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Evaluating Urban Growth Boundaries: A Case Study of Pierce County, WA'S State Route 410

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EVALUATING URBAN GROWTH BOUNDARIES

*A CASE STUDY OF PIERCE COUNTY, WA'S STATE
ROUTE 410*

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Abstract

Urban Growth Boundaries (UGBs) are an urban containment tool used historically as part of the growth management movement on the West Coast of the U.S. Growth management, in its many forms, can be hard to define, measure, or grant credence to its effectiveness. This study asks if UGBs are working in the region to preserve the study areas rural character as it sits on the outer rim of the Seattle-Tacoma region's UGB. A brief literature review focuses on growth management and UGBs as they pertain to the study area in Pierce County, WA. After an overview of the study areas geographic woes, permit data and parcel information analysis is utilized to create a two dimensional model of housing infill. The methodology is easily attained and applicable as an indicator to easily measure UGBs in the study area, and those with similar characteristics. Its results provide a simple UGB evaluation tool that can, and should, be cross-referenced with other growth management indicators in the region.

Acknowledgements

I would like to recognize the assistance of all of the public administrative staff contacted to obtain the data required. All were very professional and I would not have been able to complete the work without their help. I would also like to recognize Adam Kwakenat for lending me some of his GIS expertise. Very special and immeasurable thanks to my wife and daughter for their unconditional support throughout by studies.

Section 1. Introduction/Problem Statement

1.1 Problem Statement

The Puget Sound region is a global competitor and post-industrial force in economic markets (Hall, 1997). Research shows that uncoordinated development and growth is perilous to the natural environment, economic sustainability, and a desirable quality of life (GMHB, 2009), subsequently rapid development has required growth management methodologies and planning to steer these geographic changes. One of the many tools the Puget Sound region uses is urban growth boundaries (UGBs) to curb unfettered suburban sprawl and contain existing growth. State Route (SR) 410 is located in the south-easterly reaches of Seattle-Tacoma's amassed urban growth boundaries and a burgeoning transportation corridor feeling the pressure of suburban sprawl. Its prime locale has it poised to evolve into a newfound position along a post-Fordist metropolitan transportation corridor for a number of reasons, and follow the natural progression of suburban sprawl (Knox & McCarthy, 2005). So, are UGBs working to prevent the spread of sprawl along SR410?

1.2 The Risks of Inaction

Uncoordinated development and growth is perilous to the environment, economic sustainability, and a desirable quality of life (GMHB, 2009). Less efficient land uses with no lot size reduction or housing density restrictions drives up construction, infrastructure, and public costs while leaving urban cores abandoned, diffusing infill by distributing the population through the production of low-density single-family homes (Staley, 1999; Pendall et al., 2002). This lack of devotion to a gradual urban to rural transition, and growth management ideals in general, is the cause of the highest rates of conversion for natural lands, agricultural uses, and open space in Pierce County. Without effective

growth management tools suburban sprawl can negatively impact the nature, character, and health of communities many work tirelessly to preserve.

1.3 A Brief Growth Management Act History

By the 1970's the Seattle-Tacoma region already had planning regulations in place to inhibit the Interstate-5(I-5) corridor from morphing into a sprawling megalopolis. Washington State, reacting to signs of a new scale of unencumbered development in the Puget Sound region, attempted to change the course of growth by passing the Growth Management Act (GMA). To ensure consistent regulatory administration and enforcement of GMA among compliant entities, the Growth Management Hearings Board hears and determines if actions are compatible with GMA objectives. The GMA is a long-range set of goals and regulations that require adherence within areas that trigger compliance to maintain economic and socially sustainable goals (WSL, 1990). The act's enforcement authority relies heavily on local jurisdictions and comprehensive insight in maintaining development intensity and design in prescribed areas. I will utilize decades of planning history, theory and data to examine growth management and the use of urban growth boundaries by state and local entities to meet program objectives (GMHB, 2012).

1.4 Literature

This study, through a review of available urban planning, planning education literature, growth management regulations, and planning theory literature focuses on defining, measuring, and showing the effectiveness of growth

management, and the use of UGBs to direct growth.

1.5 Variables

The variable assessed for this study is the number of single-family homes built within a specific study area between 2006 and 2012 (the most readily available sets of data) in Pierce County, WA. Whether these new dwellings are located within or outside Urban Growth Boundaries (UGBs) along the prescribed study area paralleling SR 410 will indicate a level of GMA compliance. UGBs are a well-studied growth management tool implemented to keep growth in areas currently designated as urban, to reduce land use conversion outside city limits, taking much needed funds for infrastructure, economic, and entitlement improvements from urban inhabitants. A review of the parcel locations and year the single-family home was built helps measure the effectiveness of Washington's GMA housing density policy that dictates increasing density within urban growth boundaries and reducing sprawl to meet the planning's critical goals for GMA compliance. If urban growth boundaries have been properly coordinated across the study area then there administrative implementation should result in higher rates and percentages of housing increasing inside, rather than outside, UGBs.

1.6 Target Audience

This topic and research is of special interest to officials, growth management administrators, and the public concerned about the regulatory success of UGBs in the specific study area, or those interested in growth management studies in similar spaces with issues pertaining to urban and suburban containment needs emerging from the single-family housing sector. This topic is also of interest to lawmakers ensuring UGB enactment and implementation is lessening unregulated growth and development. More specifically it would be of special in-

terest to planning and GIS staff challenged with measuring growth management or officials responsible for decision-making that affect urban and suburban sprawl to utilize this form of UGB evaluation as a tool to their advantage.

1.7 How & What?

Part of the reasoning for the selection of the study area is the presence of a tell-tale geographic template for sprawl in the formation of UGBs along SR 410. Consistent with Altshuler and Gomez-Ibanez' (1993) definition of a form of sprawl, development has leapfrogged past agricultural pockets of land to leave a "patchwork of developed and undeveloped tracts" with gaps in between UGBs (p. 67) from Puyallup to the county border. These gaps, presumably, would be absorbed and meet their fate as part of the overall Puget Sound region's UGB as the region's population grows steadily, and infill reaches capacity on the UGBs outer rim. There are also benchmarks on the horizon that will increase access and traffic to SR 410's on ramp that will presumably change the dynamic of the south end of Highway (Hwy) 167, SR 410's major connecting highway. A study of this type can be applied to validate or further improve growth management efforts throughout this reach of Pierce County or other jurisdiction with similar geographic characteristics on the periphery of a regional UGB. If statistics show that growth management regulations have failed to prevent unregulated growth within the study area boundary we may also assume similar failures in GMA policy is present in other counties and amending GMA policy to meet its own goals may be in order.

To better understand the implementation quality of UGBs

in the study area, I plan to apply a proven GIS analysis tool related to requested and available single-family home parcel information, the resulting data will then be converted into a two dimensional representations of density in and outside UGBs within the set transportation corridor.

1.8 Research Question

The Washington State Growth Management Act was enacted in 1990 to curb uncontrolled sprawl and its many ramifications (Duany, Plater-Zyberk, & Speck, 2000) through the creation of mandatory long-range, economic and socially sustainable planning goals (WSL, 1990). The act's enforcement authority relies heavily on local jurisdictions and comprehensive insight in maintaining development intensity. These jurisdictions often lack access to readily available tools that measure its effectiveness in their locale. In this study we ask if the growth management tools used, UGBs, are concentrating population infill to curb sprawl through a case study of the boundaries Pierce County, WA's SR 410 bisects.

Section 2. Literature Review

2.1 Literature Themes

As the world's population and economic prosperity expands, what urban growth management is, does, and is comprised of is part of an ever-growing global discourse. The literature on this form of urban containment is too vast to cover within the pages of this study, and the various applications used to measure and monitor various urban growth management techniques are nearly as extensive. A conventional research analysis cannot encapsulate the totality of either of these topics. The methods used to measure urban growth and the applicability of the myriad indicators applied to these studies, and ease of use, are also multifaceted and are as varied as the locales where they are measured. However,

in this literature review, an attempt has been made to briefly document literature that focuses on a similar approach to the case study herein. The literature reviewed includes growth management, urban containment analysis, and some that specifically use urban growth boundaries to direct growth, preferably without the use of census data alone.

The adoption of Washington State GMA policy, and more specifically, changes to help curb the effects of unplanned development (Dear, M., 1988) were in response to the threat of exponential growth in the Seattle-Tacoma city-region. As a result, growth containment efforts are not the focus of one specific agency, entity, or management strategy, but "multi-scaled and institutionally complex" (Carlson & Dierwechter, 2007, p. 211). Today, Seattle-Tacoma growth management involves comprehensive planning, regulatory and administrative congruency, and a regionally unified approach to modeling and growth projections.

2.2 Defining Urban Containment

To start, there were works that attempted to define urban containment that met the criteria for this review. Connerly (1986) provided an early article on growth management that suggested research and implementation of public education to help define growth management and the tools associated with planning were first in order. Public education could then be followed by support, or at least further understanding, during urban containment's early stages. Early emphasis on education continued as modern literature encourages education and public participation efforts to define elements of growth

management success. This ensures urban containment and its various planning tools are derived and implemented in an approachable and easily understood manner for the average citizen, as well as the choice of indicators used to assist in evaluating and correcting possible urban growth or urban sprawl management programs (Doody, Kearney, Barry, Moles, & O'Regan, 2009). An applied regional context and agenda will assist in facilitating communicative action when identifying stakeholders and applying a calculated strategy to regional growth decisions (Dierwechter, 2007; Haiman, Steere, & Sweetser, 2006). Tam-Scott (2008) spends considerable time not only providing a historical overview of the adoption of UGBs, but also implores growth management professionals to not only look more closely at the how and why of UGBs, but the who and what UGBs effect, to understand the ramifications and uses for urban containment and its limitations. Tam-Scott ultimately concludes that, "the indisputable effect of urban growth boundaries is that they preserve undeveloped land" (2008, p. 49) and is why the UGB is the focus of this study.

2.3 Measuring

A significant portion of the literature reviewed focused specifically on measuring the results of growth management efforts. Some are very pragmatic and ask planners to rely on statistics that are most accurate (Repetti & Desthieux, 2006). Many emphasize that a city or region's character is the key to identifying a varied list of growth management indicators to evaluate growth (Anthony, 2004). Some have been able to measure positive results of growth management and underline the fact that the earlier growth management tools are in place the better the results (Nelson & Peterman, 1993). Others, from the same era, are detractors of growth management efforts (Pivo, 1993), but many take the notion of a locations specific character a step further by evaluating physical geographic changes over long periods of

time to assist in collecting data from their selected indicators (Tregoning Agyeman, & Shenot, 2002; Troyer, 2002; Verburg, Schot, Dijst, & Veldkamp, 2004; Bhatta, 2010; Fichera, Modica, & Pollino, 2011; Hepinstall-Cymerman, Coe, & Hutyra, 2011). Some recommend using a select few indicators initially, then during the revision process long and short-term goals will reveal the indicators to be replaced, eliminated, or added to growth management efforts across a specific base of participants (Shen, Ochoa, Shah, & Zhang 2011), and others recommend no study is complete without the indispensable use of Geographic Information Systems (GIS) (Nedovic-Budic, 1999). Some throw their hands in the air in frustration, but asks planning professionals to make sure to differentiate between sprawl and regulated growth when selecting specific indicators and study methods (Blair, 2001).

2.4 What is effectiveness?

Understanding growth management and its effectiveness is a widely studied urban research agenda since impending development and administration of urban areas require detailed evidence of ongoing processes and growth patterns. State-based planning legislation with a strong emphasis on uniform enforcement methods hold much potential for lowering cases of urban sprawl, while growth management programs that require uniformity may unintentionally contribute to it (Carruthers, 2002). Others state that the economic health of an area using urban constraints will influence results, and its externalities such as tax increases, prescribed land uses, and land value fluctuations also influence growth management's

outcomes in these same areas (Cho, Zhuo, Yen, & Eastwood, 2006).

There are also authors who, like the case study presented here, choose to focus on the effectiveness of UGBs specifically. Incremental evaluation has led UGBs to be used as a blunt instrument to focus capital projects within their boundaries, and whether social benefits are truly measurable is suspect (Ding, Knaap, & Hopkins, 1999). Studies show UGBs actually suppress urban growth, but with mixed results (Nelson & Moore, 1993; Kline & Alig, 1999, Kline, 2005; Carlson & Dierwechter, 2007; Gosnell, Kline, Chrostek, & Duncan, 2011), and UGBs had varied results by locale within suburban or urban subareas (Cho et al. 2008). Some authors offer warnings about UGBs use resulting in subsidized low and high-density development which can be avoided by proper economic evaluation, mixed with public input, to ascertain policy goals for a community (Staley, Edgens, & Milder, 1999). Some suggest automatic expansion of UGBs, rather than waiting to meet density requirements, leads to growth management and economic failure (Hana & Lai, 2012). Others have reached very definitive conclusions about the requirements for UGB success: a fixed, immobile UGB, public participation and approval, and a consistent strategy for growth management is requisite at the state and regional level for effective urban containment (Steel & Lovrich, 2000; Pendall & Fulton, 2002). And a few conclude that there are successful techniques to managing growth, but the use of UGBs is not one of them (Landis, 2002). The most in-depth and comprehensive results to aid this research came from the State of Washington's 2008 GMA Effectiveness Report, where the Puget Sound region's growth is well documented, along with government recommendations for future GMA decisions. Each of these works concludes in measuring the effectiveness of land use and development to critique the usefulness of growth management.

2.5 Thinking ahead

There is a definable importance to thinking and planning for growth management that improves a geographic region's overall quality of life. In an effort to keep government participants and sponsors involved, and politically and administratively interconnected, I plan to use GIS to discover UGB success or failure in the SR 410 region of Pierce County. The results will be an example of a less often used indicator, the construction of new single-family residences, to assist in measuring the effectiveness of growth management (and UGBs specifically) in a format that elected staff, public employees, and members of the public may acquire easily. The ability to incorporate a readily available indicator to improve urban containment standards will assist administrative and political staff taxed with growth management implementation strategies to improve more comprehensive forms of growth management partnerships.

Although there are disagreements involving sequence, measurement and effectiveness of UGBs, the objective of UGBs is to compact growth in an efficient fashion, increase walkability, provide open space, preserve natural resources, and focus the provision of public services and amenities (Puget Sound Regional Council, 1995). Whether the overall functional goals of the GMA subsist in the Seattle-Tacoma region will require further inquiry beyond this study.

Section 3. Methodology

Pierce County is known for its geographic diversity, rising

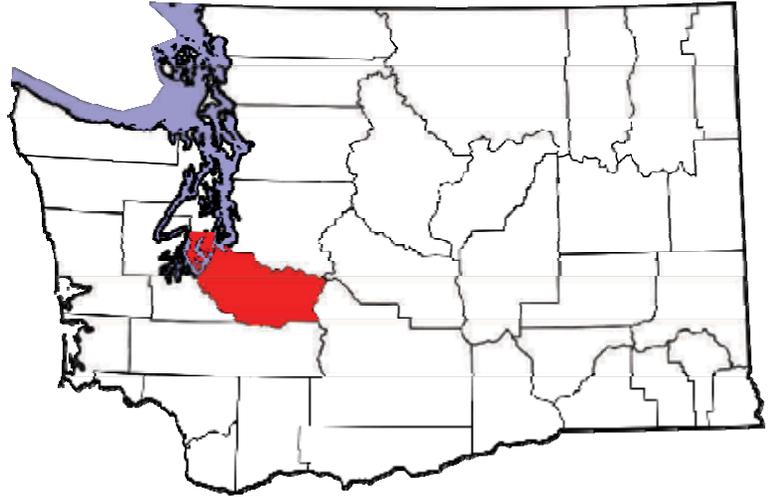
from sea level in its northwest corner along the waters of Puget Sound, to 14,410 feet at the peak of Mt. Rainier in the southwest corner. The more urban and densely populated areas of the county are in the northwestern third of the county, but moving south and east from the Puget lowlands it descends into the Nisqually National Wildlife Refuge that originates from water flowing from the foothills of the Cascade Range within Mt. Rainier National Park.

There is a roughly forty square mile area east of Tacoma, Pierce County's most populous city and Washington's third most populous city, three miles in width and extends thirteen miles (Fig. 2) paralleling SR 410, one of the more congested commutes in the south Puget Sound region. The route then ascends from an ever more crowded highway off-ramp at a suburban hub, into less-developed exurban, then rural lands up to the foot of Mount Rainier, and was selected for this study.

Participants in my study will be the jurisdictions that issue building permits located in proximity to SR 410 from Sumner, WA city limits until it reaches the easterly border of Pierce County, WA. This stretch of state highway is the connecting thoroughfare between the largest isolated piece of urban growth boundary (UGB) and the main body of UGB that extends from metropolitan Tacoma to Sumner. This reach of state highway currently has the potential to be the major thoroughfare to feed polycentric, leap-frog growth, similar to other state highways in the region (Calthorpe & Thornton, 2001; Pendall & Fulton, 2002) into a largely rural and wild portion of the county. The jurisdictions involved in the study will be the cities of Buckley, Bonney Lake, Sumner, and Puyallup, as well as unincorporated portions of Pierce County near SR 410.

The rationale for choosing this stretch of state highway to study is its similarity to a predominantly undeveloped thoroughfare from one growing edge city to another in

[Figure A] Pierce County WA



Retrieved from http://.wikimedia.org/wiki/File:Map_of_Washington_highlighting_Pierce_County.svg

[Figure B] Study Area showing Pierce County's Urban Growth Boundaries



the two most populous counties in the Washington State: King and Pierce Counties. This stretch of highway has a number of factors working against its semi-rural character. There are a number of state highways that are similar in size in the region that started with an unmanaged growth pattern that included sprawling housing developments comprised of single family residences that brought expensive and unsustainable transportation, commercial and housing practices to former rural areas that are now bustling exurban and suburban nodes. As a result of these changes the study area was chosen for the following reasons as well: Hwy 167 will be completed (from a simple on ramp at the start of a jammed commercial and residential bypass into a completed interstate connected by way), a major planned community to the south of the study area (Cascadia) is presumed to continue construction after a long delay, and wanton developer's attention. Each end of SR 410 is also wrapped in UGB, one of the indicators and methods of growth management (Carlson & Dierwechter, 2007). A template for sprawl, tell-tale by the formation of UGBs along SR 410, is already in place and consistent with Altshuler and Gomez- Ibanez' (1993) definition of a form of sprawl, where development has leapfrogged past agricultural pockets of land to leave a "patchwork of developed and undeveloped tracts" with gaps in between UGBs (p. 67). These gaps, presumably, would be absorbed and meet their fate as part of the overall Seattle- Tacoma region's UGB as population grows steadily and infill reaches capacity on the outer rim of UGBs, the first in proximity to this study area being identified as the Alderton-McMillin Community Plan, whose character and agriculture protections have recently been upheld. Reducing the rise of SFHs outside of the urban growth boundaries in unincorporated stretches of land would indicate that development is meeting prescriptive growth management regulations whose results are aimed at ending unmanaged growth. In the author's opinion it is a sub-region that, as much of the theory and literature presented here recommend, will

require constant monitoring for proper growth.

State Route 410 starts near the apex of Hwy 167 in Puyallup, WA. Hwy 167, once negotiations with local tribes are finally resolved, will ultimately be the highway that ascends into the Port of Tacoma, then out to either connect to Interstate 5 (I-5), the main U.S., west coast interstate from the Canada to Mexico, or further south toward Hwy 167 which eventually parallels then reconnects to I-5 north of Seattle (WSDOT, 2013). The highway project's completion will drastically change the trip from Tacoma and the Interstate to the onramp on SR410 (and every town in the area). What is now a 30 minute drive to Tacoma along an arterial road, will soon be a 4 minute drive on a new four lane highway. This capital project will drastically reshape the history of every facet of life improved by connectivity and the time spent in traffic for commuters. Currently the only reason commercial uses have not expanded east from Bonney Lake and west from Buckley is the lack of access to water and sewer. Commercial building codes in both jurisdictions require utility connections to obtain building permits, and there are questions as to the capacity of both systems to take on new, larger commercial districts (Beckley, 2012). As such, this stretch of highway should be monitored to help relate the effects growth or urban containment efforts and how such expansive transportation can affect policy.

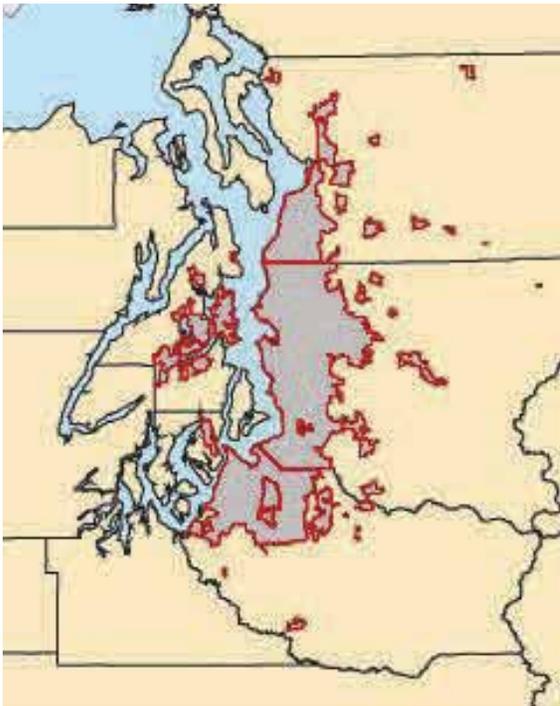
Those currently using SR 410 generally live within the corridor. Areas to the north of SR 410 are largely low density, rural farm land and the areas to the south are heavily wooded foothills of the Cascade Range. With the exception of the small towns of South Prairie and Wilkeson, SR 410 only feeds the more densely populated areas within a mile and a half of its path. Cascadia, a

major planned community that is the contiguous portion of UGB that extends south of Bonney Lake from the study area, and its residents will also add to the congestion on SR 410 once construction starts on its proposed 6500 residential units and commercial areas.

3.2 Study Focus

The focus of this study will be the application of a method to measure the effectiveness of UGBs within a very specific transportation corridor,

[Figure C] The Seattle-Tacoma region's Urban Growth Boundaries



and see if invariably new single-family homes are being built in the manner and location they are supposed in the presence of UGBs. Washington's GMA is a legislative tool used to appropriately direct growth and curb the expansion of urban sprawl within Washington's most densely populated counties, most prominently on the inland shores of Puget Sound, using urban containment as one objective. There are many spatial entities in play at many levels, each with a range of planning legisla-

tion, and tools to shape the regions geography. One of the more effective modern planning tools is the use of GIS (Nedovic-Budic, 1999). GIS software will be utilized to determine the number of single-family homes (SFH) built between 2006 through 2012 within a prescribed study area defined above: the city limits of Bonney Lake and Buckley, as well as portions of Sumner and Puyallup within the study boundaries, and unincorporated Pierce County, WA within roughly 1½ miles of SR 410.

3.3 Reading the Data

First, a dataset will need to be created to apply the SFH geocoded data. To extrapolate the raster files created through the ArcGIS Spatial Analyst Toolkit, X- and Y- coordinates provided in the acquired parcel layer were utilized to create a point, rather than polygon, based shape file. Using this method, permit data, parcel numbers, or county assessor/treasurer parcel searches were used to match new SFH parcel numbers with a specific geocoded location on the ground, then used to assess every home built within the study areas boundary and within the prescribed time frame of 2006 through 2012.

3.4 Collecting the Data

The sampling procedures for this study will include "purposeful sampling" (Stringer, 2007, pp. 43-47) by measuring the growth of, and raw data from, all cities directly connected to SR 410. The collection of available permit information was easy with the help of some jurisdiction's staff, and quite laborious in others. A better method would have been to acquire a data set from a search of the Pierce County Assessor/Treasurer's office (A/T). The A/T office lists taxable structures on

parcels, as a part of this they maintain information for the year constructed. An ordered list of SFHs by the year built would suffice to create an accurate representation of SFH infill. This would have eliminated the need to test the findings of each method, receiving permit data from each jurisdiction versus reviewing each parcel within a search area for the year the home was built, or to cross reference each collection method for accuracy and/or congruency. Since I was not able to access the specific temporally sensitive attribute (the year the home was built) as a search parameter, time constraints only allowed for combining each of these methods to create a complete picture of all new single-family homes within the designated SR 410 study area. These results are very specific and show merely one indicator of growth management and must be interpreted as such, which as discussed in the literature review, provides positive aspects to growth management analysis, but using a using a lone indicator has its drawbacks. Still, after each of these cities provides the appropriate permitting data and statistics to extrapolate SFH density patterns, visual proof of the effectiveness of UGBs will be prevalent within the prescribed Pierce County sample region.

This method of discover SFH in the study timeframe emerged from the inability to obtain permit data from Buckley, WA. Buckley lacks accurate permit tracking software, so most of the records are hard-copy only. This made it impossible to collect reliable permit information from the city itself. Instead, city parcel data was meticulously searched for every single-family home within city limits that fell within the study timeframe. Puyallup's portion of the study area was also reviewed in this manner to retrieve the appropriate parcel numbers. Despite low staffing levels since the economic downturn (Maynard, 2012) Pierce County's, Sumner, and Bonney Lake permitting staff provided the building permit data required a polygon/shape file using GIS software that will provide accurate research for the SR410 corridor. The kernel density application utilized to receive "a more

sophisticated and accurate approach to modeling sprawl than normal density calculations" (Carlson & Dierwechter, 2007, p.215) was then applied to the extrapolated population of homes.

Informed consent procedures were not required, as the data used was secondary information published for the Puget Sound Regional Council, retrieved through open source searches, or through public records request. All state and local public record query regulations were abided by to represent the data through graphs and kernel density calculation display maps. As a part of this research methodology's design, all of the data I require is a matter of public record and must be provided upon request within a reasonable amount of time according to Washington State law.

My intent is to utilize a previously published instrument implemented in a study by Carlson & Dierwechter (2007) to measure the effectiveness of urban growth boundaries within a study area using building permit data and GIS. I intend to use the same qualitative geospatial methodology and mathematics, or a derivative thereof, to apply the relative density approach presented by Fotheringham, Brundson, and Charlton (2000) to create a two dimensional representation of density using GIS. Validity questions should be answered at face value as there is intentional simplicity and no hidden intent in this methodology.

After the applicable data is received and organized, the ArcGIS density toolset application can be applied to render the maps needed in tandem with various GIS layers and shape files collected free of charge from the PSRC and the United State Geological Survey (USGS) websites,

or purchased through a user agreement with Pierce County Applications and Geographic Information Services (AGS). Parcel numbers of newly built homes were cross referenced with geocoded parcels within the study area to determine the density of single-family residence building permits from 2006 through 2012 to the county's parcel layer. The results provide the ability to tell whether each parcel with a building permit centroid falls within or outside a UGB within the study area. The final measure will be in creating a kernel density map (ArcGIS, 2011) that represents the visualization of a calculation per location of SFH annual growth throughout the study area to assess growth management success along this state highway.

This research does have its limitations and delimitations. The limitations are that it merely shows where intensity of single-family home building has happened, or is happening, during a certain period of time and place where the permit and GIS data were collected. Using this methodology over such a short period of time, six years in this study, on a stand-alone would not help predict where or when future growth will happen in all zoning designations, but merely residential unless the timeframe is extended or continuous. The main delimitation is that compiling this data in two-dimensional format shows visually whether growth is occurring at an acceptable rate within a geographically identifiable area. The information utilized, however, does not note whether the home built is a replacement for a destroyed or removed previous dwelling so there will be a margin of error involved there that will not be explored. Since most developed nations maintain a searchable building permit system, this format is adept at measuring the placement of new single family homes to discover a number of geographic, urban or policy driven research in any jurisdiction with the data and knowhow applied as an indispensable tool for growth management professionals and officials alike.

Section 4. Results & Analysis

4.1 Measurability

In an effort to represent a measurability of urban containment through the use of UGBs, the location of new single family homes within the prescribed study area in Pierce County, WA is represented in Table 1, showing that from 2006 through 2012 73% of the 1728 new homes built in the area were within UGBs. The data also shows the steep decline of the construction single-family homes in the study area during the economic recession. New homes dropped from 319 to 67 in just three years. Despite the fluctuations in the number of homes the lowest levels of new homes inside UGBs was 64% (2010), and the highest was 80% (2008) before the economy slowed down.

4.2 effectiveness

As a visual aid, kernel density maps highlight the location of concentrated development. Figure 5 represents years 2006 through 2012, and a combination of all seven years, and the concentrations of all of the SFH data collected within the study area. The 'glowing' areas represent concentrated growth and are visibly more present within UGBs (the gray shaded areas) than in unincorporated portions of the county represented in the SR 410 corridor.

In the end, this study shows that utilizing parcel information and the ArcGIS kernel density toolkit is an accessible way to create a visual form of measuring the effectiveness of UGBs as an urban containment policy tool, not only

over a large area of study, but a smaller specific region of a county that has requirement to comply with GMA. The results will determine the location and density of single-family homes and whether they are located more predominantly within, or outside of, the SR410 corridor's designated UGBs both as a graph and a map. When this same methodology was used and permits were last mea-

sured in 2002 it was shown that permitting outside of UGBs had dropped dramatically since the inception of GMA (Carlson & Dierwechter, 2007, p. 217), and this study shows this trend continued in the latter part of the last decade and into the current one.

[Table 1]

Table 1. *New single-family residences and location in or outside urban growth boundaries (UGB) within the study area*

Permit Year	Inside UGB	Outside UGB	% Inside UGB	% Outside UGB	Annual Permit Totals
2006	263	133	66%	34%	396
2007	319	110	74%	26%	429
2008	252	62	80%	20%	314
2009	95	48	66%	34%	143
2010	67	38	64%	36%	105
2011	138	24	85%	15%	162
2012	138	41	77%	23%	179
Overall Totals	1272	456	73% avg.	27% avg.	1728

[Figure D]

Figure D. *Single-family homes built from 2006-2012*

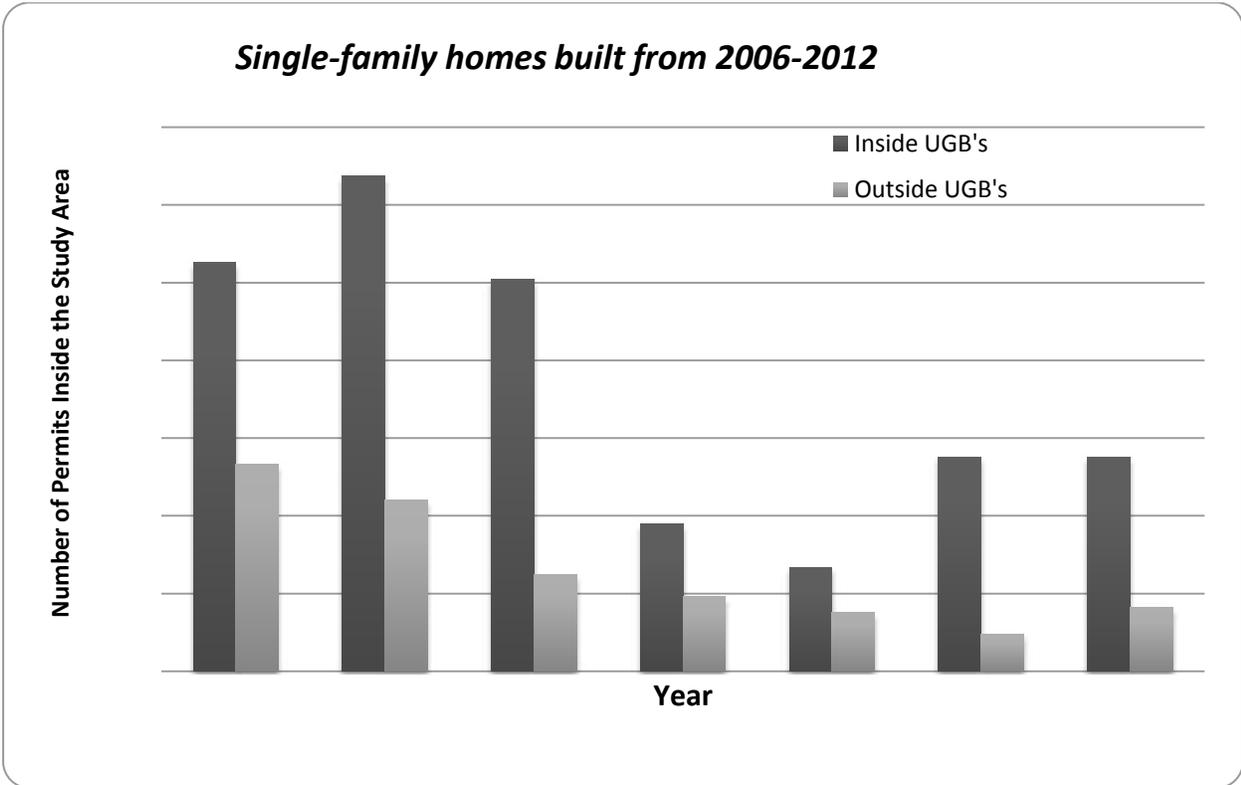
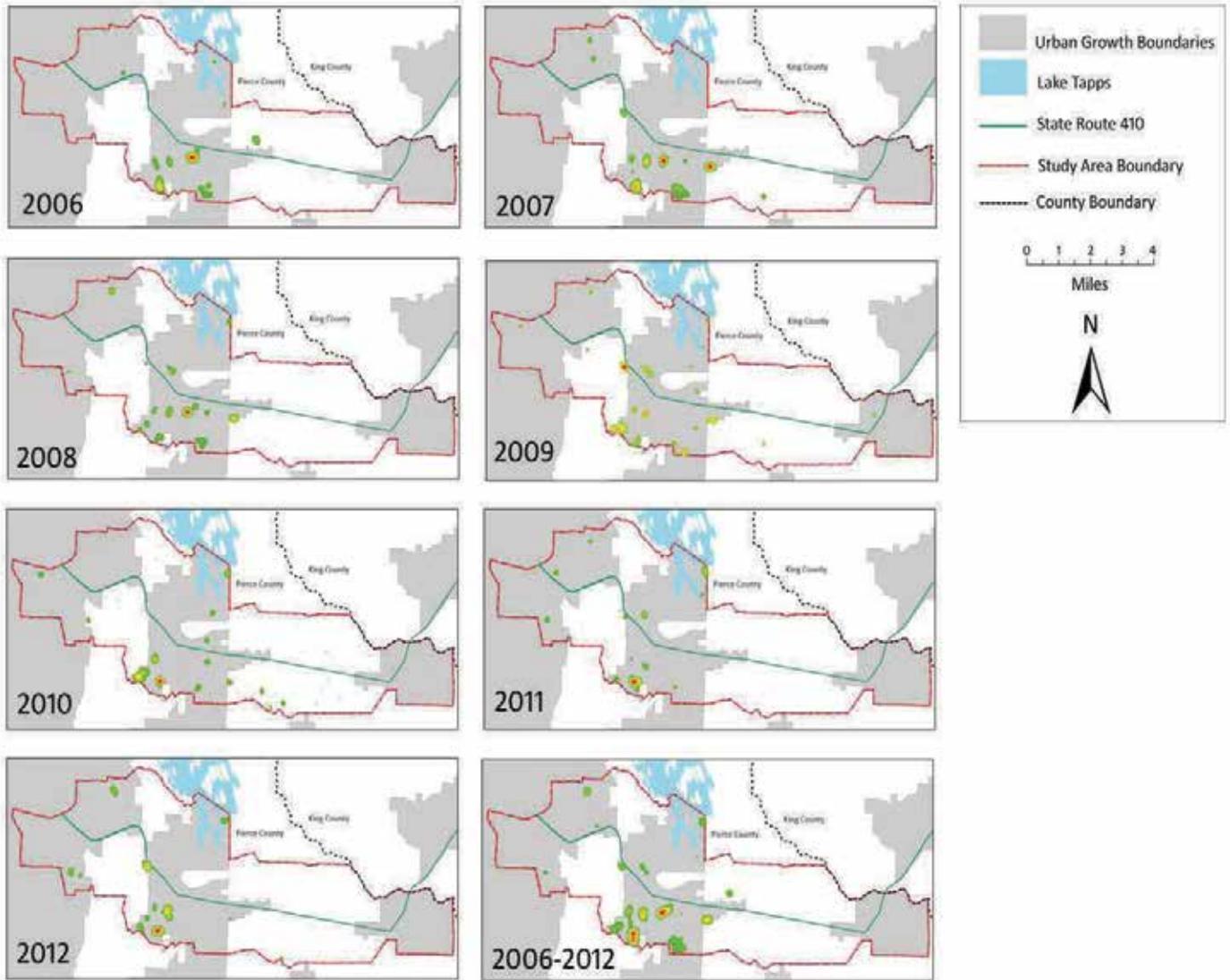


Figure E. Pierce County's State Route 410 kernel density calculations 2006-2012



5.1 Conclusion

Section 5 .Conclusion

Washington State's Growth Management Act's enforcement authority relies heavily on local jurisdictions and comprehensive insight in maintaining development intensity, but many jurisdictions lack access to readily available tools that measure its effectiveness in their locality. This study questioned whether jurisdictions with access to GIS data have a readily available evaluation tool for a growth management indicator already in place by studying concentrations of development in- or outside Urban Growth Boundaries (UGBs) using building permit data and the results of parcel information searches for the year homes were built. This methodology has proven to be successful through the study of the entirety of Pierce County, WA (Carlson & Dierwechter, 2007), and others have used different GIS methods within a study area to measure the effectiveness of other growth management indicators in the Puget Sound region (Robinson, 2005), whereas this study employed both the use of building permit, parcel information, and GIS data within a prescribed study area.

In an effort to properly measure the location of single-family homes built between 2006 through 2012 most of the jurisdictions within the study area gave what permit data they had upon request with the exception of the Town of Buckley who expressed an inability to provide that information within a prescribed timeline. Instead, Buckley's data was retrieved through the review of every single-family residence within Buckley city limits and a confirmation of the year each home was built utilizing the Pierce County Assessor parcel search interface on the county website. The permit data provided by the other study locations required extensive parcel data sorting and editing for accuracy or duplicity of parcel numbers and readability by the GIS software. The data from each jurisdiction could have been much easier to extrapolate if the year each home were built was part of a searchable menu provided by any of these jurisdiction's

building division or the Pierce County assessor. The data provided for the study contained attributes compatible with geographic information systems (GIS) software, software that is readily available to each identified jurisdiction independently or through Pierce County Applications and Geographic Information Services, to commence with the prescribed study methodology and creation of kernel density maps.

All in all, this endeavor to quantify the effectiveness of UGBs, like many others (Carlson & Dierwechter, 2007; Wassmer, 2006; Nelson et al., 2004), was a success. As an example of growth management measurability, the location and density of single-family homes in-and-outside urban growth boundaries were identified through the evaluation of building permits and parcel research within a three mile study area paralleling Pierce County, WA's SR 410. The results clearly showed that between 2006 and 2012 an average of 73% of infill within the study area has persisted within designated UGBs along this burgeoning transportation corridor (Table 1).

The major supposition reached in this study is that the slow growth that happens between suburban nodes after the leapfrog affect that perpetuates urban sprawl is slowed by the condensing effect of UGBs. Also, Pierce County regulations mandate that density requirements be met within UGBs are dependent upon whether UGBs to annex new territory. This means this growth inside UGBs will continue until infill standards are reached within their boundaries, concentrating capital projects to build well planned cities (Calthorpe and Fulton, 2001). There are, however, limitations to what can be safely interpolated from the results of a single indicator (Gray & Wiede-

mann, 1999). There are those who would question the validity of the results of UGBs as a positive, or question whether they are a detriment to meeting other elements of Washington's Growth Management Act (Tam-Scott, 2008; Housekeeper, 2009). This data also shows that during the recent economic downturn development inside UGBs was dramatically increased over previous years, but it may not answer why.

Although there are quite sophisticated methods of measurement (Ewing, R., Pendall, R., & Chen, D., 2002), and those that state there is not enough information present to evaluate growth management (Talen, 1996) there is a simple method of growth management analysis available. By design the information and tools used to assess this growth management indicator are generally accessible to the public to readily monitor progress in growth management in their region. Just as this specific study could be analyzed by elected officials, community development departments within the study area boundaries, and state and regional officials alike, each of these groups could commission or perform a study in a similar fashion to monitor growth and/or sprawl in their designated home regions.

5.2 Recommendations

Recommendations for the area would be for jurisdictions involved, in addition to their current level of coordination countywide planning policy (RCW 36.70A.210 and .215), to enact policy codifying a new level of regional cooperation. Officials would be encouraged to order a feasibility study that create legislation that stems from, as recommended in the literature review section, the appropriate number of type of urban containment indicators to make decisions that would protect the already bursting levels of population capacity from the start of SR 410 and the protected agricultural lands within the Alderton- McMillin Community Plan area, out to a historically preserved Buckley, WA near the Pierce County border (Duany & Talen,

2002). There is already case history backing the preservation of lands of an agricultural nature near the confluence of this growing traffic snarled byway. In the morning, where SR 410 meets Hwy 167 is thoroughly monitored on all of the local media and transportation authority websites due to its nature as a traffic bottleneck, and in the evening, where SR 410 ascends Elhi Hill and onto the plateau are daily traffic congestion points. After reaching the top of the hill travelers are greeted with one of the more spectacular viewscapes Mt. Rainiers has to offer. Once Hwy 167 is completed connectivity with Interstate-5 is a reality, capacity in the region will be at its maximum.

Beyond Bonney Lake city limits are patches of older commercial uses and a green belt of marsh, old pasture, and wetlands that stretches nearly the entire trip to Buckley. For now, I would recommend that until better transportation decisions are made Pierce County, cities, and the GMHB designate protected areas within this study area and continue to enforce the density requirements for commercial and residential development exclusively. This would halt the expansion of UGBs at this southeastern most portion of the Seattle-Tacoma region, out and along State Route 410, and stall the reshaping of the geography of this scenic byway in ways that negatively impact its character

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