



Toward sustainable urbanization on Mainstreet Cascadia

Gary Pivo

*Department of Urban Design and Planning, University of Washington, Seattle, WA 98195, USA
(e-mail: garypivo@u.washington.edu)*

Mainstreet Cascadia is a band of urban development stretching from the Canadian city of Vancouver, British Columbia to the US city of Eugene, Oregon. The rate and pattern of urbanization there have produced deep public concern over growth related problems and negative environmental consequences. City and regional plans have been prepared in response to these conditions with the common goal of promoting more sustainable urbanization. Some cities in the area already exhibit elements of sustainable urbanization and census data indicate these places are measurably different from other places. Demographic and market trends suggest the plans can be successfully implemented. Copyright © 1996 Elsevier Science Ltd

Introduction

The International Centre for Sustainable Cities (ICSC) is part of Canada's response to Agenda-21 of the 1992 United Nations Conference on Environment and Development. The Centre receives support from the Government of Canada and in collaboration with other organizations carries out demonstration projects promoting sustainable urbanization.

One of the first of these projects is the Georgia Basin Sustainable Urbanization Project. An initial report was released in March of 1994 (The Cascadia Institute and The Discovery Institute, 1994). It provided bi-national policy context, a snapshot of current initiatives, and a basis for further work. It identified sustainability, transportation, trade and economic development as issues for the region.

This paper is based on the second report of the Georgia Basin project (Pivo, 1995a). It examines urbanization trends along "Mainstreet Cascadia", identifies growth patterns that promote sustainable development and points to "low impact cities" that might be models for other cities to follow.

Georgia Basin-Puget Sound lies at the heart of what many are now calling "Cascadia". Cascadia includes the provinces of British Columbia, Alberta and the Yukon in Canada, as well as the states of Washington, Oregon, Idaho and Montana in the US.

At its core, Cascadia contains one of the fastest growing, economically vital, ecologically sensitive, and politically complex urban conurbations in North America. This is Mainstreet Cascadia which extends

as a nearly continuous band of urban development along US Interstate Highway 5 in Oregon and Washington and through the Lower Mainland and southern Vancouver Island of British Columbia.

Mainstreet Cascadia runs past cities, farms and forests connecting several major metropolitan areas and rural towns and centers. Among these are the US state capital of Salem, Oregon and Olympia, Washington and the Canadian provincial capital of Victoria, British Columbia. Along this corridor are the international cities of Seattle and Tacoma in Washington and Vancouver in British Columbia. Important regional centers, such as Portland, Oregon and Bellingham, Washington also contribute to its vitality.

Sustainable urbanization

Urbanization is the process of transformation that affects geographic regions when they become more urban. During the urbanization process, a growing share of a region's land and people become included in cities, suburbs and towns. At the same time, the share of land and population in rural areas declines. This is precisely what is occurring on Mainstreet Cascadia.

Urbanization affects the physical shape of a region as well as the social experience of those who live there. Physical urban growth alters the natural and built landscape while population growth reshapes politics and culture.

The ways in which urbanization transforms a

region depends on the nature of what occurs. Socially, urbanization may increase the richness and diversity of a region's population or cause tension and conflict between competing groups. Physically, urbanization may produce new urban spaces and livable neighborhoods or destroy critical environmental features and important cultural resources.

Sustainable urbanization occurs when the urbanization process harmonizes with principles of sustainable development. It is sustainable development's urban embodiment and provides an urban manifestation of its fundamental ideas.

Timothy Beatley has explored the meanings of sustainability in his introduction to a recent special issue of the *Journal of Planning Literature* (Beatley, 1995). He claims the most commonly cited definition of sustainable development is probably that of the World Commission on Environment and Development (WCED, 1987). They define sustainable development as that which "meets the needs of the present without compromising the ability of future generations to meet their own needs." Beatley argues that this and other definitions share an emphasis on "living within the ecological carrying capacities of the planet, living off the ecological interest, and protecting future generations." Beatley also notes that sustainable development is only recently being applied to the urban planning field (Van der Ryn and Calthorpe, 1991; Roseland, 1992; Beatley and Brower, 1992; Rees and Roseland, 1991).

Opportunities for Achieving Sustainability in Cascadia (The Cascadia Institute and Discovery Institute, 1994) described basic principles of sustainable development. Briefly summarized, they include limiting environmental impacts, minimizing resource depletion, maintaining current stocks of resources, fairly distributing the benefits and burdens of resource use and protection, governing in ways that achieve these goals, and supporting human values that are consistent with sustainable development.

Critics of sustainability point out that the emphasis on minimizing resource depletion and maintaining current resources is inconsistent with the economic principle of substitution which holds that when a given resource becomes scarce, its price will rise which in turn will promote conservation and a shift to lower priced and more plentiful alternatives. However, it may not be necessary to choose between this view and that of sustainable development if one recognizes that the social and environmental consequences of urbanization trends are growing costlier and that sustainable urbanization may be the alternative being produced by the economic law of substitution.

In this paper, it's assumed that the principles of sustainable urbanization are valid and that they will continue to be debated and refined. The subject here is not the principles but rather how urban growth affects our ability to follow them.

Population growth trends

Over 7 million people live in the cities and counties along Mainstreet Cascadia. Most live in the three urban regions centering on Vancouver, BC, Seattle, and Portland which together account for three-quarters of the total population (GVRD, August 1993b; ODOT, 1993b).

Mainstreet Cascadia has experienced tremendous population growth over the last few decades, particularly in the large metropolitan areas. The populations of greater Vancouver and metropolitan Portland doubled between 1960 and 1990 and the population in the Puget Sound region grew by over 80% (GVRD, 1993b; Metro, 1994a; PSRC, 1994a).

The pace of growth in the large metropolitan areas is one of the fastest in North America. Between 1985 and 1990, for example, the greater Vancouver and Puget Sound regions were tied in having the fourth highest growth rates of any metropolitan area in the US and Canada with populations over 1 million (BC Round Table, 1993).

This extraordinary population growth has been generated by natural increases and migration (PSRC, 1994; GVRD, 1994). Migration from overseas and domestic origins played the larger role. In the Greater Vancouver area, for example, roughly two-thirds of the population growth over the past few decades has come from migration, split about equally between domestic migration and immigration. About 60% of the growth in the Puget Sound region has come from migration.

Population growth has fluctuated over the years because migration has been affected by vacillating job growth. Growth dipped in the early 1980s and again in the early 1990s, corresponding with macroeconomic recessions. It swung upward in the late 1970s and late 1980s during times of greater economic vitality (Metro, 1994a).

Planners throughout the region expect population growth to be strong in the foreseeable future. By 2020, the Puget Sound region is expected to grow by 1.2 million people, the greater Vancouver region by 1.2 million and the metropolitan Portland area by 700 000 (PSRC, 1994a; GVRD, 1994; ODOT, 1993a). This means the region can expect a 50–75 percent population increase over the next 25 yr.

Planners are forecasting the growth will favor the three major urban regions of Vancouver, Seattle and Portland. Although many of the less populated non-metropolitan areas are anticipating high rates of growth, the largest real increases are forecast for the three large urban areas (GVRD, 1993c).

The population is not only growing it is also changing in character. Two particularly important trends are shifts in the average age of the population and in household structure. People are getting older and households are getting smaller (GVRD, 1993c; PSRC, 1994a). This is causing an increase in the

demand for smaller housing units. However, it also means that communities wishing to increase population densities will have to increase housing densities even faster than before because new and existing housing units will contain fewer people.

Urban growth patterns

Over the past few decades, communities along Mainstreet Cascadia have become less compact and slightly more complete. Compactness refers to density while completeness refers to the mix of land uses in an area (e.g. jobs, housing, recreation and shopping). The typical city is mostly characterized by lower density housing areas segregated from jobs and services which are too few in number to meet the needs of the residential population.

Communities that have existed for many years have grown denser over the past 20 years. In fact, a study on Washington State by the author found that cities that existed in 1970 were 20% denser by 1990 (Pivo, 1995b).

However, the development of many new low-density settlements on the urban fringe, together with an increase in the proportion of people living in suburbs rather than central cities, have resulted in the average person in 1990 living at lower densities than 20 yr before.

Not only are people living in less compact communities, the density they are living at is too low to be effectively served by public transportation. In 1970 about one in three people in Washington were living at densities high enough to support public transit. By 1990 one-fifth were living in transit oriented places (Pivo, 1995b).

The suburbanization of jobs over the past few decades has increased the completeness of some communities and the number of people who are living in complete communities. However, these gains have been very small and the vast majority of people are still living and working in communities that are either job centers or bedroom communities.

The dispersed pattern of urban development along Mainstreet Cascadia over the past few decades has consumed tremendous amounts of land.

A recent study commissioned by the Puget Sound Regional Council compared satellite images from 1984 and 1992. It found that in that 8 yr period alone, 182 km² of land were converted from non-urban to urban land uses in the four county Puget Sound Region surrounding Seattle. Moreover in 1992, over 96% of the developed land was used for low-density development while less than 4% was used for high-density development (PSRC, 1994b).

Studies by several different planning agencies have confirmed the fact that over the past few decades the amount of developed land has grown by two to three times as much as the population.

These findings reveal that a great deal of the

impact that urban development is having on the land is attributable to the way we grow rather than to how much we grow.

To satisfy its appetite for land, the urban edge has moved outward. In the Portland area, for example, urbanized land has increased by about 100 km² every 10 yr (Aspeslaugh, 1994).

Housing

Housing is the largest consumer of urban land along Mainstreet Cascadia and has had a major influence on the urban growth pattern.

A growing share of new housing is multifamily. In most urban areas more than half the new housing built over the past decade is multifamily. However, most of the existing stock remains single family and most new single family housing is being developed in low-density subdivisions on the urban fringe.

Despite higher densities in the central cities, overall housing densities are relatively low. They run at around 350–900 dwelling units/km² which is similar to those found in other urban regions of the western US and Canada (Metro, 1994a).

Two opposing trends are affecting housing densities. One is the increase in housing densities that is occurring in existing cities and suburbs from redevelopment and infilling which is pushing densities upward. The other is the creation of low-density subdivisions on the urban fringe which is pulling densities downward.

King County, Washington, which includes Seattle and its suburbs, provides an example of these competing trends. Overall, housing densities increased by around 20% over the past two decades. However, between 1985 and 1992, the average density of new lots was about 0.8 lots/ha which muted the density gains (King County, 1994). Single family lots of traditional detached design can be created at up to 3 units/ha (Alexander, 1988) but new lots in King County are typically being platted at a quarter of this potential.

Not all of the housing growth has been occurring inside urban areas. So-called "exurban" development has become increasingly common. In portions of the Portland area, for example, as much as 20% of new housing has been built in rural areas beyond suburbia within short commuting distances to the city (1000 Friends of Oregon, 1991).

Centers and subcenters

As the region has spread, the relative importance of higher density downtowns and suburban centers has waned. However, compared to many regions of North America, centers have done better than might be expected.

The Vancouver area has been among the most successful in attracting growth to centers. However, even there, commercial space outside centers has grown faster over the past 20 yr than inside centers.

This trend is occurring even more quickly in other parts of Mainstreet Cascadia and causing traditional urban centers to lose their dominance.

While many downtowns have grown, others remain stagnant. The central business districts of the largest cities grew a great deal. Particularly during the late 1970s and early 1980s, downtown Portland, Seattle and Vancouver exploded with new offices and, to a lesser extent, new housing. On the other hand the central business districts of places like New Westminster and North Vancouver in the greater Vancouver area and Everett, Bremerton and Tacoma in the Puget Sound area grew little from 1960 to 1990 (PSCOG, 1990b).

Despite the growth of some downtowns, they now contain a smaller share of total employment than ever before. In the Greater Vancouver region for example, downtown Vancouver's share of the region's jobs dropped from 51% in 1971 to 39% in 1991.

The same relative decline has occurred in the smaller cities along Mainstreet Cascadia like Salem, Oregon where central city areas have not kept pace with peripheral areas (Salem, 1993).

In the Seattle region too, downtown Seattle is no longer the sole focus. Several nuclei have emerged in a regional form of clusters and corridors (PSCOG, 1990a). Only 12% of the households and 36% of the jobs are in areas with both dense jobs and housing (Pivo, 1995b).

Suburban centers have grown up over the past decade. However, their natural histories have varied. In the Greater Vancouver area, for example, there has been more success locating residential growth at centers than commercial growth (GVRD, 1993a). Meanwhile, just the opposite has occurred in Oregon and Washington.

Employment

Increasingly, jobs are located in low-density suburban areas. Retail, office and industrial activities are no longer concentrated in central cities. Instead, they are mostly located in shopping centers, retail strip malls, office parks and industrial parks along suburban freeways and arterials.

Jobs and housing tend to be segregated into separate areas. Local jurisdictions either have more jobs than are needed to employ their residents or more housing than is needed to house their workers.

Things to come

Planners are projecting that the pattern of low density segregated land uses will continue unless efforts are made to change direction. Regional planners in the greater Vancouver area, for example, have projected that the region could spread suburban development into agricultural and rural areas with the highest growth rates farthest from the region's center (GVRD, 1993c). Current trends

would generate a population increase of 1.2 million over the next 30 yr outside and to the east of the established metropolitan area (GVRD, 1994).

A detailed description of things to come by 2040 in the absence of a new direction was done for the Portland region by its regional government Metro (1994b,c). It is indicative of similar forecasts being made by planners all along Mainstreet Cascadia:

- Most development will be low density.
- Housing growth will move outward in a diffused ring and regional density will fall by about 10%.
- Single family housing will remain at about 70% of all housing.
- Jobs will move outward as well, with little growth in centers other than downtown Portland.
- The central city will remain dense.
- New suburban centers will be slow to grow and growth in the central city, regional centers and sub-regional centers will be primarily jobs.
- Rural land will be converted at low densities.
- Daily vehicle miles of travel per capita will grow from 20 to 21 km.
- Single occupant vehicles will be used for 92% of all trips.
- Congested road kilometers will grow from 250 to 800.

The environmental costs of urban growth trends

Traffic and auto dependence

Two of the most obvious results of the population growth and development patterns along Mainstreet Cascadia have been increased automobile use and traffic congestion.

Studies throughout the region show that vehicle miles of travel are growing faster than population. For example, between 1970 and 1990, the population of Oregon grew by 38% while vehicle miles traveled grew by 97% (Livable Oregon, Inc., 1994). Similarly, between 1985 and 1992, the population of Greater Vancouver grew by 21% while total vehicle trips grew by more than 42% (GVRD and BC, 1993).

One reason that vehicle miles and trips have grown so quickly is that the proportion of trips made by public transportation and carpooling have declined. For example between 1961 and 1987, the share of all trips made by single occupant vehicles in the Central Puget Sound region increased from 58 to 69% (BC Round Table, 1993). Even in the Greater Vancouver area, with its superior transit service, there was an aggregate decline of about 12% between 1985 and 1992 in the share of all trips made by transit and an increase of about 5% in the share made by driving alone (GVRD, 1993a-d; 1993). It should be noted that in areas of greater Vancouver where transit investment were made (e.g. Sky-

Train), transit's share of trips was maintained. Thus, the problem may be more a lack of investment in transit rather than a failure of transit itself.

The average daily traffic on streets is growing even more quickly than vehicle miles of travel and vehicle trips because street expansion and construction have not kept pace with the growth in travel demand. On many major streets in the Eugene area, for example, traffic has grown at a rate of 3–6% or more (Lane COG, undated). Meanwhile, traffic on US Interstate 5 has been growing at an annual rate of 1.6% inside the Portland area and between 3 and 4% outside the Portland area (ODOT, 1993b).

Worsening congestion is the most obvious result of these trends. In Eugene, Oregon at least half the local residents find roads are congested at various times during the day and the vast majority of residents find them congested during rush hours (Lane COG, undated).

Both major and minor streets are affected by congestion. As major streets grow more congested, traffic is diverting to neighborhood streets.

Changes in population size and character are also contributing to the growth in auto dependence. Not only are there more people but people are traveling more. A greater share of the population is working which generates more work trips. Households are smaller, requiring more people to travel to meet basic household needs. Incomes are higher, increasing the number of trips per person, car ownership and car use. More of the population has driver's licenses, reducing bus use by transit dependents. Thus, for several reasons, a more auto-mobile population is living along Mainstreet Cascadia.

Urban growth patterns are another factor in the growth of auto dependence. The segregation and dispersion of land uses have increased the distance people travel between destinations and have reduced their ability to use alternatives to driving alone.

Most transit service is designed to move people between the suburbs and the central city. However, the suburb to city trip represents a shrinking slice of the travel pie while the share of trips between suburbs is growing.

In the Greater Vancouver area for example, the suburb to suburb share of trips grew by 7% while the suburb to Vancouver share fell by 25% between 1985 and 1992 (GVRD and BC, 1994).

The dispersed pattern of origins and destinations in suburban areas, the poverty of facilities in suburbia for bicycles and pedestrians, and the prevalence of free parking have placed alternatives to driving alone at a competitive disadvantage.

Planning projections of current development trends are being conducted throughout the region. One notable finding of these studies is that there appears to be a basic tradeoff that must be dealt with between auto use and traffic congestion.

Alternatives that decrease the proportion of trips made by driving along generate more congestion. Congestion can increase certain types of air pollution. On the other hand, alternative growth patterns that reduce auto congestion, increase auto use.

One such projection was done by Metro for the greater Portland area (Metro, 1994a–d). Its projections of current trends in 2040, compared to more compact alternatives, showed that current trends would result in an extensive road system and more low density development. Current trends would generate the least congestion of any alternative even though vehicle miles of travel would grow to be twice that of 1990, more than any other growth alternative. Commute times would increase by more than 18% over 1990, the non-auto share of travel would be the lowest of any alternative and vehicle miles of travel per capita would increase by 5% over 1990 levels.

Land consumption

Another result of urban dispersion has been the conversion of rural and resource lands into urban land uses and related impacts on natural resources and environmentally sensitive areas like farmlands and wetlands.

Stocks of farm and forest land on the urban fringe have been particularly hard hit by land extensive development.

Between 1980 and 1987, 750 ha of the highest quality agricultural land were converted to urban uses in the Lower Fraser Valley east of Vancouver due to expansion of the Greater Vancouver region. This occurred even in a region with one of the strongest agricultural land protection programs in North America. Most of the developed land was not under the protection of the agricultural reserve program. However, in the agricultural areas around Greater Vancouver that were part of the official reserve program, 8.5% of the farmland was lost to urban uses between 1973 and 1990. This was over 20 times the rate that occurred in more remote locations of British Columbia (BC Round Table, 1993).

Environmentally sensitive areas like wildlife habitat, wetlands, erodable slopes and aquifer recharge areas have also been affected by expansive urban growth. In the Puget Sound region, for example, nearly 60% of coastal salt marsh wetlands in the Puget Sound region have been lost and in some river basins the loss is almost total (BC Round Table, 1993).

Water pollution

Urban runoff is a major source of water pollution problems all along Mainstreet Cascadia.

The auto dependent development pattern has exacerbated urban runoff. Much of the urban runoff pollution comes from roadways. Roadway runoff increases with both miles of roadway and vehicle

miles traveled. Both of these have been increasing.

Washington State prepared a thorough inventory of its water quality conditions in 1988 (Washington State Department of Ecology, 1988). It found that urban runoff and construction were contributing to over 800 km of rivers and streams, over 250 km² of estuaries, and over 170 000 ha of lakes being incapable of fully supporting beneficial uses like fishing and recreation. For lakes, it is the third largest cause of water quality problems after industrial discharges and mining and mineral processing.

Non-point pollution from urbanization is also one of the most common sources of groundwater pollution. Non-point groundwater pollution is often due to failed septic systems. Low density residential development on the urban fringe typically relies on septic systems. The rapid growth of low-density rural growth is increasing the risk and occurrence of groundwater pollution.

Air pollution

The mountains and valleys along Mainstreet Cascadia help trap air pollution and increase the region's vulnerability to air pollution problems. Carbon monoxide (greenhouse gas), particulates and ozone are the major air pollution problems in the area. Federal, state and local standards are occasionally violated. The most serious problem is ground level ozone. This has declined recently, but violations continue to occur and projections indicate it will continue to be a problem (BC Round Table, 1993).

Carbon monoxide is associated with traffic congestion. When violations occur they tend to be located in congested settings like central business districts and shopping centers (PSCOG, 1990c). It is because of the link between congestion and carbon monoxide pollution that planning studies have shown that more compact development patterns can increase carbon monoxide pollution even though they decrease the proportion of trips made by driving alone. This is one of the negative side effects of more compact urban form that must be mitigated.

Small particulates are another problem and tend to be associated with the region's industrial areas such as Seattle's Duwamish valley. Violations of particulate standards have declined recently and annual mean levels have been improving (PSCOG, 1990c).

Infrastructure deficiencies

Infrastructure such as sewerage, water supply systems, drainage facilities, parks, schools and libraries affect the sustainability of urban growth in both environmental and social terms.

The nature of sewer, water, energy and drainage systems, for example, can encourage the conservation or consumption of natural resources. They can help reduce the adverse effects of human waste disposal. They can even affect the conservation of

resources by the way they are sited as land users.

Infrastructure also sustains the social dimensions of a region. Schools, libraries, community centers, police services and other services can improve communities, reduce unrest and provide stability.

Urban growth along Mainstreet Cascadia has outpaced its infrastructure capacity. Planning studies report that deficiencies commonly exist in services like schools, parks and water supplies. A Council of Governments report for the Eugene-Springfield, Oregon area declared that portions of that area lacked key services and that community and neighborhood parks in particular were inadequate to meet the demand (Lane COG, 1987). Other cities in the region are making similar findings.

Besides the problem of catching up with infrastructure deficiencies, there is the need to keep up with new demands on infrastructure from continuing urban growth. Water facilities in the Portland area, for example will need to be greatly expanded to accommodate the growth anticipated there (Metro, 1994a).

Altogether, catching up and keeping up with infrastructure needs will be very expensive. New comprehensive plans now being adopted by most cities and counties in Washington State, for example, project a cost of nearly \$6 billion (US) to provide the capital facilities needed during the next 6 yr programming period (Mattox, 1995).

Sprawling growth patterns are more expensive to serve with infrastructure than alternative development patterns (Frank, 1989). Current trends toward spreading development in the Portland area, for example, will mean drastic increases in service costs and response times for emergency vehicles according to planners there. Serving current growth trends in Vancouver would require extending urban infrastructure the full 12 km of the lower Fraser Valley and doubling the number of bridge lanes from 47 to 85 by 2021 (GVRD, 1993c).

The planning response

In response to these conditions, government agencies at all levels are adopting plans to make urban growth more sustainable. A close examination of these plans suggest there are six basic principles that planners are pursuing to make cities more sustainable.

Compactness

The Round Table recommends that the Province of British Columbia strongly encourage urban containment, residential intensification, and compact community development . . . [From *Georgia Basin Initiative: Creating a Sustainable Future*, British Columbia Round Table on the Environment and the Economy, 1993].

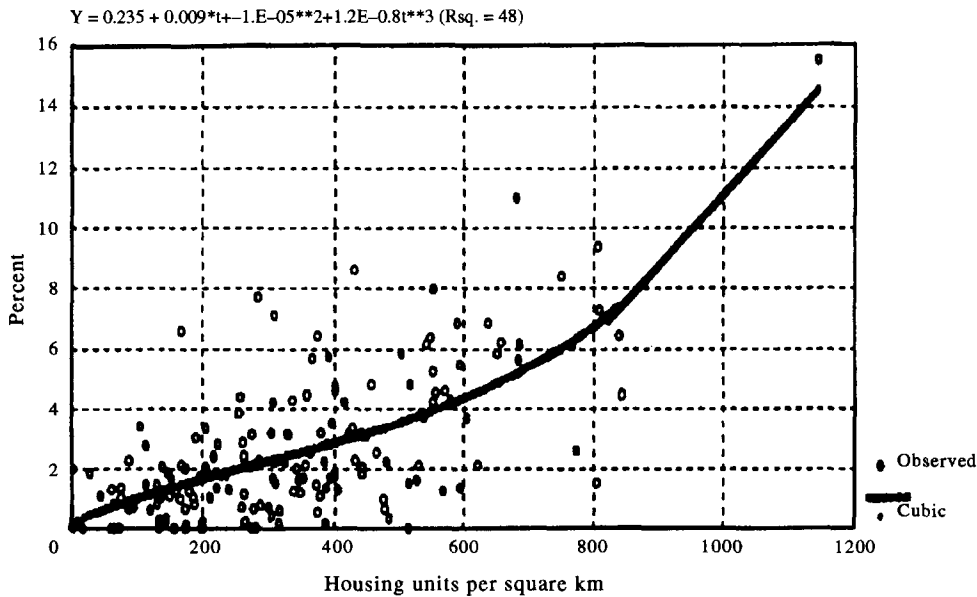


Figure 1 Percentage of residents who bus to work as a function of housing density at place of residence

The first principle is that more compact or densely developed cities are less auto dependent, less expensive to serve with infrastructure, and place less pressure on farms, forests and environmentally sensitive areas.

Empirical research on growth patterns in Cascadia confirms that a link exists between compact development and less auto dependence. Figure 1, from a study by the author on communities in Washington State, shows that the percentage of people who bus to work increases as the population density rises in the city where they live (Pivo, 1995b).

Other recent studies support the idea that compact urban form is less expensive to serve with infrastructure. A recent consultation report on growth options for King County, Washington (where Seattle is located), for example, concluded that an urban containment strategy would save the county and its taxpayers money over the long run (Tischler Associates, 1994).

There is also proof that compact growth helps reduce the loss of farmland and forest land. Research in Oregon on land use policies that curtail urban sprawl has confirmed that farms and forests are more effectively sustained when urban growth is more compact (1000 Friends of Oregon, 1991).

Completeness

Creating a better balance between jobs and the labour force in all parts of the region can help to provide more opportunities to live closer to work or to work closer to home. [From *Livable Region Strategy: Proposals*, Greater Vancouver Regional District, 1993c]

Another precept underlying many plans being made in the region is that the segregation of urban activities should be reduced. Communities should be more balanced by including jobs, housing, shopping and other land uses.

Reducing the segregation of land uses reduces the distance people must travel between activities. This can lower auto use, traffic congestion, air pollution, energy consumption and water pollution.

Better balance may also reduce the price of housing near job centers by bringing supplies in line with demand for housing near job sites.

Researchers continue to debate the impact of complete communities (Cervero and Landis, 1995), however empirical evidence on Washington state supports the hypothesis that complete communities can reduce commuting. Figure 2 shows the results of a study on the cities of Washington State (Pivo, 1995). It demonstrates that as the number of jobs in a community increases relative to the number of housing units (i.e. as it moves away from being a bedroom community toward being a job center), more people who live in the community will work in the community. The inverse is also true: As housing increases relative to jobs, the number of people who work where they live decreases. Thus, a system of balanced communities minimizes commuting to work.

Conservation

Protect sensitive environmental areas such as wetlands, riparian zones, landslide hazard areas and steep slopes from urbanization (and) preserve historic, visual and cultural resources, including

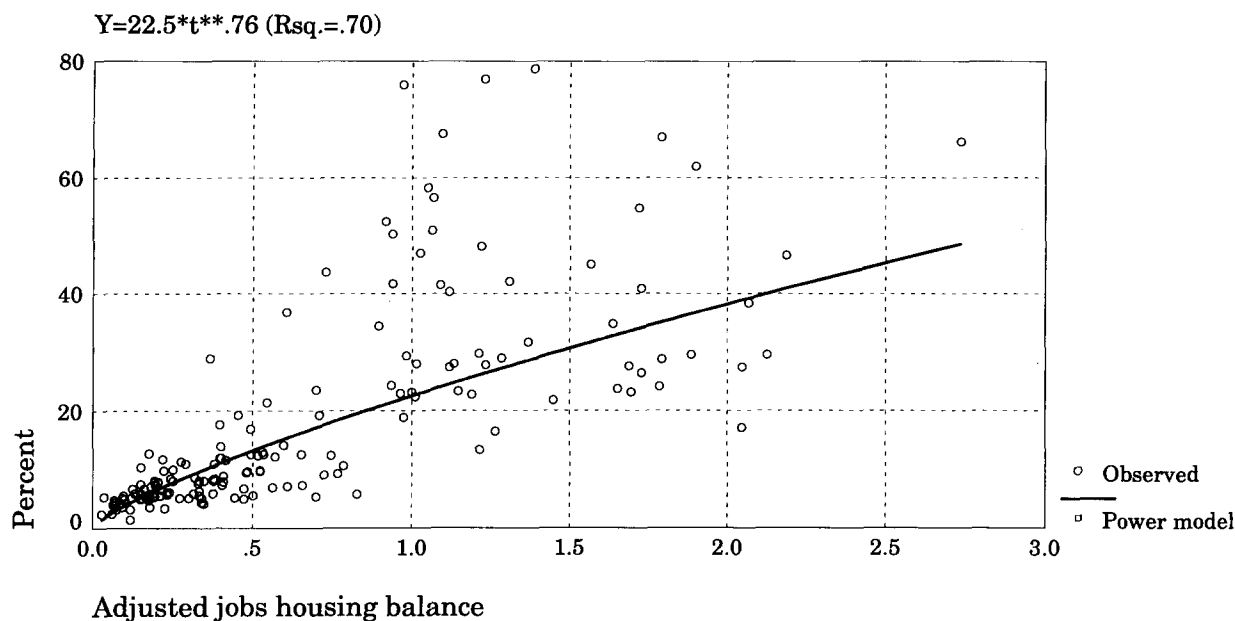


Figure 2 Percentage who work in place of residence as a function of jobs housing balance at place of residence

views, landmarks and areas of special locational character — “the sense of place” definers. [From *Vision 2020: Growth and Transportation Strategy for the Central Puget Sound Region*, Puget Sound Council of Governments, 1990b].

A third principle underlying planning for sustainable cities is that urban growth should be restricted in and around sensitive environmental features. For some areas, such as wetlands, wildlife habitat and aquifer recharge zones, the purpose of protection is to preserve their ecological functions. For other areas, such as frequently flooded or geologically hazardous zones, the goal is to protect public health and safety.

A major issue generated by regulatory efforts to protect environmentally sensitive areas is generally referred to as the property rights or takings issue. Some property owners, particularly in rural areas, feel that regulations prohibiting them from harming sensitive areas unfairly burden them in order to benefit the public and that the public should reimburse them for any diminution of property value caused by the regulations. They are essentially arguing that the burdens and benefits of resource use and protection are being unfairly distributed, which goes to one of the six basic principles of sustainable development discussed above. Others feel that the rules are fair and property owners should not be compensated for regulations that protect the environment and other property owners from harmful development practices.

In Washington State, over 200 000 citizens signed an initiative in the last months of 1994 asking the state legislature to adopt a law requiring compensation for property owners whose property values are

lowered by environmental regulations. The legislature responded by adopting such a law in 1995, however a subsequent referendum placed the law on the November ballot where it was defeated in a statewide election.

This issue of how to balance the benefits and burdens of resource use and protection will remain for some time to come. There are a number of tools, other than traditional land development regulations, that could be employed to protect sensitive areas (Kelly, 1993). They include tax incentives, fee simple and less than fee simple land acquisition, cluster development, and transferable development rights, to name just a few. However, the fundamental issue is how the burden of sensitive area protection should be distributed among property owners and taxpayers and that issue is as of yet unresolved (Cordes *et al.*, 1983).

Comfort

The identity and functioning of communities in the region shall be supported through ensuring that incentives and regulations guiding the development and redevelopment of the urban area promote a settlement pattern which is pedestrian “friendly” and reduces auto dependence . . . [Objective 19.iii.a., Regional Urban Growth Goals and Objectives for Metro Portland, 1994a–d].

A fourth concept is that it is important to create public spaces that are comfortable for pedestrians. This not only promotes alternatives to driving alone, it creates opportunities for citizens to share spaces with people from a diversity of backgrounds and

cultures and to be more aware of the social complexity of their society.

A recent study in the Portland Area found that the design character of streets positively affects pedestrian activity. More people walk when sidewalks are continuous, streets are easy to cross and connected in a grid pattern and the topography is conducive to walking (Parsons Brinckerhoff Quade and Douglas, Inc., 1993).

Coordination

. . . the issues of metropolitan growth are inter-related. Consequently, the planning and growth management activities of many jurisdictions are both affected by and directly affect the actions of other jurisdictions in the region. In this region, as in others throughout the country, coordination of planning and management activities is a central issue for urban growth management. [From Background Statement, Executive Recommendations, *Region 2040 Plan: Decisions for Tomorrow*, Metro Portland, 1994d].

Coordination is a fifth principle of planning for sustainable urban growth. It is manifested in a number of ways.

One kind of coordination takes the form of coordinated planning among communities in a region. Communities have learned they share problems with their neighbors and must work together to solve them. One example is the effort now underway to create a coordinated land use and transportation strategy for the Willamette Valley from Portland to Eugene in Oregon. Communities are working together to decide upon a regional strategy for managing growth so that mobility, air quality, and other values can be sustained (Livable Oregon, Inc., 1994).

Another kind of coordination that forms the basis for many new plans is coordination between land and infrastructure development. It is known as concurrency planning and maintains that infrastructure should be available at the time new development occurs. It is generating greater coordination between both land use and infrastructure planning and between development permitting and capital investment programming.

A third kind of coordination is called regulatory consistency. It refers to the need to ensure that plans are coordinated with implementing regulations like zoning controls.

Collaboration

The Round Table . . . recommends . . . funding to ensure the appropriate stakeholder groups can participate in the process in a proactive and meaningful way. [From Recommendation 17, *Georgia Basin Initiative: Creating a Sustainable*

Future, British Columbia Round Table on the Environment and the Economy, 1993].

Collaborative cities share power and involve people in the decisions that affect their future. Disputes are avoided and support is obtained for long-range progress toward sustainable urbanization by bringing people together early in the decision making process to work toward win-win solutions to complex problems.

An example of collaborative planning along Mainstreet Cascadia is Partnership for the Willamette Valley's Future (Livable Oregon, Inc., 1994). It is one of several efforts being funded by the State of Oregon, federal agencies and private foundations. The project is building new partnerships to strengthen community vitality and enhance the quality of life as the population grows. The focus is on what people can do *together* to build a quality future. It began last October with a meeting to build recognition and understanding among community leaders from the government, business and non-profit sectors and to identify what must be done to protect and enhance the valley's quality of life in the decades ahead. The project is designed to facilitate an *ongoing dialogue* about issues of common concern that have regional implications in the Willamette Valley.

Attitudes toward sustainable urbanization

The sustainability of urban growth is a major public issue in the study area. While the term "sustainable urbanization" is not the phrase most commonly used to describe the issue, a review of public attitudes about urban growth leaves little doubt that that is what people desire.

One survey completed by the Oregon Business Council in 1992 found that the biggest fears of Oregon's citizens were overpopulation, environmental destruction, the loss of forests and uncontrolled growth (Oregon Business Council, 1992). In fact, growth has become a bigger worry than either crime or the economy.

Similar feelings have surfaced elsewhere. A recent survey in British Columbia found more than half the people there felt growth was negatively affecting their quality of life (Province of British Columbia, Ministry of Municipal Affairs, 1994). Another survey in the four county area around Seattle known as the Puget Sound Region indicated that growth and traffic join crime and weather as top citizen complaints (Elway Research, 1993).

Citizens strongly support more coordinated government action to manage growth. Surveys in the Vancouver, BC and Seattle areas found support for more regional planning and better regional governance. People seem aware of the need for a coordinated approach to urban growth issues.

Citizens appear unhappy with how urban growth has been occurring. They support efforts to reshape development to be less sprawling and auto dependent.

While the public supports new directions in urban development, they are cautious about specific actions that they think might threaten existing neighborhood character. For example, surveys done by Metro, for greater Portland regional planning agency, found popular support for channelling new growth toward corridors that are served by public transit and for redeveloping city centers (Metro, 1994d). Yet people signaled caution when it came to intensifying development in order to create a more compact region.

Although a majority in the Portland survey favored reduced lot sizes to help slow urban sprawl, nearly a third of the respondents opposed smaller lots. That was the highest level of opposition to any proposal for managing growth.

People were cautious about more intense development because they worry it might be incompatible with what they want for their communities. Respondents desired adequate space for playgrounds and recreation, less crime, harmony between neighbors, affordable housing, neighborhood character and home ownership. A large minority were concerned that more intensive development may be incompatible with these goals.

Similar feelings exist in the Seattle region (Elway Research, 1993). People support more compact and complete communities in concept but oppose smaller lots, more townhouses and more apartments. Concentrating growth is seen as good for the environment but bad for crime.

Traffic congestion is a common problem up and down Mainstreet Cascadia and people want mass transit to be part of the solution. Surveys in both the Seattle and Vancouver, BC regions have uncovered strong public support for better transit and regional transit systems (Elway Research, 1993; GVRD, 1994).

Another popular sentiment is for keeping taxes down (Elway Research, 1993; GVRD, 1994). This could convert into popular support for compact urban patterns if citizens realize it can lower taxes by reducing spending on public infrastructure (Frank, 1989). The same sentiment, however, produces opposition to pricing strategies, such as gas taxes and freeway tolls, that are considered by many policy analysts to be effective tools for reducing auto use and traffic congestion (Downs, 1992).

Are there models to follow?

In response to the planning being done to implement these six principles, leaders are naturally asking several key questions. What do places really look like when they follow these planning principles?

Does growth really have fewer negative environmental consequences when it's managed accordingly? How do people feel about living in more sustainable places?

These are important questions that must be answered if sustainable cities are to move from theory to practice. Changes are risky for the leaders who promote them. So they deserve to know whether the results will be worth the trouble.

To obtain concrete answers to these questions, a search was made for "low impact cities" along Mainstreet Cascadia.

Data were examined on the compactness and completeness of every municipality, city and unincorporated urban place. Compactness was measured in terms of housing and employment densities. Completeness was measured in terms of jobs-housing and retail-housing balances.

Each of the four components was standardized to a scale of 0-25 and each community was scored relative to other places in their state or province.

For example, the city along Mainstreet Cascadia in Oregon with the highest housing density relative to all other places along Mainstreet in Oregon received a score of 25 for housing density. The one with the lowest housing density relative to others received a score of zero.

This was done for all four measures for every community along Mainstreet Cascadia in Oregon, Washington and British Columbia. The individual scores for each component were then summed to give each community an overall score on the compact and complete community index. Thus, the maximum score possible was 100 and the lowest was zero.

Tables 1-3 show the most complete and compact communities along Mainstreet Cascadia. They list the values for the variables used to compute the standardized scores, the standardized score for each component, and the total populations for each place listed.

The leading places represent a variety of communities types. Their population sizes range from as little as 7500 to as much as 516 000. They also vary in location and include central cities, like Vancouver, BC, suburban cities like Kirkland, Washington and rural centers like St Helens, Oregon.

Most readers will be unfamiliar with the communities listed. This makes it hard to imagine what they actually look like. Moreover, just knowing what they look like does not tell how they perform in terms of indicators of sustainability.

Therefore, Table 4 was prepared to give the reader an idea of how the most compact and complete places compare to other communities. It was done for Washington State only and compares the 25 most compact and complete places in the state with the other 173 communities in the state.

The first set of indicators describe just how com-

Table 1 Characteristics of the ten most compact and complete communities in British Columbia's Lower Mainland, 1991 (density in jobs or units/km²)

Place (total standardized score)	Job density (standardized score)	Housing density (standardized score)	Adjusted jobs- housing balance ^a (standardized score)	Adjusted retail- housing balance (standardized score)	Total population
1. Vancouver (91)	2809.71 (25)	1803.74 (25)	1.28 (17)	1.05 (24)	476 378
2. New Westminster (74)	1628.54 (15)	1446.48 (15)	0.92 (23)	0.71 (17)	43 585
3. Matsqui (59)	678.07 (6)	670.42 (9)	0.83 (20)	1.03 (24)	68 064
4. Port Coquitlam (56)	605.79 (5)	479.04 (7)	1.04 (24)	0.81 (19)	6 773
5. N. Vancouver City & District (55)	812.36 (7)	914.79 (13)	0.73 (17)	0.77 (18)	113 593
6. Langley	388.17 (3)	365.60 (5)	0.87 (21)	0.98 (25)	85 805
7. Delta (53)	663.49 (6)	659.51 (9)	0.82 (20)	0.75 (18)	88 978
8. Burnaby (52)	1220.50 (11)	801.62 (11)	1.25 (17)	1.43 (13)	158 858
9. White Rock (52)	962.44 (9)	1632.47 (23)	0.48 (9)	0.52 (11)	16 314
10. Chilliwack (51)	206.58 (2)	190.84 (3)	0.89 (22)	0.98 (25)	49 531

^aAdjustments are made to 1.00. A score of greater than 1.00 indicates there are more total jobs or retail jobs than needed in the community while less than 1.00 indicates there are fewer than needed.

Table 2 Characteristics of the ten most compact and complete communities along I-5 in Washington, 1990 (density in jobs or units km²)

Place (total standardized score)	Job density (standardized score)	Housing density (standardized score)	Adjusted jobs- housing balance (standardized score)	Adjusted retail- housing balance (standardized score)	Total population
1. Seattle city (93)	2021.62 (25)	1146.11 (25)	1.39 (19)	1.11 (24)	516 259
2. Kirkland city (73)	837.94 (10)	651.46 (14)	1.01 (25)	1.16 (23)	40 052
3. Tacoma city (71)	821.67 (10)	603.88 (13)	1.07 (24)	1.11 (24)	176 664
4. Vancouver city (69)	955.53 (12)	574.28 (13)	1.31 (21)	1.08 (24)	46 380
5. Edmonds city (67)	620.53 (8)	684.45 (15)	0.71 (21)	0.88 (24)	30 744
6. Richmond Highlands (66)	510.76 (6)	806.91 (18)	0.50 (18)	0.88 (24)	26 037
7. Des Moines city (65)	576.47 (7)	844.56 (18)	0.54 (18)	0.62 (21)	17 283
8. Burien (65)	524.67 (6)	687.00 (15)	0.60 (19)	1.05 (25)	25 089
9. Federal Way (63)	491.41 (6)	551.49 (12)	0.70 (21)	1.03 (25)	67 554
10. Bothell city (60)	601.42 (7)	373.74 (8)	1.27 (21)	1.16 (24)	12 345

compact and complete the communities were in 1990. The top 25 places had average employment densities that were about 3.5 times that of other places and housing densities that were about 1.8 times that of others. In addition, the top communities had excel-

lent jobs- and retail-housing balances while the others generally had shortages in both employment and retail services.

Travel behavior is compared in the next group of indicators. Busing to work is higher and driving

Table 3 Characteristics of the ten most compact and complete communities along I-5 in Oregon, 1990 (density given in jobs or units/km²)

Place (total standardized score)	Job density (standardized score)	Housing density (standardized score)	Adjusted jobs- housing balance (standardized score)	Adjusted retail- housing balance (standardized score)	Total population
1. Milwaukee (84)	1098.96 (20)	662.72 (21)	1.26 (18)	1.06 (23)	18 692
2. Portland (80)	1045.93 (19)	614.38 (20)	1.29 (17)	1.08 (23)	437 319
3. Corvallis (74)	771.50 (14)	517.15 (17)	1.13 (22)	1.16 (21)	44 757
4. Beaverton (72)	1133.85 (21)	672.69 (22)	1.28 (18)	1.51 (12)	53 310
5. Woodburn (69)	496.56 (9)	451.02 (15)	0.83 (21)	0.98 (24)	13 404
6. Newberg (69)	551.37 (10)	430.57 (14)	0.97 (24)	0.82 (20)	13 086
7. St Helens (68)	441.35 (8)	332.47 (11)	1.01 (25)	0.97 (24)	7 535
8. Springfield (68)	517.28 (10)	520.70 (17)	0.75 (19)	0.92 (23)	44 683
9. Albany (68)	542.06 (10)	414.30 (13)	0.99 (25)	1.21 (20)	29 462
10. Forest Grove (66)	545.44 (10)	477.49 (15)	0.87 (22)	0.75 (19)	13 559

Table 4 How the 25 most compact and complete communities in Washington compared to other communities in Washington

Indicator	Top 25 in Washington	All others in Washington	Top 25 compared to others
<i>Compactness and completeness</i>			
Mean compact and complete index	64.65	43.54	More C & C
Median employment density (jobs/km ²)	620.53	181.25	More dense
Median housing density (units/km ²)	551.49	304.88	More dense
Median adjusted jobs-housing balance	1.00	0.37	More balanced
Median adjusted retail-housing balance	1.04	0.37	More balanced
<i>Travel behavior</i>			
Median percentage of workers who bused to work	4.24	1.98	More busing to work
Mean percentage of workers who drove alone to work	73.77	77.37	Less SOV use to work
Median percentage of workers who worked in place of residence	28.89	8.12	Less out-commuting
<i>Social characteristics</i>			
Median percentage of persons 25+ with college degree	19.90	19.09	More college degrees
Mean percentage family households	64.48	73.92	Fewer families
<i>Housing characteristics</i>			
Percentage housing units that were owner occupied	52.16	63.82	Less housing ownership
Mean median contract rent (US\$/month)	396.08	433.28	Lower rent
Median median value of housing (US\$)	100 000	89 350	Higher housing values

alone to work is lower in the most compact and complete communities. The differences would be even larger if the density of the top 25 were greater, however most of them did not have densities that exceeded thresholds normally required for higher transit use.

The most dramatic difference in travel behavior was the percentage of workers who worked in the community where they lived. A median of nearly 30% of the workers living in the most compact and complete communities worked where they lived

compared to under 10% in other communities. This is primarily a function of the greater jobs-housing balances in the compact and complete communities.

The social indicators present other differences of considerable interest. First, about the same percentage of adults had college degrees in both groups of communities. This suggests that living in compact and complete places is no less attractive to college educated adults, who tend to be sensitive to quality of life issues, than traditional suburbs with their lower densities and segregated land uses.

A social indicator that does raise concern, however, is the proportion of households that are families (ie households with two or more related persons). This was somewhat lower in the compact and complete places although families still represented a majority of all households.

The lower family household rate is probably due to a number of factors associated with the most compact and complete communities that are unrelated to their density and balance.

For example, a higher proportion of the top 25 places are central cities. Central cities tend to have fewer family households because of their reputations for higher crime and poorer schools and because of their more expensive housing.

Of course, families may also be reluctant to choose higher density living, but most of the reasons for the lower proportion of families to compact and complete communities are probably unrelated to their more sustainable urban form.

This suggests that if a community can provide a compact and complete development pattern that is safe and affordable and that offers good schools and family oriented amenities, like playgrounds and housing with adequate yards, there is no reason why they cannot be family-oriented places.

The last set of indicators describe housing conditions. While the majority of housing units are owner occupied in the compact and complete communities, about 10% more are owner occupied in other places.

This again is probably due to the fact that housing values are about 10% higher in compact and complete communities. As with the family household rate, the higher prices are probably related to the higher property values in central cities which are disproportionately represented among the top 25 places.

If we build it will they come?

One of the key questions about sustainable urbanization is whether it will be able to compete in the marketplace. In other words, if new growth is developed in a manner that is consistent with the six principles of sustainable urban growth, will there be a market for it among consumers.

There is little controversy about whether consumers would be attracted to communities that conserve environmental resources, make people feel comfortable by providing quality urban design, coordinate their activities and collaborate with stakeholders. There is more controversy however over whether citizens want to live in more compact and complete communities.

Complete communities seem to be attractive to those who are tired of having to commute to work and other destinations. A recent survey of workers in Silicon Valley in California, where there is a shortage of housing relative to jobs, showed that

many workers would prefer to live closer to work if they could find an affordable place. They would even be willing to settle for a smaller house and yard if it meant not having to commute as far to work.

Other studies have shown that there is an unmet demand for housing close to where people work. The low vacancy rates in rental units around downtown Seattle is further evidence. If better jobs-housing balances can be achieved while not changing the price and type of housing, it would probably be well received in the marketplace.

Of course, one of the major reasons why job centers have less housing than they need and why other places become bedroom communities is that land prices make it difficult to provide affordable housing of the type people prefer close to jobs centers. Public policies are needed that would make potential housing sites close to jobs competitive with more remote locations.

Another reason for poor jobs-housing balance is the tendency for residential communities to discourage employment centers nearby. Here again, mechanisms for overcoming this resistance must be found in order to achieve more balanced communities.

Thus, the problem for jobs-housing balance lies more on the supply-side than the demand-side of the marketplace.

Impediments to better retail-housing balance may be more of a demand problem. The typical community is retail-poor and its residents have to drive elsewhere to visit shopping centers. This is encouraged by a distinct competitive advantage enjoyed by the agglomeration economies of retail trade. Retail likes being close to other retail because it helps attract customers who like to comparison shop or buy on impulse from one retailer while visiting another.

People may like closer shopping, but they also like the advantages of large shopping centers that offer lower prices and more choices.

Here again, there is a role for the public sector in order to help sustain more decentralized shopping. Public policy could help keep rents for local shopkeepers low so they can offer prices that are competitive with major outlets. It can also help provide high amenity shopping streets that can offer experiential qualities in local shopping areas to offset their more limited set of choices.

Thus, there are both challenges on the supply and demand sides of the marketplace to creating more complete communities.

Even more controversial, perhaps, than complete communities, is the creation of more compact communities. However recent development trends, demographic trends and new research on the marketplace and housing design suggest there is plenty of room for progress toward more compact communities.

First, development trends show that most communities are growing denser. As was noted earlier, densities in communities that have existed for the past two decades have increased by roughly 20% over that time frame. Only the creation of new low density places on the urban fringe has caused overall densities to decline or go unchanged. Thus, efforts to increase the density of places is consistent with current forces operating on urban form.

Second, demographic trends toward smaller and older households are increasing demand for smaller housing units and attached types of housing.

Third, recent market studies have shown there is a market for more compact housing. One study was recently done for the City of Seattle in cooperation with the Puget Sound Regional Council (Decision Data, Inc., 1993). It found the housing market could be divided into three groups roughly equal in size. The first group were people only interested in living in single family detached housing. The second group were those preferring apartments, condominiums, townhouses and other attached housing. The last group were people only secondarily interested in housing type. They were primarily concerned with affordability, security, parking, yards and privacy. In other words, they were willing to live in alternatives to detached single family housing if the alternatives could be designed to be affordable and include the features they were looking for.

Finally, recent design studies have reached two relevant conclusions that support the feasibility of denser housing. One is that traditional single family housing can be built at densities that are much higher than those currently being achieved and still provide the privacy, open space and other features associated with single family living (Alexander, 1988). The other is that the perception of density and actual density are two very different things. People perceive a place to be lower in density if there is greater building articulation, less facade area or smaller buildings, and a greater number of "house"-like dwellings (Bergdoll and Williams, 1990).

Thus, there is a convergence of development, demographic, market and research trends that indicate it is possible to build compact communities that fit the needs of housing consumers.

Conclusion

People all along Mainstreet Cascadia are deeply concerned about the direction of urbanization and are looking for more sustainable alternatives. The social and environmental costs of unmanaged urban growth top their list of concerns. Current trends suggest a future of more people, more traffic, more pollution and deficient infrastructure. Current patterns of urban growth cannot sustain the region's high quality of life.

A more sustainable urban pattern is being planned to be more compact, complete, conservational, comfortable, coordinated and collaborative. Scientific evidence supports the belief that these planning principles will help stem environmental decline. Critical questions exist about the feasibility of sustainable cities. Debates persist about their marketability, political viability, economic practicality and environmental benefits. Many of these issues may be resolved by examining existing communities that exhibit elements of sustainable urban form.

More sustainable cities should be carefully studied to find out how effective they are at conserving natural resources, what processes have led to their more compact and complete urban form, and what lessons they might have for other places with similar objectives. In addition to learning how to implement compactness, completeness and other current principles of sustainable urbanization, we need to discover other ways of making cities more sustainable. This could be done by searching out and studying low impact cities.

Environmental indicators have been developed for the region by Sustainable Seattle (1993), The Oregon Progress Board (1994), and other agencies which could be used to identify the lowest impact cities. These indicators measure things such as the acres of farmland developed per 1000 new residents, the gallons of water consumed per capita per year, the unemployment rate and the crime rate. These and other indicators could be used to locate the most sustainable central, suburban and rural cities along Mainstreet Cascadia. Investigators could explore why these places are more successful than others. This could reveal new and useful principles for sustainable urban planning and suggest possible refinements to existing ones. Similar efforts could be made in other regions.

It is exciting to realize that throughout Cascadia and beyond, people are searching for ways to make cities more sustainable. It is even more exciting to know that some places already are more sustainable than others and offer us living laboratories to learn from. By studying them more closely, we may be able to learn how to move other cities toward locally appropriate models of sustainable urbanization.

Acknowledgments

The author wishes to thank the International Centre for Sustainable Cities in Vancouver, Canada for supporting the work which led to this paper and Dr Alan Artibise, the Centre's former Executive Director, for his thoughtful suggestions.

References

Abbott, C (1994) *Settlement Patterns in the Portland Region: A*

- Historical Overview, Metro Future Vision Commission, Portland.
- Alexander, E R (1988) *Density Measures and Their Relation to Urban Form*. Center for Architecture and Urban Planning Research. University of Wisconsin-Milwaukee, Wisconsin.
- Aspelaugh, W (1994) *Carrying Capacity and Its Application to the Portland Metropolitan Area*, Metro Future Vision Commission, Portland.
- Beatley, T (1995) 'The many meanings of sustainability: Introduction to a special issue of JPL' *Journal of Planning Literature* 9 (4) 339–342.
- Beatley, T and Brower, D T (1993) 'Sustainability meets Mainstreet: principles to live — and plan — by' *Planning* 59 (5) 16–19.
- Bergdoll, J and Williams, R W (1990) 'Density perception on residential streets' *Berkeley Planning Journal* 5 15–38.
- British Columbia Round Table on the Environment and the Economy (1993) *Georgia Basin Initiative: Creating a Sustainable Future*, Province of British Columbia, Victoria.
- The Cascadia Institute and Discovery Institute (1994) *Opportunities for Achieving Sustainability in Cascadia*, The International Centre for Sustainable Cities, Vancouver.
- Cervero, R and Landis, J (1995) 'The Transportation–Land Use Connection Still Matters' *Access: Research at the University of California Transportation Center* 7 2–10.
- Cordes, J J, Goldfarb, R S and Barth, J R (1983) 'Compensating when the government harms' in Zeckhauser, R J and Leebaert, D (Eds) *What Role for Government? Lessons from Policy Research* Duke University Press, Durham, NC.
- Decision Data Inc (1993) *Seattle Planning Department Residential Preference Study*, Seattle Planning Department and Puget Sound Regional Council, Seattle.
- Downs, A (1992) *Stuck in Traffic: Coping with Peak Hour Traffic Congestion*, The Brookings Institution, Washington, DC.
- ECO Northwest (1993) *Region 2040: Decisions for Tomorrow. Existing Conditions: The Natural and Built Environment*, Metro, Portland.
- Elway Research (1993) *Vision 2020 Update Survey*, Elway Research, Inc., Seattle.
- Frank, J (1989) *The Costs of Alternative Development Patterns: A Review of the Literature*, The Urban Land Institute, Washington, DC.
- Greater Vancouver Regional District (GVRD) (1993a) *Major Centres in Greater Vancouver: Current Status and Policy*, GVRD, Burnaby.
- Greater Vancouver Regional District (GVRD) (1993b) *Managing Greater Vancouver's Growth*, GVRD, Burnaby, BC.
- Greater Vancouver Regional District (GVRD) (1993c) *Creating Greater Vancouver's Green Zone*, GVRD, Burnaby, BC.
- Greater Vancouver Regional District (GVRD) and Province of British Columbia (BC) (1993d) *A Long-Range Transportation Plan for Greater Vancouver: Transport 2021 Report*, GVRD, Burnaby, BC.
- Kelly, E D (1993) 'A challenge to planners: solve the takings problem' *Land Use Law and Zoning Digest* Sept.
- King County, Washington, Land Development Information System (1994) *Recorded formal subdivisions in King County, 1985–1992 — lots, acres, and average density per gross acre*, Unpublished.
- Lane Council of Governments (COG) (1987) *Eugene/Springfield Metro Area General Plan, 1987 Update*, Lane Council of Governments, Eugene.
- Lane Council of Governments (COG) (undated) *TransPlan: Trends, Issues and Opportunities* Lane Council of Governments, Eugene, OR.
- Livable Oregon, Inc. (1994) with the assistance of Moore Iacofano Goltsman of Eugene, and Barney and Worth of Portland (undated) *Partnerships for the Willamette Valley's Future*, State of Oregon, Oregon Progress Board, Salem.
- Mattox, M (1995) 'Preliminary study shows huge local infrastructure cost', *About Growth: A Quarterly Publication About Growth Management by the Washington State Department of Community, Trade and Economic Development*.
- Metro (1994a) *Region 2040: Concepts for Growth: Report to Council*, Metro, Portland.
- Metro (1994b) *Region 2040: Recommended Alternative Decision Kit*, Metro, Portland.
- Metro (1994c) *Region 2040: Recommended Alternative Technical Appendix*, Metro, Portland.
- Metro (1994d), 'You Said It', *2040 Decisions for Tomorrow: Metro Region 2040 Update*, Metro, Portland.
- Ministry of Municipal Affairs (1994) *Updating British Columbia's Planning System. Growth Strategies for the 1990s and Beyond: Interactive, Inclusive, Flexible*, Province of British Columbia, Ministry of Municipal Affairs, Victoria.
- 1000 Friends of Oregon (1991) *Special Report. A Growth Management Progress Report*, 1000 Friends, Portland.
- Oregon Business Council (1992) *Oregon Values and Beliefs*, Oregon Business Council, Portland.
- Oregon Department of Transportation (ODOT), Policy and Strategic Planning Section (undated) *Population Estimates for Selected Willamette Valley Urban Areas*, unpublished.
- Oregon Department of Transportation (ODOT) (1993a) Policy and Strategic Planning Section (8 December) *Commuting Patterns Among Willamette Valley Counties: An Analysis of 1990 Census Data on Worker Trips*, unpublished.
- Oregon Department of Transportation (ODOT) (1993b) Strategic Planning Section (27 September) *Willamette Valley Trends and Issues, Discussion Paper*, unpublished.
- Oregon Progress Board (1994) *Oregon Benchmarks: Standards for Measuring Statewide Progress and Institutional Performance, Report to the 1995 Legislature*, Oregon Progress Board, Salem.
- Parsons Brinckerhoff Quade and Douglas, Inc. (1993) *The Pedestrian Environment: Volume 4A*, 1000 Friends of Oregon, Portland.
- Pivo, G (1995a) *Toward Sustainable Urbanization on Mainstreet Cascadia*, International Centre for Sustainable Urbanization, Vancouver, BC.
- Pivo, G (1995b) *Land Use Trends Affecting Auto Dependence in Washington's Metropolitan Areas*, Washington State Transportation Center (TRAC), Seattle. University of Washington, Washington State Department of Transportation. Report No. WA-RD 380.1. Available through the National Technical Information Service, Springfield, VA.
- Pivo, G and Lidman, R (1990) *Growth in Washington: A Chart Book*, Washington State Institute for Public Policy at The Evergreen State College, Olympia.
- Province of British Columbia, Ministry of Municipal Affairs (1994) *The Georgia Basin Initiative: Remarkable Region — Critical Challenge*, The Province, Victoria.
- Puget Sound Council of Governments (PSCOG) (1990a) *Land Use and Neighborhood Character Supplement Report*, PSCOG, Seattle.
- Puget Sound Council of Governments (PSCOG) (1990b) *Vision 2020: Growth and Transportation Strategy for the Central Puget Sound Region*, Puget Sound Council of Governments, Seattle.
- Puget Sound Council of Governments (PSCOG) (1990c) *Air Quality Analysis* Puget Sound Council of Governments, Seattle.
- Puget Sound Regional Council (PSRC) (1994a) *Vision 2020 Update Staff Draft, 3rd draft*, PSRC, Seattle.
- Puget Sound Regional Council (1994b) *Summary Statistics: Change to Urban Land Cover, 1984–1992*, unpublished.
- Salem, Oregon (1993) *Salem–Keizer Infill and Transit-Related Development Study*, The City, Salem, Oregon.
- Solid and Hazardous Waste Program, Washington State Department of Ecology (1990) *Hazardous Waste in Washington: A Planning Report*, The Program, Olympia.
- Sustainable Seattle (1993) *The Sustainable Seattle 1993 Indicators of Sustainable Community*, Sustainable Seattle, Seattle.
- Tischler Associates (1994) *Marginal Cost Analysis of Growth Alternatives for King County, Washington*, Bethesda, MD and Los Angeles, CA, Tischler Associates.

Sustainable urbanization: G Pivo

Van der Ryn, S and Calthorpe, P (1991) *Sustainable Communities*, Sierra Club Books, San Francisco.

Washington State Department of Ecology (1988) *Water Quality in Washington: A Summary of the 1988 Statewide Water Quality Assessment*, Washington State Department of Ecology, Olympia.

Washington State Department of Ecology (1992) *Air Quality Program, Annual Report*, Air Quality Program, Department of Ecology, Olympia.

World Commission on Environment and Development (WCED) (1987) *Our Common Future*, Oxford University Press, Oxford, UK.