effectively use zoning ordinances to achieve sustainable development.

Takeaway for practice: This review of zoning ordinances can alert local planners to the many ways in which zoning ordinances could be used to achieve sustainability goals and suggest how planners can assess the contribution of their zoning ordinance to the sustainable development of their communities.

Keywords: sustainability, sustainable development, land use regulations, zoning, planning strategy

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Sustainable development has been characterized as balancing the "three Es" of ecology (or environment), equity, and economy, a characterization that has received considerable attention in the planning literature (see Berke, 2002; Campbell, 1996; Jepson, 2004; Saha & Paterson, 2008). Publications focused on sustainability often begin with common definitions of sustainability, such as the oft-quoted Brundtland Report: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987, p. 8).

However, we find little focus in the planning literature on the integration of sustainability into planning implementation tools such as zoning ordinances. The aim of this research is to gain a sense of how U.S. communities include sustainability principles in their zoning ordinances to help them achieve their sustainability development goals. Among communities in the United States that have adopted sustainability goals, to what extent do zoning ordinances incorporate sustainable development principles and regulatory items? We identify nine sustainability principles and 53 associated regulatory items found in the literature that might be included in a sustainable zoning ordinance.

In this study, we first briefly review the relevant literature on sustainability and zoning and identify the sustainability principles and regulatory items supporting those principles that might be contained in zoning ordinances. In the next section, we describe how we selected a random sample of zoning ordinances and how we evaluated whether they include the regulatory items related to sustainability. Then, we discuss the extent to which the zoning ordinances we reviewed include specific regulatory items. We also discuss

selected regulatory items that are, or are not, included in the zoning ordinances.

Our research shows a wide variation in the form and content of zoning ordinances and how cities use zoning to achieve sustainability goals. However, we also find a large measure of consistency: Many sustainability principles and the regulatory items that support those principles appear in many zoning ordinances regardless of the population of the city or where in the United States it is located. Of the 53 regulatory items we consider, 11 are included in a majority of the 32 ordinances we examined, while only 10 are found in two or fewer of the ordinances. At the same time, a number of the ordinances do not include sustainability principles considered important by many planning and environmental organizations and researchers.

However, many of the ordinances we studied had not been updated in some time. Over time, as ordinances are modified, it is likely that more recently recognized sustainability issues, such as reducing the use of fossil fuel or expanding urban agriculture, will be added to those ordinances. We conclude that zoning is, and can be, an important tool of sustainable development. Our analyses highlight for planners the ways in which important principles of sustainability can be captured in their zoning ordinances.

Background

While sustainability continues to be variously defined within the planning profession (Jepson, 2009; Jepson & Edwards, 2010; Saha & Paterson, 2008), its presence in the planning literature has been extensive, with an emphasis on integration into practice. In 2000, Berke and Conroy suggested six operational performance principles: harmony with nature, livable built environment, place-based economy, equity, polluters pay, and responsible regionalism. In 2003, Jepson suggested the "community development implications" of eight elements in a sustainable development theoretical framework (p. 392). That same year, Portney presented a sustainability index of 34 activities that characterize a community's commitment to "become more sustainable" (2003, pp. 64–65), ranging from the elimination of sprawl to the protection of environmentally sensitive areas and lessening dependence on fossil fuels.

In 2004, Wheeler identified the policy implications of 12 "local sustainability issues," including urban form and resource use. A year later, Hanna (2005) reported the four elements of community character, accessibility, affordable housing, and greenspace as emerging from a community sustainable development planning initiative. In 2006, Jabareen characterized sustainable development policy in terms of seven "themes" of urban form. Saha and Paterson (2008) presented a list of 36 local initiatives for "promoting sustainable development" organized around energy efficiency, open space protection, smart growth, and six other policy categories. Most recently, Jepson and Edwards (2010) presented 14 "land development principles" derived from an ecosystem-based definition of sustainable development.

The American Planning Association (APA) has addressed the practice dimensions of sustainable development in a number of ways, from establishing a sustainability policy guide (APA, 2000) to publishing reports such as "A Planner's Guide to Sustainable Development" (Krizek & Power, 1996) and "Assessing Sustainability: A Guide for Local Governments" (Feiden & Hamin, 2011). Similarly, attention is starting to focus on the tools of planning and integrating sustainability into them. *Zoning Practice,* published by the APA, regularly addresses the planning dimensions of such sustainability issues as renewable energy, urban agriculture, and habitat issues.

Information about sustainability in practice has been gained principally through studies of the content of plans. Many of these studies have focused on a specific aspect of sustainability such as climate (Bassett & Shandas, 2010), environment (White & Boswell, 2007), housing (Connerly & Mueller, 1993), and natural hazards (Brody, 2003). Edwards and Haines (2007) and Berke and Conroy (2000) evaluate the extent to which plans have incorporated sustainability-related goals and principles. A departure from this focus on the content of plans is Talen and Knaap's (2003) use of a survey to study land use regulations in Illinois for the extent to which they had incorporated smart growth regulations.

Links of sustainability to planning practice through smart growth and other development approaches have also been studied. Grant (2009) differentiates between the principles of smart growth, new urbanism, and sustainability and compared the challenges of implementation. Jepson and Edwards (2010) examine the different ways that planners interpreted the relationship between the principles of sustainability and the development approaches of smart growth, new urbanism, and the ecological city.

Specific aspects of sustainability have also been evaluated in the planning literature. For the most part, these studies have focused on effects and effectiveness. For example, Pendall examines the effects of land use controls on sprawl (1999) and racial exclusion. Talen (2012) evaluates urban form, and Zhou (2008) examines the land value effects of land use regulations. Others have examined the effectiveness of zoning regulations in protecting agricultural land (Smith & Giraud, 2006) and lakeshore ecology

(Butsic, Lewis, & Radeloff, 2010). In 2013, Hirt used a case study approach to evaluate the effect of regulations on mixed land use, which she identified through a content analysis of 25 zoning ordinances.

Yet, overall there is a gap in our knowledge: We have limited understanding of exactly what zoning ordinances contain that work to achieve sustainable development goals. Our research addresses this gap by analyzing if and how 32 randomly selected communities have incorporated sustainable development principles and the regulatory items that support those principles into their zoning ordinances.

Research Approach and Data

Our research approach had four phases. In the first phase, we selected a sample of zoning ordinances to evaluate. In the second phase, we identified regulatory items that may be present in a zoning ordinance to implement sustainability principles. In the third phase, we determined if the regulatory items we identified are present in our sample of zoning ordinances and measured the extent to which sustainability has been included in zoning. In the fourth and final phase, we reviewed selected regulatory items we consider important that appear only rarely in the zoning ordinances.

Phase One: Sample

To draw our sample, we used 2010 membership data from the ICLEI-Local Governments for Sustainability (ICLEI-Local Governments for Sustainability [ICLEI], 2010).[1] An international organization with more than 1,200 members, including 450 U.S. cities and counties in 46 states (ICLEI, 2014), ICLEI has been a partner with the APA and the International City/County Management Association (ICMA) in organizing various summits, webinars, and programs on the topic of sustainability. In a 2010 survey conducted by the ICMA, ICLEI members were found to have a "substantially higher adoption rating for sustainability-related actions" than nonmembers (Svara & Watt, 2013). Based on these considerations, we felt that the members of ICLEI could reasonably be assumed to represent a group of communities that are interested in sustainable development.

To select communities for this analysis, we first organized the ICLEI membership list into the four U.S. Census regions of the Northeast, Midwest, South and West.[2] We then numbered the communities and used the Microsoft Excel random number function to select our initial sample. We used four screening criteria for the final selection. First, the community had to have an available online zoning ordinance. Second, all of the communities had to be from different states because we wanted our sample to be representative of all regions of the country. Third, we limited our selections to cities only because we wanted to be sure that municipal powers and policy options were roughly the same for all communities. Fourth, the communities in each region had to be equally divided among those with less than 50,000 residents and those with 50,000 residents or more because we wanted our sample to be representative of both large and small cities. If any selection did not meet one of these criteria, it was dropped from the sample and randomly replaced.

Phase Two: Identification of Regulatory Items

To evaluate the extent and nature of the incorporation of sustainability into zoning ordinances, we needed to first characterize sustainability in terms of its key organizing concepts, or "principles." We then needed to identify the regulatory dimensions of these principles (i.e., how these principles might be manifested in zoning ordinances), which we labeled "regulatory items." To formulate the principles, we turned to two key APA documents that represent the current state of practice in sustainable development: *Policy Guide on Planning for Sustainability* (APA, 2000) and *Policy Guide on Smart Growth* (APA, 2012). We also reviewed eight other APA policy guides concerned with some aspect of sustainability.[3] After identifying nine sustainability principles, we then used the APA's *Growing Smart Legislative Guidebook* (APA, 2002) and the Rocky Mountain Land Use Institute's *Framework—Sustainable Community Development Code Beta Version 1.5* (Rocky Mountain Land Use Institute [RMLUI], 2104)[4] to help identify possible regulatory items that could be associated with the principles. Through our analysis of these documents, we identified 53 ways that the nine sustainability principles could be included in a zoning ordinance, or "regulatory items." The principles and their associated regulatory items are shown in Table 1.

We are concerned only with the kinds of local sustainability actions that a zoning ordinance can be expected to contain. This means that many actions that might be included in a plan for sustainable development are not in our list because they are not amenable to land use regulation. Examples of such types of actions from the APA's *Policy Guide on Planning for Sustainability* (APA, 2000) include the promotion of "financial and social equity in the workplace" and "the recycling of waste materials." It is also likely that some actions in some communities are incorporated into municipal codes and documents other than the zoning ordinance, such as subdivision regulations. Thus, the results of our analysis should not be construed to reflect

Table 1. Sustainability principles and regulatory items.

Sustainability principles	Regulatory items
I. Encourage higher density development	1. Infill development 2. Maximum lot size/minimum net density 3. Purchase or transfer of development rights (PDR/TDR) 4. Small lot residential development permitted (<3,000 square feet)
II. Encourage mixed use	1. Commercial uses permitted in standard residential districts (e.g., R1) 2. Housing of any kind permitted in standard commercial districts (e.g., C1) 3. Live/work units permitted in standard residential districts (e.g., R1)[a] 4. Mixed-use land development 5. Mixed-use buildings/mixed occupancy permitted in standard residential districts
III. Encourage local food production	1. Agricultural uses permitted in standard residential or commercial districts[b] 2. Commercial gardens permitted in standard residential or commercial districts 3. Community gardens permitted in standard residential or commercial districts 4. Farmers markets permitted in standard residential or commercial districts 5. Minimum lot size/maximum net density (ag districts only) 6. Urban agriculture/farming, including animal keeping
IV. Protect ecosystems and natural functions	1. Conservation subdivisions/cluster housing 2. Conservation landscaping 3. Green/eco-roofs 4. Green infrastructure/on-site water management 5. Open space protection/preservation, including agriculture 6. Parking lot landscaping 7. Pervious surfaces 8. Steep slope and hillside protection 9. Water resources/wellhead protection, including riparian buffers 10. Wetlands and wildlife habitat protection
V. Encourage transportation alternatives	1. Bicycle paths and/or parking 2. Complete streets/*woonerf* 3. Parking maximums 4. Shared/joint use parking 5. Transit-oriented development (TOD) 6. Transit stops/stations permitted in standard residential districts
VI. Preserve/create a sense of place	1. Form-based code 2. Grocery stores permitted in standard residential districts 3. Historic/cultural preservation 4. Maximum building size or building occupancy 5. Natural hazards (except flooding) 6. Neighborhood or district development/preservation 7. Pedestrian-friendly development 8. Public and civic spaces/urban plazas 9. Public markets permitted in standard residential or commercial district 10. Transportation connectivity (within and between neighborhoods) 11. Urban design/design review
VII. Increase housing diversity and affordability	1. Accessory/secondary dwelling units 2. Boarding and rooming houses/single-room occupancy housing permitted in standard residential districts 3. Community housing permitted in standard residential districts 4. Cooperative housing permitted in standard residential districts 5. Inclusionary/affordable housing 6. Manufactured housing permitted in standard residential districts 7. Small dwelling units (<1,000 square feet) permitted in standard residential districts[c]

(*Continued*)

Table 1. (*Continued*). Sustainability principles and regulatory items.

Sustainability principles	Regulatory items
VIII. Reduce the use of fossil fuels/encourage the use of fossil fuel alternatives	1. Green buildings 2. Solar energy systems or projects 3. Wind energy systems or projects
IX. Encourage the use of industrial byproducts	1. Eco-industrial park development

Notes:
a. Not including "home occupations."
b. Not marked if commercial gardens, community gardens, or urban agriculture/farming are permitted uses.
c. Not including accessory dwelling units.

the full regulatory dimensions of the sustainable development strategies of these communities.

In addition, given the continued evolution of the concept of sustainability and the volume of information contained in the documents we reviewed, it is inevitable that some regulatory possibilities have been omitted inadvertently. Thus, our list should be viewed as a representative, rather than a definitive or comprehensive, list of the zoning options available to communities for sustainable development. Finally, there are some regulatory items that may not be appropriate among all of the communities. For example, wetlands are less likely to be found in Arizona than in Georgia, and steep slope conditions are less likely in Iowa or Kansas than in Vermont or West Virginia. As another example, transit-oriented development is less likely to be a planning objective in small cities than in large ones.

Phase Three: Zoning Ordinance Review

We accessed the zoning ordinances for the 32 communities in our sample online so we could decide whether they include one or more of the 53 regulatory items. Following Talen and Knaap (2003), our intent was to characterize the zoning ordinances based on the presence of these regulatory items. Owing to the wide variation in the form and terminology of the zoning ordinances that we collected, we did not attempt to develop a strict procedural protocol for the review of the ordinances. Rather, our first step was to define the possible ways, or forms, that a regulatory item might be included in a zoning ordinance. After consideration, we decided on four regulatory forms:

- permitted use in any standard residential district (e.g., R1);
- permitted use in any standard commercial district (e.g., C1);
- special regulations or procedures; and
- special/overlay district or zone.

We then developed a worksheet that made it possible for us to check off the 53 regulatory items for their presence in one or more of the four regulatory forms.

To test our methods of coding, each author used the worksheet to independently review two additional ordinances not included in our random sample. We achieved an 89% agreement; that is, when we compared reviews, 89% of the regulatory items that were checked as being included in the ordinances by Reviewer 1 were also checked by Reviewer 2. Based on this experience, using keyword searches and a final page-by-page scan, we developed a basic evaluation protocol that synthesized the review of the key elements of each ordinance: ordinance tables, chapters, and definitions.

In some cases, the codification was straightforward: For example, some regulatory items either permit a specific land use or they do not, and thus involved a simple yes or no. To account for other, less clear, determinations, we applied two rules: If a regulatory item is simply mentioned, it is not included; if there is some quantitative standard, it is included. For example, a statement that "green roofs will be encouraged" would not qualify green roofs as being present in the ordinance, whereas a setback requirement of a number of feet for green roofs would. To avoid duplication, we did not mark regulatory items if such items are contained within a special or overlay district and are created to achieve the purpose of the regulatory item. For example, if regulations pertaining to historic preservation are part of the requirements for a special historic preservation district, the "special/overlay district or zone" regulatory category was marked, but not the "special regulations or procedures" category. On the other hand, we did mark regulatory items that are applied in a particular district that are not intended for the specific purpose of the regulatory item. For example, if bicycle parking regulations are incorporated into a mixed-use district, the "specific regulations or procedures" category for bicycles was marked (as was also the special district category for "mixed-use land development").

We based our evaluation of the zoning ordinances for including, or the "presence" of, each of the 53 regulatory items in every possible form. For example, if conservation subdivisions are included in a zoning ordinance as a

permitted use in residential and commercial districts and there are special regulatory provisions as well as an overlay district, we coded this ordinance as 4 since it was present in all four of the possible regulatory forms. The summation of all of these codes is the score that we interpret as indicating the extent to which a city's zoning ordinance includes sustainability; the highest possible score is 93.[5] We also kept track of the number of times that each regulatory item was present in all the ordinances in any one of the four regulatory forms. For example, if an ordinance includes solar energy systems in more than one of the possible regulatory forms (e.g., as both a permitted use and as a special district), it would be coded as 1 to indicate its presence in the ordinance.[6]

The presence level of each regulatory item is reported as a percentage, which is the sum of its codes (i.e., the total number of times it is present in all of the ordinances) divided by the number of ordinances in the sample (n = 32).

Phase Four: Selected Review

To augment our findings, we also did a special review of 15 regulatory items that were not present in many zoning ordinances. We view communities that include these particular regulatory items as vanguard communities. Thus, information about what they have done can serve important instructional purposes, which may in turn increase how frequently they are included in ordinances in the future, enabling greater progress toward more sustainable development.

How Common Are Sustainability Principles and Regulatory Items?

The scores of the 32 cities are shown in Table 2; these scores represent how often the 53 regulatory items are included in each city's ordinance, using our assessment criteria. Burlington (VT) includes the most regulatory items in its zoning ordinance with a score of 33; New London (CT) includes the fewest, with a score of 1 (out of a possible total score of 93). Four of the 10 highest scoring cities have populations of less than 50,000, as do six of the 10 lowest scoring cities. All four of the census regions are represented among the 10 highest scoring cities, and three census regions are represented among the 10 lowest scoring cities.

Table 2 also shows the level of inclusion of the 53 regulatory items for each city's zoning ordinance. In contrast, Table 3 shows how often the nine sustainability principles and 53 regulatory items are included in the zoning ordinances. Overall, we find substantial variation in how often the principles and regulatory items appear within these ordinances; that is, their presence level. Taken together, the 53 regulatory items identified show up in nearly 70% of the ordinances. Another 10 regulatory items appear in 34% to 66% of the ordinances. The remaining 35 regulatory items are present in less than one-third of the ordinances.

Table 2. Zoning ordinance presence scores.

City	Census region	Population	Presence score
Burlington, VT	NE	42,282	33
Northampton, MA	NE	28,592	31
Lee's Summit, MO	MW	92,468	27
Santa Fe, NM	W	69,204	27
Lawrence, KS	MW	89,512	26
Missoula, MT	W	68,394	26
Edinburg, TX	S	81,029	25
Golden, CO	W	19,186	24
Traverse City, MI	MW	14,911	24
Hailey, ID	W	7,920	23
Knoxville, TN	S	182,200	23
Nashua, NH	NE	86,933	23
Rochester, NY	NE	210,532	21
McMinnville, OR	W	32,535	20
Berkeley, CA	W	115,403	19
Portland, ME	NE	66,214	19
Tulsa, OK	S	393,987	17
Lynnwood, WA	W	36,275	16
Decatur, GA	S	19,853	15
Marshfield, WI	MW	18,952	15
Frankfort, KY	S	27,590	14
Tempe, AZ	W	166,842	14
Des Moines, IA	MW	206,688	13
Fairmont, WV	S	18,737	12
Golden Valley, MN	MW	20,776	12
New Brunswick, NJ	NE	56,160	12
Norfolk, VA	S	245,782	11
Merdian, MS	S	40,832	9
Springfield, IL	MW	117,126	8
Meadville, PA	NE	13,263	7
Athens, OH	MW	23,755	6
New London, CT	NE	27,707	1
Average		82,270	17.9

Table 3. Presence levels of sustainability principles and their associated regulatory items.

Sustainability principle	Principle presence level[a]	Regulatory item presence level[b]		
		Low (0–33%)	Medium (34–66%)	High (>66%)
I. Encourage higher density development	Low (14.1)	1. Infill development (28.1) 4. Small lot residential (15.6) 2. Maximum lot size (6.3) 3. PDR/TDR (6.3)	None	None
II. Encourage mixed use	Medium (39.4)	5. Mixed-use buildings (18.8) 3. Live/work units (15.6) 1. Commercial uses (6.3)	None	4. Mixed-use land development (81.3) 2. Housing of any kind (75.0)
III. Encourage local food production	Low (19.3)	6. Urban agriculture (31.3) 1. Agricultural uses (21.9) 3. Community gardens (21.9) 4. Farmers markets (18.8) 5. Minimum lot size (15.6) 3. Commercial gardens (6.3)	None	None
IV. Protect ecosystems and natural functions	Medium (36.6)	7. Pervious surfaces (18.8) 10. Wetlands and wildlife protection (18.8) 3. Green roofs (12.5) 4. Green infrastructure (9.4)	5. Open space protection (65.6) 2. Conservation landscaping (40.6) 1. Conservation subdivisions (40.6) 9. Water resources (46.9) 8. Steep slopes and hillside (37.5)	6. Parking lot landscaping (75.0)
V. Encourage transportation alternatives	Low (31.3)	3. Parking maximums (21.9) 5. TOD (15.6) 6. Transit stops/stations (12.5) 2. Complete streets (6.3)	1. Bicycle paths/parking (59.4)	4. Shared parking (71.9)
VI. Preserve/create a sense of place	Medium (11.2)	8. Public and civic spaces (25.0) 4. Maximum building size (21.9) 1. Form-based code (15.6) 10. Transportation connectivity (12.5) 9. Public markets (9.4) 2. Grocery stores (6.3) 5. Natural hazards (3.1)	None	3. Historic/cultural preservation (78.1) 6. Neighborhood or district development (71.9) 7. Pedestrian-friendly development (71.9) 11. Urban design/design review (71.9)
VII. Increase housing diversity and affordability	Low (29.0)	3. Community housing (18.8) 7. Small dwelling units (3.1) 4. Cooperative housing (0.0)	2. Boarding and rooming houses (53.1) 1. Accessory/secondary dwelling units (46.9) 6. Manufactured housing (40.6) 5. Inclusionary/ affordable housing (37.5)	None
VIII. Reduce the use of fossil fuels	Low (30.2)	3. Wind energy systems (25.0) 1. Green buildings (21.9)	2. Solar energy systems (43.8)	None
IX. Encourage the use of industrial byproducts	Low (3.1)	1. Eco-industrial park development (3.1)	None	None
Average percentage of all regulatory items: 30.2				

Notes:

a. The principle presence levels are on the regulatory item presence level scale (i.e., 0–33% = low presence level). The number in parentheses is the average presence level of the regulatory items that are included in the principle.

b. The regulatory item presence level is the percentage of the ordinances that included each regulatory item. In each column, the regulatory items are arranged from highest presence level to lowest. The regulatory items are organized in descending order of presence. For practical reasons, many of the regulatory item titles shown here have been shortened from the version shown in Table 2. To facilitate cross-referencing of the tables, the regulatory items here include the numbers they were assigned in Table 2.

Encourage mixed use has the highest level of presence of the nine sustainability principles. This principle is found in a large number of zoning ordinances because two of its five regulatory items—"mixed-use land development" and "housing of any kind"—are present at very high levels (included in 81.3% and 75.0% of the ordinances, respectively). The remaining three regulatory items supporting this principle are found in less than 20% of the ordinances.

The sustainability principle *protect ecosystems and natural functions* has the second highest level of presence, with its regulatory items appearing in nearly 37% of the ordinances. Of the 10 regulatory items that support this principle, six are rated as having a medium or high presence, which is more than any other sustainability principle. The four regulatory items related to water quantity and water quality have the lowest presence.

The principle *preserve/create a sense of place* has a medium presence level, but its regulatory items are bifurcated between high and low presence levels. On the one hand, this principle has the highest percentage of associated regulatory items in the high presence category (7 of 11, or 36%), with one of those—"historical/cultural preservation"—having the second highest presence level of all 53 regulatory items (included in nearly 80% of the ordinances). On the other hand, all of the remaining four regulatory items that support this principle have low presence levels of less than 33%.

The *encourage transportation alternatives* principle has an overall low presence level in the ordinances. Two of its six regulatory items have high or medium presence levels: "shared parking," which is present in 72% of the ordinances, and "bicycle paths/parking," which is present in almost 60% of the ordinances. The remaining four regulatory items supporting this principle all have a low presence, ranging from about 6% ("complete streets") to about 22% ("parking maximums").

The principle *reduce the use of fossil fuels* is also not commonly seen. None of the three regulatory items supporting the reduction of fossil fuels has a high presence level; two—"green buildings" and "wind energy systems"—have presence levels of 25% or less. The regulatory item supporting this principle with the highest level of presence—"solar energy systems"—is present in fewer than half of the ordinances (44%).

The principle *increase housing diversity and affordability* is present in only 29% of the ordinances. While none of its seven regulatory items are in the high presence category, more than half have a medium presence. This principle also includes the only regulatory item that is not found in any of the zoning ordinances: "cooperative housing."

The principle *encourage local food production* has a similarly low presence level in the ordinances, appearing in less than 20% of the ordinances. The highest ranked regulatory item that supports this principle—"urban agriculture"—is found in roughly 30% of the ordinances.

The principle *encourage higher density development* is present in fewer than 15% of the zoning ordinances, which is the second lowest presence level of the nine principles. None of its four regulatory items fall into either the medium or high presence categories. "Purchase or transfer of development rights" (PDR/TDR) and "maximum lot sizes" have low levels of presence: Both are found in only two of the 32 ordinances. The regulatory item supporting this principle with the highest presence level, "infill development," is found in less than 30% of the ordinances.

Last, the principle *encourage the use of industrial by-products* has the lowest presence level among the nine principles; this may be because it has only one regulatory item, "eco-industrial park development." At 3.1%, its presence equals only two other regulatory items ("grocery stores" and "natural hazards"); only "cooperative housing" had less presence because it was entirely absent from the ordinances.

Close-Up View of Selected Regulatory Items

We also reviewed the regulatory items that are present in less than 15% of the ordinances. The reviews shown in Table 4 are intended to convey a sense of the form these rare regulatory items take and how they fit into the standard methods of zoning practice.

For example, regulations in Burlington (VT) and Santa Fe (NM) related to grocery stores in residential districts focus on size limitations and use designations (i.e., in one ordinance it is a conditional use and in another it is a special use). In Rochester (NY), the continued use of nonconforming buildings for commercial purposes in residential districts is allowed, subject to some restrictions. Lee's Summit (MO) implements complete streets through "livable streets" provisions that require retrofitting of existing streets to meet the needs of "pedestrians, bicyclists, transit riders, and motorists." Green infrastructure regulations in Edinburg (TX) designate pervious surfaces as a priority and storm sewers as a last resort. Density or development bonuses have been formulated with respect to small dwelling units (Edinburg) and green roofs (Lawrence, KS). Several ordinances specifically require that streets have certain characteristics related to connectivity and accommodation.

What Does This Tell Us About Zoning and Sustainability?

We found substantial variation in the presence of sustainable development regulatory items in our sample of zoning ordinances. One possible explanation may lie in the static nature of zoning ordinances. Meck, Wack, and Zimet

Table 4. Lowest presence regulatory item reviews.

Regulatory item	Review
Cooperative housing (VII.4.)	None of the communities in our sample had integrated cooperative housing (i.e., shared ownership and common use) provisions into their zoning ordinances. The range of possible actions include allowing it as a permitted use, providing density bonuses, requiring common use areas in new developments, and waiving occupancy and development standards related to inhabitants, density, and parking.
	Despite its recognition as an important element in "family friendly communities" by the APA, a 2008 survey indicated that only 19% of communities have or promote "cooperative housing or common living spaces" (Israel & Warner, 2008).[a]
Grocery stores in residential districts (VI.2.)	Burlington (VT): Grocery stores of less than 10,000 square feet are listed as a conditional use in a residential district; however, the conditions have not yet been formulated.
	Santa Fe (NM): Neighborhood grocery stores are permitted as special uses in residential districts. There is a maximum floor area restriction of 3,000 square feet and the requirement of a peripheral masonry wall.
Eco-industrial development (IX.1.)	Burlington's "agriculture processing and energy district" is intended to serve as a "community of manufacturing and service businesses that work together to improve their environmental and economic performance" and "to coordinate the flows of energy and materials for maximum efficiency." All uses are conditional and include manufacturing, laboratories, warehouses, community gardens, and day care centers.
Natural hazards (excluding flooding) (VI.5.)	Berkeley (CA) is unique among the studied communities in its establishment of a special environmental safety district. The district's characteristics of substandard vehicular access, steep slopes, inadequate water pressure, and proximity to a fault line and vegetated wild lands make it especially susceptible to earthquakes, wildfires, and landslides. Development recommendations are issued on the basis of an environmental assessment that considers site and district impacts and a Specific Plan of Development must be prepared and approved by the Zoning Officer or Adjustments Board.
Commercial gardens in residential or commercial districts (III.3.)	Decatur (GA): Small and medium market gardens are permitted in one of two single-family districts and one of two higher density residential districts. Large market gardens are also permitted in one of two higher density residential districts after a public hearing. All garden sizes are permitted in all non-residential districts. Classified as "urban agriculture," the gardens may include animal facilities. Production is not for personal consumption, and on-site sales are allowed. Small gardens may be no larger than 5,000 square feet and medium gardens no larger than 2 acres. Large gardens may be of any size.
	Missoula (MT): "Agriculture, crop" use is permitted in all residential and commercial districts, which is defined as "growing, raising, or marketing of plants to produce food, feed or fiber commodities." Does not include personal gardens or aesthetic landscaping. There are no regulatory restrictions.
Commercial uses in residential districts (II.1.)	Knoxville (TN): In the R3 high density residential district, retail businesses are permitted on review provided that they are "only for the convenience of the occupants of the building" and there is no outside entrance.
	Rochester (NY): Provisions allow the continued use of nonconforming buildings in all residential districts when used for retail, service, or office. There are different distance and hours of operation restrictions for low- and high-impact retail and service uses and full-line food stores.
Complete streets/ *woonerf* (V.2)	Lee's Summit (MO): The zoning ordinance must implement the city's "livable streets policy." Livable streets are "designed to serve everyone—pedestrians, bicyclists, transit riders, and motorists." A provision requires that streets will be "designed or retrofitted to meet standards" for all of these users.
	Tempe (AZ): The purpose of Chapter 5 of the ordinance—Access and Circulation—is to "ensure that all developments provide safe and efficient access and circulation for pedestrians (including ADA and transit accessibility), motorized vehicles and bicycles." Motor vehicle regulations provide "universal pedestrian and bicycle access" through "continuous pathway systems" that incorporate regulations related to convenience, safety, and comfort (including maximum block length and shade requirements).
Maximum lot size/ minimum density (I.2.)	Burlington: For mixed-use downtown districts, the city uses a "maximum intensity" regulatory approach with floor-area ratio (FAR) as the method of measurement.
	Lee's Summit: In a sustainable development overlay district, density requirements are expressed as both a maximum and a minimum. For example, single-family detached developments may not have a density less than six units per acre.
Small dwelling units (<1,000 square feet) (VII.7.)	Edinburg (TX): Density bonuses are available for the construction of "small family units," which can be single-family detached or attached "atriums" (fence-enclosed dwelling unit and private yard). Maximum size is expressed as a ratio of floor area to lot area and ranges from 640 to 800 square feet.
PDR/TDR (I.3.)	Northampton (MA): Special permits may be granted to owners of land in a special resource conservation district to transfer residential development rights to a special "planned village district" or "other receiving parcels" subject to the development constraints in the sending district.
	Traverse City (MI): Allows for the transfer of "Development Capacity" among subareas within and contiguous to a redevelopment district for the purposes of stimulating development and protecting natural resources and open space.

(*Continued*)

Table 4. (*Continued*) Lowest presence regulatory item reviews.

Regulatory item	Review
Green infrastructure/ on-site water management (IV.4.)	Edinburg: Drainage plans should be designed for avoidance of runoff. The design hierarchy includes minimization of impervious surfaces, preservation of natural stream channels, and on-site infiltration as the top three priorities. Streets and storm sewers should be used only as a "last resort." Recommended use of minimization techniques such as water gardens, rain barrels, pervious pavements, and green roofs.
	Lee's Summit: In its "sustainable development standards," the ordinance includes the goal of "no net increase in stormwater runoff volume or rate" for new developments. Up to 70 of the 200 to 250 points required for designation as a sustainable development can be earned through such actions as increasing landscaping over the minimum requirements, using rain barrels, and installing pervious pavement.
	Santa Fe: Among the goals of the development and design standards is to encourage "water collection and infiltration on site." The design provisions include the protection of significant trees, the use of cisterns, the elimination of sediments, and the reduction of post-development runoff below pre-development levels on steep slope properties.
Public markets (VI.9.)	Burlington: Within the Downtown Waterfront–Public Trust District, public markets are a permitted use.
	Rochester: The zoning ordinance includes a special "public market village district" that has the historic Rochester Public Market as its focal point. Among the permitted uses are "outdoor markets" that provide short-term vendor spaces for the display and sale of goods.
	Traverse City: "Markets, public or municipal" are included as a permitted use in Regional Center (C4) districts. The use is not defined.
Green/eco-roofs (IV.3.)	Edinburg: Green roofs, defined as roofs "that have been planted in vegetation," are permitted for all buildings and "strongly encouraged" for buildings with roof areas exceeding 40,000 square feet. Methods of encouragement are not described.
	Knoxville: There is some flexibility in setback and height restrictions for "rainwater collection or harvesting systems."
	Lawrence (KS): Up to 100 development bonus points may be earned for the provision of a green roof or rooftop garden to "control stormwater runoff." Each 10 bonus points allows one additional dwelling unit per acre.
	Lee's Summit: In a special sustainable development district, new buildings are "encouraged" to incorporate a variety of green design features, including a green roof. Points toward sustainable development designation are available if at least 50% of the buildings in a project have green roofs that have "drought-tolerant" landscaping.
Transit stops/ stations (V.6.)	Des Moines (IA): Transit benches and shelters are permitted so long as they are deemed by officials to not "interfere with pedestrian or vehicular circulation."
	Lawrence: Up to 75 development bonus points may be earned for developments that are located adjacent to a transit stop and have "transit stop amenities." Each 10 bonus points allows one additional dwelling unit per acre.
	Missoula: The zoning ordinance allows up to a 15% reduction in the number of off-street parking spaces required for nonresidential uses that are located within 500 feet of a transit stop that is served at intervals of 30 minutes or less.
	Nashua (NH): "Bus passenger shelters/bus stops" are permitted in all seven residential districts.
Transportation connectivity (VI.10.)	Burlington: Within its land division, design review standards have provisions requiring that all streets be interconnected with "the established grid," the extension of the "established sidewalk network" and the maintenance and extension of "trail networks and uninterrupted corridors of greenspace."
	Edinburg: For new projects, the development of "areawide conceptual circulation plans" is required that will "enhance connectivity" within superblocks, provide a choice of travel routes, and reduce traffic conflicts and vehicle miles traveled. Regulations include requirements for traffic calming and mid-block pedestrian connections and bikeways to "link major destinations" such as neighborhoods, parks, schools, and employment centers.
	Lee's Summit: Regulations are intended to "support the creation of a highly connected transportation system" to provide "choices for drivers, bicyclists, and pedestrians." Avoidance of "superblocks" and the provision of pedestrian walkway networks, pedestrian circulation routes, and trail linkages are among the requirements.
	Tempe: Zoning regulations are intended to implement the Comprehensive Transportation Plan to provide "safe and efficient access and circulation" through the accommodation of "all modes of transportation" and connectivity between neighborhoods, buildings, and transit stops. Provisions include restrictions on block lengths and the installation of traffic-calming features.

Note:

a. Boulder (CO) and Madison (WI) are two cities that have developed regulatory approaches to cooperative housing (see https://www-static.bouldercolorado.gov/docs/PDS/forms/104.pdf and https://www.cityofmadison.com/neighborhoods/zoningrewrite/documents/cohousing051509.pdf, respectively).

(2000) and others recommend "a major overhaul" of zoning ordinances once every 10 years (p. 362). Yet, 11 of our zoning ordinances were adopted or significantly revised more than 10 years ago; three are more than 20 years old. To determine whether the number of regulatory items included in the zoning ordinances is related to the age of the ordinances, we did a correlation analysis between the ordinance scores and the number of years since the ordinances were adopted. We found a significant negative correlation: The presence of sustainability items tends to go down as the age of the ordinances goes up.[7]

We found that although the regulatory items associated with smart growth are frequently present in the zoning ordinances we reviewed, some surprising regulatory items supporting this development approach are often not used. For example, "mixed-use land development," "housing of any kind," and "open space preservation" are all present at high levels in the zoning ordinances. But "infill development" is present in less than one-third of the ordinances, while "PDR/TDR" is only present in two of the ordinances. Despite the presence of these facets of smart growth in the planning and development literature for more than 20 years, communities are only selectively incorporating them into their land use regulations.

Also somewhat surprising is how infrequently regulatory items related to the *encourage local food production* principle are included in zoning ordinances. The APA (2014b) identified local food production in its *Policy Guide on Community and Regional Food Planning* in 2007 as being related to the "core principles" of sustainability. This policy guide also expresses puzzlement about its "omission as a focus of serious professional planning interest" and a call for its stronger incorporation into the professional planning agenda. Yet, despite this, less than a third of the zoning ordinances include "urban agriculture" as a regulatory item and fewer still include "farmers markets," "community gardens," and "commercial gardens." That these are infrequently included in zoning ordinances may be a continuing reflection of its "omission" from the profession noted by the APA more than seven years ago.

It is also possible that the omission of regulatory items related to local food production reflects imbedded notions about the difference between urban and rural (i.e., it may be hard for many people to accept, let alone support, the presence of food crops or animal husbandry in their urban neighborhoods). As a consequence, there may be little political pressure for associated changes in local regulations. Of course, its omission in the zoning ordinances we studied may be related to the static nature of zoning; these issues may be still too new to be widely seen.

We were somewhat surprised by the low presence level of *reduce the use of fossil fuels*. While roughly 40% of the zoning ordinances include "solar energy systems" as a regulatory item, "wind energy systems" and "green buildings" were present in only about half that many ordinances. These findings may be due to the unique and inherent difficulty that has been associated with the adoption of policies related to climate change, the issue to which this principle is directly tied (Bedsworth & Hanak, 2010; Burch, 2009; Dunlap & McCright, 2011). It may also be that regulatory decisions about alternatives to fossil fuel are driven more by the nature of a given technology and the efforts of the advocates of that technology than by a general commitment to the principle of reducing the use of fossil fuels.

The regulatory items under the principle of *protect ecosystem and natural functions* appear often in the zoning ordinances we studied, but there is significant variation among the regulatory items that support that principle. Both "open space" and "water resource protection" regulatory items are present in many zoning ordinances, while "pervious surfaces" and "green infrastructure" are not. "Wetlands" and "wildlife habitat" regulatory items both have low presence levels, appearing in only six of the ordinances. These characteristics of place may vary by land and climatological conditions so that not all cities would need to address them in the same way or to the same degree. Still, it is doubtful that more than 80% of the cities in our sample are bereft of wetlands and wildlife habitat or a need for their protection.

It is important to keep in mind that our analysis misses other ways in which communities can address sustainability. For example, the city code of Lawrence (KS) includes a smart growth code along with a land development or zoning code. Regulations in this code cover such areas as civic space, infill development, and streetscape requirements. Similarly, Norfolk (VA) has separate codes covering such aspects of development as streets and sidewalks, stormwater management, wetlands, and fair housing. The codes of Decatur (GA) also cover an extensive range of topics, including historic preservation, open space protection, streets and public spaces, and urban farming.

We also discovered that some cities are adapting their zoning ordinances in unique ways. For example, Lee's Summit (MO) has designated a special sustainable development district that includes a "menu of sustainability options" to determine whether a development project can proceed. Portland's (ME) approach to affordable housing includes a housing trust fund and a carefully crafted range of affordable housing incentives. Lynnwood (WA) is unique among our group of communities in its permitting provisions for tent encampments as a form of temporary housing. Traverse City's (MI) renewable energy chapter stands out for the

comprehensiveness of its regulatory treatment of wind and solar energy systems. Lawrence and Lee's Summit have developed land use regulations for electric vehicle charging stations, which sets them apart from the other zoning ordinances but puts them in step with a recent mushrooming of that type of land use (Alternative Fuels Data Center, 2014). A systematic examination of how such unique approaches came about could be extremely valuable.

Summary and Conclusions

In many ways, this review of the inclusion of sustainability into zoning is a study in variation: variation in the format and content of the ordinances, variation in how often sustainable development regulations appear in the ordinances, variation in the use of zoning as a tool of sustainability. At the same time, there is evidence of some consistency: Many principles and regulatory items appear in many zoning ordinance regardless of differences in geographic location or population. Of the 53 regulatory items we considered, 11 are included in a majority of the ordinances, while only 10 are found in two or fewer of the ordinances.

At the same time, these 32 communities did not include in their ordinances many of the principles of sustainability and their associated regulatory items that have been proposed by important planning and environmental organizations. Of course, more than zoning ordinances influences land development in a community. Many of the communities that we studied have unified development codes that include land use regulations in documents other than their zoning ordinance.

On the basis of this research, we conclude that zoning is an important tool of sustainable development. While the highest ordinance score of 33 is only about a third of the total possible score, all but one of the 53 regulatory items are included in at least one of the ordinances. If one ordinance includes a regulatory item that supports sustainability, there is the potential for all ordinances to include it. Whether zoning ordinances actually will increase how many regulatory items they include in support of sustainability is an open question. The inverse relationship between the age of the zoning ordinance and the number of regulatory items it includes (i.e., as the age of the ordinance goes down, the number of items goes up) suggests that as cities committed to sustainability modify their zoning regulations to reflect that commitment, we will see more of these regulatory items in their ordinances.

Of particular concern is that the principles of local food production and fossil energy reduction/replacement were not more commonly incorporated into the zoning ordinances. Both of these are increasingly recognized as core sustainable development planning issues; reducing the use of fossil fuel is one of the main challenges of our time. Potentially useful research would focus on the political and planning process characteristics of communities that scored high in their incorporation of the regulatory items associated with these two principles.

Potential research could also focus on the role of planners: Did they play a different role in the cities with many regulatory items in their zoning ordinances than they did in cities with fewer items? Research of this kind will shed light on the relationship between planners and their communities in the development of a sustainable approach to development: How much of a force for change can planners be? A comparison of the zoning ordinances of communities that are ICLEI members with the ordinances of communities that are not would give us an idea of the significance of cities that have made a public demonstration of commitment to sustainability.

Finally, it bears repeating that we have analyzed only what zoning ordinances say and contain; we do not know the extent to which the sustainability aspects of land use are actually being realized in these communities. There is a rich potential for research uncovering how zoning ordinances affect a range of issues, including sustainability, which we have focused on in this study. Is it possible that communities that adopt the regulatory items we suggest here will actually become more sustainable? If residential solar energy systems are permitted, will the energy footprints of our cities shrink? If more small-lot residential development is allowed, will the density of our cities increase? Understanding the gap between having regulatory items in a zoning ordinance and achieving their desired outcomes is a difficult but necessary and important question for planners. Understanding that link could have profound significance for our communities as they attempt to adapt to a rapidly changing world and for our profession as it attempts to contribute to that adaptation.

We believe that this review of zoning ordinances can make planners aware of the ways in which important principles of sustainability can be captured in their zoning ordinances. Our work also provides ways for planners to assess the contribution of their zoning ordinance to the sustainable development of their communities.

Notes

1. This was the most recent membership list available.

2. The four census regions consist of the following states: Northeast: CT, ME, MA, NH, NJ, NY, PA, RI, VT; Midwest: IL, IN, IA, KS, MI, MN, MO, NE, ND, OH, SD, WI; South: AL, AR, DE, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN, TX, VA, WV; West: AK, AZ, CA, CO, HI, ID, MT, NV, NM, OR, UT, WA, WY.

3. The eight reviewed APA policy guides were *Community and Regional Food Planning* (2007), *Climate Change* (2011), *Endangered Species and Habitat Protection* (1999), *Energy* (2012), *Environment: Wetlands* (2002), *Historic and Cultural Resources* (1997), *Housing* (2006), and *Surface Transportation* (2010) (APA 2014a).

4. The RMLUI (2014) *Framework—Sustainable Community Development Code Beta Version 1.5* is portrayed as encompassing the environmental, economic, and social equity dimensions of community development. It is designed and intended to help "municipalities, regions and states to seamlessly audit and upgrade their development laws to remove barriers, create incentives and fill regulatory gaps based on a core set of sustainability objectives." Although still under development, it is currently used by communities "to adopt new codes, revamp existing codes or as a code audit tool." The code contains nine sections that correspond to broad dimensions of sustainable development, such as land use, transportation, and natural resources. These nine subsections are divided into 18 completed subsections, each of which contains an introduction, a list of goals, and descriptions of methods to achieve these goals. The methods were used to help identify the regulatory possibilities for this project.

5. The sum of all of the possible forms that we identified the 53 regulatory items could be included in a zoning ordinance is 93. This represents the highest possible zoning ordinance score.

6. The regulatory item presence count based on the number of times the item appears in some form is different from our evaluation of the zoning ordinances, which was based on the number of times each regulatory item appears in all possible forms. The reason for this difference in calculating presence is that while all zoning ordinances have the potential to include each regulatory item in all of its possible forms, the number of possible forms each regulatory item may appear in a zoning ordinance varies. For example, since "steep slopes and hillsides" cannot be counted as permitted uses, the regulatory item was not considered for that regulatory option. Thus, it will always show up as totaling something less than 4. On the other hand, all regulatory options are possible for "solar energy systems and projects." This means that if all 32 zoning ordinances contained both of these items in all of their possible forms—that is, all possible regulatory options for each regulatory item are marked—"steep slopes and hillsides" would necessarily have a lower presence level than "solar energy systems and projects" even though both had their respective highest possible presence levels.

7. The number of years since the zoning ordinances were adopted or significantly revised was correlated with the ordinance scores using Excel's Pearson function. The results of the correlation analysis are $r = -.481$, $t = -3.014$, and $p = .005$, which indicate that there is a 1 in 200 probability ($1/p$) that the two variables are not associated (i.e., correlated) and a 99.5% ($1\text{-}p$) probability that they are.

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