exUGA RESIDENTIAL HOUSING GROWTH, IN THE PUGET SOUND REGION, 2011-2016

2018 CRITICAL ANALYSIS

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SEPTEMBER 2018

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Expanding development, or sprawl, increases pressure on remaining ecosystem functions. Recognizing this, Washington State passed the Growth Management Act (GMA) in 1990, establishing Urban Growth Areas (UGAs) along with requirements for growth planning. UGAs represent a designated boundary within which high-density, or urban, growth for a particular city or county should be directed. UGAs are intended to house the majority of our region's population in order to avoid increasing sprawl.

Because expansion of growth outside of UGAs (herein termed exUGA, for external, or outside, UGA growth) impairs existing ecosystem functions, altering hydrology and reducing habitat, a key strategy for Puget Sound recovery is to limit exUGA growth.

The Puget Sound region has successfully directed the majority of its growth *into* UGAs. Nevertheless, there are areas showing significant, recent, exUGA growth. Washington State Department of Commerce's Puget Sound Mapping Project (PSMP) team has observed that high portions of recent growth in the Puget Sound region is occurring just outside of UGA boundaries. This is of interest because this may be a precursor to future UGA expansion, or, may effectively represent an unofficial expansion of UGAs. Furthermore, understanding development patterns helps planners to better address conservation needs.

In order to further investigate the patterns of growth along the UGA boundary, our study reviewed two geospatial datasets that report new housing development for the Puget Sound region: the PSMP data, developed from the State Office of Financial Management Small Areas Estimates Program, and permit data from the Puget Sound Regional Council. Analysis includes the years 2011-2016.

Our study sought to 1) identify where higher exUGA growth is occurring, 2) determine the factors that encourage this type of growth, and 3) identify drivers that promote building outside versus inside UGAs.

This work provides a preliminary assessment of exUGA housing growth in the Puget Sound region, assessing the relative utility of two housing datasets. We offer a quantitative definition of high-growth, and discuss growth patterns observed by county across the 12-county Puget Sound region. The appendix shares results from an initial review of ancillary data that might be used to support further analysis as well as responses from two local developers interviewed about site selection factors.

The following document is organized in two parts. Part I provides background and context for this analysis. Part II reports the analysis of the two housing datasets.

PART I: BACKGROUND

The following section describes the context for the analysis presented in Part II.

INTRODUCTION, A BACKDROP OF REGIONAL CONSERVATION PLANNING

It is important to understand this document in the context of its place within the larger Puget Sound restoration effort. The following provides a brief introduction to the framework for Puget Sound recovery within which this analysis rests.

HUMAN DEVELOPMENT REPLACES NATURAL ECOSYSTEMS

The natural resources of the Puget Sound region have been diminished in quality and quantity by the continued advancement of human development along and beyond the Sound's shores. The altered landscape, from pre-industrial forests to present urban-industrial development, has greatly increased impervious surface and reduced vegetation cover, altered hydrology, increased the volume and intensity of runoff, reduced groundwater recharge, decreased habitat and the ability to support fish and wildlife, increased pollutant loads, and generally reduced ecosystem functions. Figure 1, from the Puget Sound Regional Council's VISION 2040[1], illustrates the expansion of development since the 1940s across the four-county PSRC region.[2]

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[1] Puget Sound Regional Council. 2016. "VISION 2040 Documents." https://www.psrc.org/vision-2040-documents.

https://www.arcgis.com/home/item.html?id=e45edf1c24b540b6afa712ba1fc9faf4 (Ecology and Commerce Data on UGA)

[2] Note that the Puget Sound Regional Council (PSRC) region represents only four of twelve Puget Sound Counties, however, those four counties in the PSRC region contain the majority of the total twelve county population.
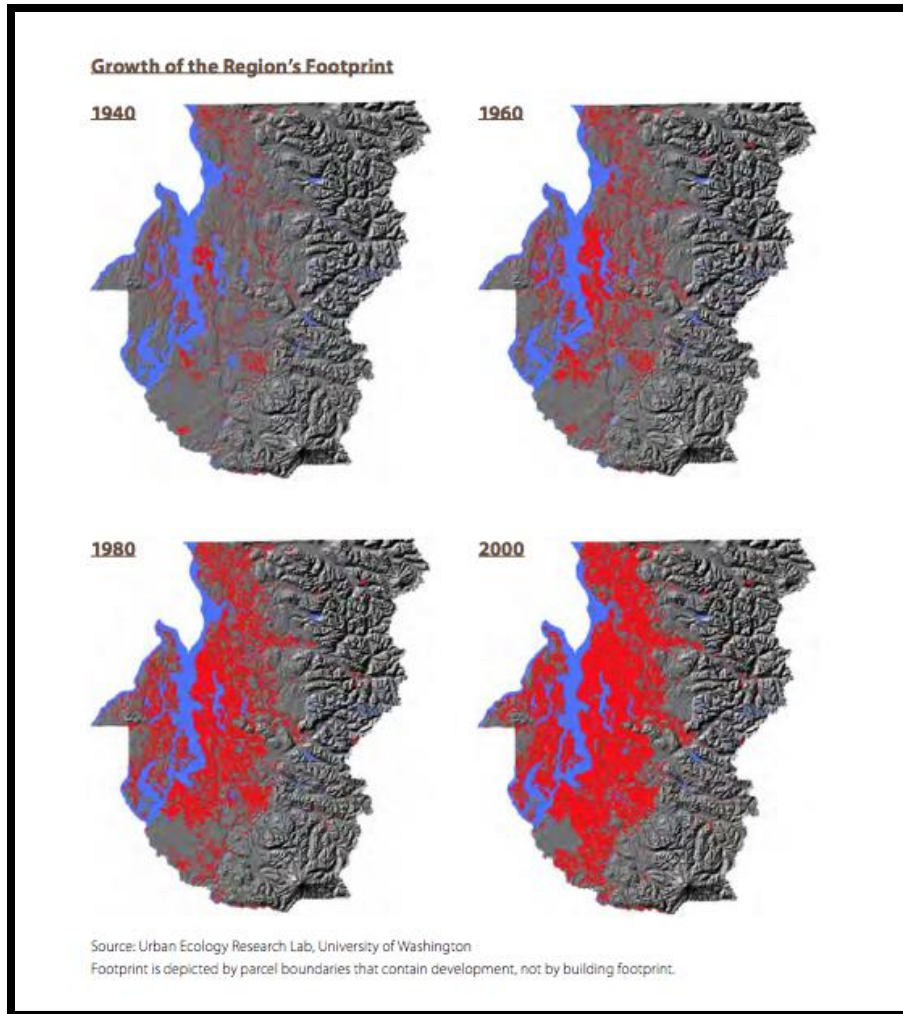
Figure 1. Expansion of growth across PSRC Counties, 1940-2000

While the figures above represent only the four PSRC counties, and not the entire twelve-county region, they represent the most populous counties and illustrate the pattern of expansion across the shores of the Sound. The steady expansion of development across the Puget Sound region has slowly eroded ecosystem functions in the Sound; regional forecasts predict continued population and housing growth, indicating further risk to remaining ecosystem/s.

RESTORATION AND RECOVERY

Recognizing the impacts that humans have had on the Puget Sound, efforts to restore and protect what remains of the natural systems in the Puget Sound have been underway for many years. In its current iterations, the effort to protect and restore the Sound are led by the Puget Sound Partnership (hereafter Partnership). A Washington State agency, the Partnership was established by the legislature in 2007 with the mandate to recover and restore the Puget Sound. While the Partnership is mandated by the state to recover the Puget Sound, the Puget Sound is also designated as an estuary of national significance. Thus, the federal government, through the National Estuary Program (NEP), funds and supports Puget Sound recovery as well.

Applying the framework provided by the Partnership, utilizing the funds provided by NEP, experts throughout the Puget Sound region, at every level of government, as well as academic and non-profit organizations, are working to protect the Sound. While the Partnership is designated as the lead agency for Puget Sound recovery and oversees the recovery framework, hundreds of organizations play a role in Puget Sound. Many operate beyond the Action Agenda framework, including government agencies, non-profits, local organizations, private businesses, and more.

While the Action Agenda cannot encompass every activity underway in the region, it does provide a framework for recovery planning, under which a large number of activities are funded. Many layers of planning are continuously being developed and utilized. Summaries of those most relevant to this analysis are provided here for context:

THE ACTION AGENDA

The Action Agenda is the organizing framework for Puget Sound recovery. The Partnership produces the Action Agenda and updates with its partners and colleagues at routine intervals. At present, the Action Agenda is revised on a four-year cycle, with the next version due in 2022.[3]

A brief glossary of key elements of the Action Agenda is provided below:

VITAL SIGNS

The Partnership has chosen a set of 25 Vital Signs to focus the restoration work under the Action Agenda. Each Vital Sign represents a key ecosystem component. Most of the Vital Signs have been assigned associated indicators and recovery metrics, or targets, to be met by 2020.[4]

Indicators

Indicators are measurable phenomenon that indicate the status of a vital sign. As an example, the Land Development and Cover Vital Sign has four indicators:

1. Rate of forest cover loss to development
2. Riparian restoration
3. Conversion of ecologically important lands
4. Growth in Urban Growth Areas

TARGETS

Most (but not all) indicators have an associated recovery target that the Action Agenda aims to meet by 2020. The four targets associated with the Land Development and Cover indicators above are:

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[3] Puget Sound Partnership. "Action Agenda 2018-2022." Accessed September 24, 2018. http://psp.wa.gov/action_agenda_center.php.

[4] Puget Sound Partnership. "Vital Signs." Accessed September 29, 2018. http://www.psp.wa.gov/vitalsigns/.

1. By 2020, average annual loss of forested land cover to developed land-cover in non-federal lands does not exceed 1,000 acres per year.

2. Restore 268 miles of riparian vegetation or have an equivalent extent of restoration projects under way.

3. Basin-wide loss of vegetation cover on ecologically important lands under high pressure from development does not exceed 0.15 percent of the total 2011 baseline land area over a five-year period.

4. The proportion of basin-wide growth occurring within urban growth areas is at least 86.5 percent (equivalent to all counties exceeding their population growth goals by 3 percent), with all counties showing an increase over their 2000–2010 percentage.

IMPLEMENTATION STRATEGIES

Implementation Strategies (IS) are a core driver of the Action Agenda. While the Action Agenda outlines recovery for the entire Puget Sound, IS are recovery plans for a specific ecosystem end, whether it be a Vital Sign, or a particular indicator beneath a Vital Sign. IS are developed by regional experts through a collaborative facilitation process called "Open Standards for the Practice of Conservation". Initially drafted by the Partnership, responsibility for developing and updating ISs now falls to groups of regional experts termed Strategic Initiative Leads (SILs). (SILs are discussed further in the following section.)

IS are living documents meant to be adaptively managed. Adaptive management means the IS are updated and revised as conditions change. There are presently IS for seven Vital Signs, with others in development over the next several years.[5]

The following Implementation Strategies are drafted:

- Estuaries
- Shellfish Beds
- Floodplains
- Land Development and Cover
- Eelgrass
- Chinook Salmon
- Shoreline Armoring

The following Implementation Strategies are currently under development:

- Benthic Index of Biotic Integrity (B-IBI) (one of three indicators for the Freshwater Quality Vital Sign)
- Toxics in Fish
- Marine Water Quality

The following Implementation Strategy is anticipated to begin development in 2019:

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[5] Puget Sound Partnership. "Implementation Strategies." Accessed September 24, 2018.
   http://www.psp.wa.gov/implementation-strategies.php.

- Summer Stream Flows

STRATEGIC INITIATIVES

Three Strategic Initiatives (SIs) emphasize arenas critical to Puget Sound recovery. They are:

- Habitat
- Shellfish
- Stormwater

Leads have been established for each Strategic Initiative within a variety of agencies. Strategic Initiative Leads (SILs) work cooperatively with regional partners to implement the management, restoration, and/or recovery of their strategic initiative arena.

The SILs are key to the development and implementation of the Action Agenda. Each SIL receives NEP funding, from which they fund sub-awards for what are termed Near Term Actions (NTAs). NTAs are projects that last between 2 and 4 years and are undertaken by a wide variety of organizations. NTAs are funded through a competitive application process, and must align with actions identified as key to recovery under the Action Agenda.

SILs have the following responsibilities:[6]

- Identify regional recovery and protection priorities
- Coordinate responses to issues that affect all three SIs (cross-cutting issues)
- Establish the appropriate sequences of actions to lead from present conditions to long term goals
- Solicit, identify, review and prioritize local and regional Near Term Actions (NTAs)
- Develop and apply evaluation criteria for the review of NTAs
- Administer NEP funds to implement priorities identified in the Action Agenda

Many of the prioritization and planning tasks for which the SILs are responsible are developed through the Implementation Strategies (IS). SILs and their partners oversee the development and adaptive management of the IS associated with their particular SI. Key tasks for each SIL include funding NTAs and stewarding respective Implementation Strategies.

THE SCIENCE AWARD

Recognizing the need for a science-based recovery process, NEP funded the Science Award. The Partnership and the Puget Sound Institute (PSI) are joint recipients of the Science Award. This four-year award spanning fiscal years 2018-2021 includes a number of tasks and subtasks aimed to foster the application and advancement of science as it relates to Puget Sound recovery

INFILL CRITICAL ANALYSIS

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[6] Puget Sound Partnership. "Strategic Initiatives." Accessed September 29, 2018. http://psp.wa.gov/strategic-initiatives-leads.php.

One the subtasks given to PSI in year one of the Science Award was to conduct a critical analysis in support of an IS. An open call for proposals was made to the SILs. Several projects were proposed. After ranking and review by PSI, the Implementation Strategies Workgroup (ISWG), and the joint Partnership-PSI Science Team, a proposal from the Habitat SIL for a spatial analysis of barriers to infill was selected.

The Habitat SIL is responsible for the Land Development and Cover Implementation Strategy (LD&C IS).[7] A goal of the LD&C IS is to preserve ecologically important lands from being developed by promoting denser development within Urban Growth Areas (UGAs), generally referred to as infill. There are uncertainties surrounding our knowledge of infill. Thus, Habitat SIL requested a critical analysis to address some of these uncertainties.

Originally, the Habitat SIL proposed a project to quantify the lands available for infill, with an emphasis on quantifying brownfields. Brownfields are widely regarded as a major category of under-utilized land that may be more desirable for development than previously undeveloped lands outside UGA boundaries.

The original Habitat SIL proposal posed the following primary question:

What are the barriers to infill in Puget Sound Urban Growth Areas?

The Key Uncertainty to address was stated as:

Where are the available lands for infill and redevelopment within Urban Growth Areas from the Land Development and Cover Implementation Strategy?

The scope of this Infill Critical Analysis project evolved from that initial proposal to one that assesses recent housing development just outside the UGA border. There were several influencing factors in this decision, the first being that concurrent analyses were already being done for both brownfields (Item I below) and for land capacity within UGAs (Item II below).

Existing analyses related to infill:

I. The Ecosystem Coordination Board (ECB), in partnership with the Department of Ecology (Ecology), was already investigating the potential for development of Brownfields into affordable housing.

II. The Growth Management Act (GMA) requires local jurisdictions to do land capacity analysis as part of their comprehensive planning. This analysis, termed Buildable Lands, is overseen by the Department of Commerce.[8]

RELATED LOCAL EFFORTS

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[7] Habitat Strategic Initiative Lead. 2018. "Land Development & Cover Implementation Strategy, Phase 2." Puget Sound Partnership. https://pspwa.app.box.com/notes/248479031753?s=w5uf45cyk7tx4ztvknh0atxtnc5e35b6.

8 Recent legislation, SB 5254, has altered the requirements for the Buildable Lands Analysis, thus Commerce is currently in the process of revising the Buildable Lands guidance. This may change how jurisdictions track and report their analyses in the future.

Because development, and housing in particular, is a critical focus for the region, many are working on these issues.[9] Summaries of several such projects follow.

PUGET SOUND REGIONAL COUNCIL

As part of its regional planning work, the PSRC provides macroeconomic and development forecasts, discussed in brief below.

MACROECONOMIC FORECASTS

Puget Sound Regional Council (PSRC) is a planning agency that represents King, Kitsap, Pierce and Snohomish Counties. Together these four counties house the majority of the Puget Sound region's population. PSRC conducts long-range regional planning and provides a number of products to support comprehensive regional planning.

VISION *2040*

VISION 2040 forecasts households, persons, jobs, and other economic and demographic variables through the year 2040 for their four-county region.[10]

VISION 2050

A 2050 forecast is in development, with provisional numbers available. The 2050 macroeconomic forecast estimates 5.8 million people (from 4.2 million in 2020), 830,000 new households, and 1.2 million more jobs (from 2.4 million in 2020).[11],[12]

DEVELOPMENT FORECASTS

PSRC also has two different development forecasts for the region:

LAND USE BASELINE

Using PSRC's UrbanSim model, PSRC's land use baseline represents future development based on the market response to growth as would occur under pre-VISION 2040 comprehensive plans.

LAND USE VISION

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[9] An overview of density planning with visual examples of projects throughout Washington State is provided in this blog article: Bengford, Bob. 2017. "Visualizing Compatible Density." *MSRC Insight Blog* (blog). April 10, 2017. http://mrsc.org/Home/Stay-Informed/MRSC-Insight/April-2017/Visualizing-Compatible-Density.aspx.

[10] Puget Sound Regional Council. 2016. "VISION 2040 Documents." Puget Sound Regional Council. 2016. https://www.psrc.org/vision-2040-documents.

[11] PSRC. 2018. "Draft 2050 Forecast of People and Jobs." Puget Sound Regional Council. www.psrc.org/sites/default/files/2050_macro_forecast_web.pdf.

[12] Puget Sound Regional Council. 2018. "2050 Forecast of People and Jobs." January 25. https://www.psrc.org/sites/default/files/eb201801-pres-2050forecastpeoplejobs.pdf.

Land Use Vision (LUV) projects how counties, cities and smaller places *could* grow in the future. The land use and growth assumptions in LUV—developed with assistance from local planners—supports long-range planning and modeling work.

LUV has population, households and jobs data. It reflects VISION 2040's Regional Growth Strategy, local policies, and each county's adopted growth targets

A comparison of the two development forecasts is given in Table 1, below.

Table 1 Comparison of PSRC's two development forecast models (*from PSRC*).

	Land Use Vision	Land Use Baseline
What It Represents:	A **policy-based** growth projection developed to align with the VISION 2040 Regional Growth Strategy, local growth targets and the regional macroeconomic forecast. The future growth pattern the region is planning for.	A **market-based** growth projection of current growth patterns. The future growth pattern if the region made no further efforts to implement VISION 2040 beyond the plans, policies and development regulations currently in place.
UrbanSim Mode:	Allocation (jurisdictional controls)	Simulation (regional controls)
Regional Macroeconomic Forecast Year:	2015	2012
Data Variables:	- Total population - Group quarter population - Household population - Households (by income quartile) - Employment (by major sectors)	
Geography:	FAZ, Tract, city/uninc'd urban/rural	
Base Year:	2010	2010
Interim Years:	Every five years 2025-40	Decadal through 2040
Horizon Year:	2040	2040

OLYMPIA'S MISSING MIDDLE HOUSING PROJECT

The "Missing Middle" was coined by Daniel Parolek of Opticos Design, Inc. in 2010 to define a range of multi-unit or clustered housing types compatible in scale with single-family homes that help meet the growing demand for walkable urban living.[13] Figure 2 below illustrates the concept of "missing middle" in relation to more traditional housing development patterns.

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[13] Opticos Design. "Missing Middle Housing." 2018. http://missingmiddlehousing.com/.
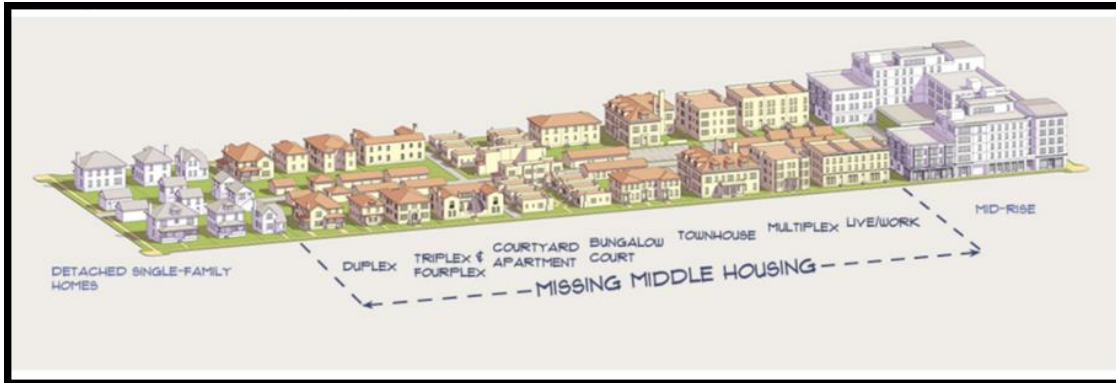
Figure 2. Missing Middle Housing as a mix of housing types, as compared to segregated single and multi-family units.

Olympia's Missing Middle Project is looking for ways to increase Missing Middle Housing in Olympia.[14]

The goals of Olympia's Missing Middle project include:

- Research how much missing middle housing currently exists in Olympia.
- Determine how much more will be needed to accommodate future population growth affordably.
- Look at Olympia's regulations and fees and how they may be impacting property owners' decisions on whether to build missing middle housing.
- Examine how additional missing middle housing can be added in a way that is compatible with existing neighborhoods.

Olympia's missing middle project demonstrates a process local planners can follow to create higher density housing in alignment with the regional goals for promoting infill to lessen development pressures outside UGAs.

More information on Olympia's Missing Middle Project can be obtained at:
http://olympiawa.gov/city-government/codes-plans-and-standards/missing-middle.aspx

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[14] City of Olympia. "Missing Middle." Accessed September 29, 2018. http://olympiawa.gov/city-government/codes-plans-and-standards/missing-middle.aspx.

Two housing datasets were used in this analysis, along with 2012 Urban Growth Area Boundaries. Analysis spanned the years 2011-2016. Ancillary data was also investigated; the processes employed to identify and obtain additional data, as well as limitation and challenges are discussed in the Appendix.

DATA USED

The following provides a brief description of the housing data used in this analysis.

PUGET SOUND MAPPING PROJECT HOUSING DATA

Developed by the Washington State Department of Commerce (Commerce), the Puget Sound Mapping Project (PSMP) provides regional land use information. Along with housing data, PSMP provides uniform land use classifications across the 12 Puget Sound counties. The land use categories are of particular interest as they are broken into unprecedented detail for the region, with 13 master categories and 32 subcategories of land use.[15]

The PSMP housing data is based on Washington State's Office of Financial Management (OFM) Small Area Estimates program (SAEP), and presently includes the years 2000-2017.[16] The SAEP calculates pre-2010 census data differently than post-2010 census data. Post-censal estimates take annual city and county housing estimates (provided by each city or county to OFM), then distributes these to census blocks based on: residential building permits, assessor records, postal delivery statistics, and federal census data. The SAEP uses whichever data are judged to be the most representative of local housing change for a given jurisdiction each year.[17]

The PSMP housing data provides total units as well as units added per year. It consists of polygons that geographically summarize housing unit info by land-use categories, city and county boundaries, 2012 Urban Growth Areas and Watershed Characterization Assessment Units. The housing units are tallied within a census block group, as provided by OFM. Because the housing unit totals are distributed across a census block group, refined analysis of specific development projects is not possible with this dataset—however, the dataset is appropriate for reviewing regional trends and patterns across larger areas.

PUGET SOUND REGIONAL COUNCIL PERMIT DATA

The Puget Sound Regional Council (PSRC) collects permit data from its member counties (King, Kitsap, Snohomish, Pierce). The data is summarized and made available on the PSRC website. Christy Lam from PSRC provided us the permit data used here directly.

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[15] Washington State Department of Commerce. "Puget Sound Mapping Project." Accessed September 24, 2018. https://www.commerce.wa.gov/serving-communities/growth-management/puget-sound-mapping-project/.

[16] Washington State Office of Financial Management. "Small Area Estimates Program." Accessed September 24, 2018. https://www.ofm.wa.gov/washington-data-research/population-demographics/population-estimates/small-area-estimates-program.

[17] Washington State Office of Financial Management. 2012. "Small Area Estimate Program User Guide." https://www.ofm.wa.gov/sites/default/files/public/legacy/pop/smallarea/docs/saep_user_guide.pdf.

Visually, a single dot represents a single permit. Each permit can potentially encompass multiple housing units, as in the case of multi-family housing, or even demolitions. Analysis of permitted unit totals was performed using the reported net housing units rather than the number of permit points.

It should be noted that the data does not indicate if a given project was actually built. However, as permitting indicates that there is or was desire to build in an area, it still provides valuable insight into recent development activities.

URBAN GROWTH AREAS (2012)

2012 Urban Growth Area boundaries are used in this study. A 2018 layer is available, however, the PSMP data was based on the 2012 UGA boundaries, therefore the 2012 are used for this analysis. Overall the 2012 and 2018 boundaries are similar, with 2018 having an additional 40 square miles of UGA—mostly from an expanded UGA around Everett.

PROJECTION

All data has been re-projected to Washington State Plane North and clipped to the 12 Puget Sound counties as needed. Figure 3 shows the coverage areas of the datasets employed.

Figure 3.Overview of Puget Sound counties, PSRC counties, and 2012 UGAs.

TOTAL NET HOUSING

The PSRC permit data consistently has larger—in some cases much larger—total net unit units than the PSMP data. PSRC reports 120,000 units, whereas PSMP reports 87,000 units for the four counties, a 27% difference. Interestingly the difference between the two datasets is only 1.6% for Kitsap, which has roughly 2,500 permits/unit, versus 33% for King County, which has 55,455 units under PSMP and 82,249 units under PSRC. All values are given in Table 2.

There isn't enough knowledge of the underlying data to assess where the difference arises (it may stem in part from the PSRC data including permits that were not acted on, for example, but it is hard to say for sure). What is probably more important is that the ratio of UGA to exUGA net housing units is consistent across the datasets. For example, for King County, the relative percentages of UGA and exUGA units only vary by 0.1% between the two datasets. Additionally, when graphed side-by-side, the two datasets follow the same pattern for each of the four PSRC counties, inside the UGA, outside the UGAs, and overall, as shown in Figure 4 below.
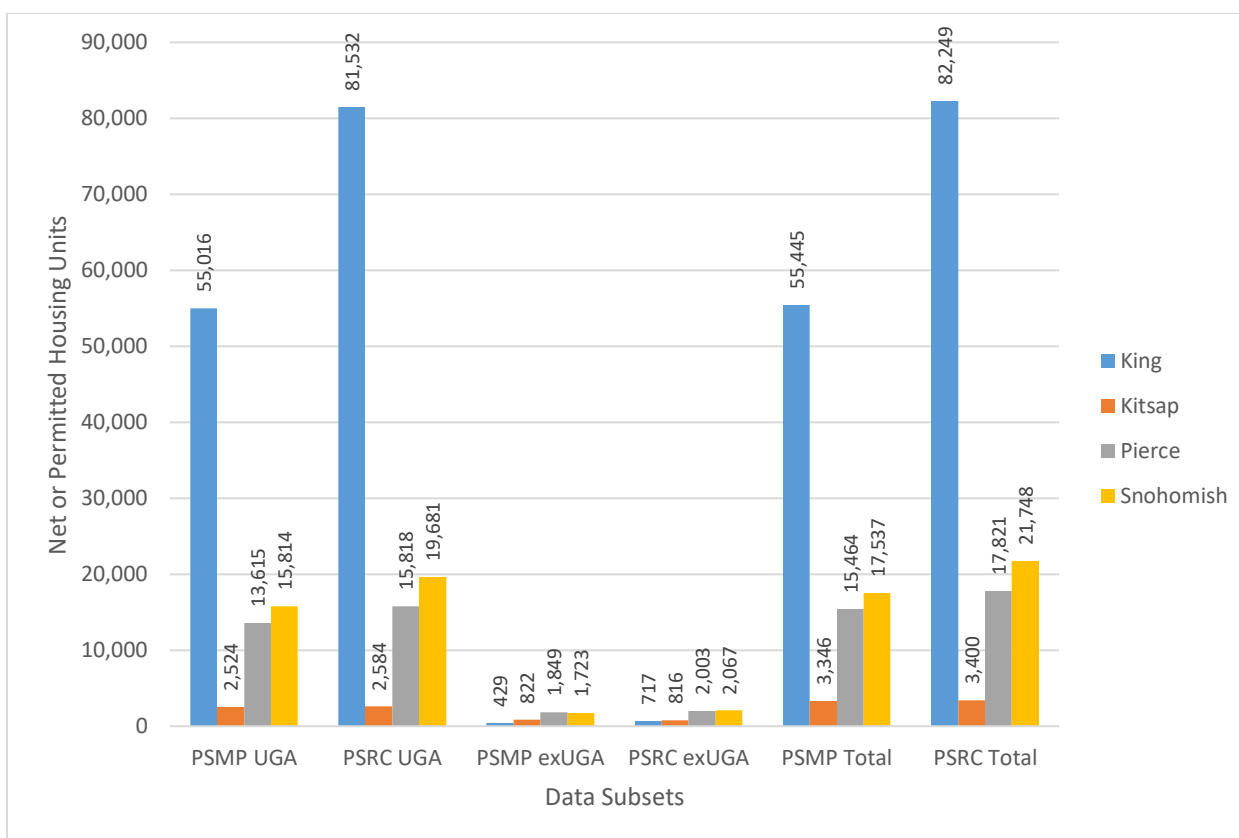
Figure 4. PSMP and PSRC reported new housing unit totals (2011-2016), in comparison.

Table 2. Total new net housing, comparison of PSMP housing units and PSRC permits (2011-2016).

County	Total Net Units							Percent				
	UGA		exUGA		Total		Difference*	Difference* *(PSRC-PSMP)/PSRC	UGA		exUGA	
	PSMP	PSRC	PSMP	PSRC	PSMP	PSRC	*PSRC-PSMP		PSMP	PSRC	PSMP	PSRC
PSRC Counties												
King	55,016	81,532	429	717	55,445	82,249	26,804	32.6%	99.2%	99.1%	0.8%	0.9%
Kitsap	2,524	2,584	822	816	3,346	3,400	54	1.6%	75.4%	76.0%	24.6%	24.0%
Pierce	13,615	15,818	1,849	2,003	15,464	17,821	2,357	13.2%	88.0%	88.8%	12.0%	11.2%
Snohomish	15,814	19681	1,723	2,067	17,537	21,748	4,211	19.4%	90.2%	90.5%	9.8%	9.5%
Subtotal	86,969	119,615	4,823	5,603	91,792	125,218	33,426	26.7%	94.7%	95.5%	5.3%	4.5%
Clallam	399	--	683	--	1,082	--	--	--	36.9%	--	63.1%	--
Island	282	--	940	--	1,222	--	--	--	23.1%	--	76.9%	--
Jefferson	205	--	425	--	630	--	--	--	32.5%	--	67.5%	--
Mason	76	--	783	--	859	--	--	--	8.8%	--	91.2%	--
San Juan	103	--	421	--	524	--	--	--	19.7%	--	80.3%	--
Skagit	1,135	--	379	--	1,514	--	--	--	75.0%	--	25.0%	--
Thurston	6,221	--	1,293	--	7,514	--	--	--	82.8%	--	17.2%	--
Whatcom	3,308	--	1,054	--	4,362	--	--	--	75.8%	--	24.2%	--
Subtotal	11,729	--	5,978	--	17,707	--	--	--	66.2%	--	33.8%	--
Total	98,698	--	10,801	--	109,499	--	--	--	90.1%	--	9.9%	--

Several methods for visualizing the PSMP data were explored in order to understand how to best utilize it for this study.

CHOROPLETH SYMBOLOGY

A common way to visualize data is through choropleth symbology, where different color gradients represent different values. In this case each colored polygon corresponds to a particular housing density. This can be deceiving, however, as the PSMP polygons do not have a uniform area, thus density values can be distorted. For example, one large polygon may have a high density in a portion of its area, making it display as a higher density value, while the remainder of the polygon is actually of a lower density, but still displays as the high density color. This type of analysis may work well at lower resolution, but is difficult to scale or translate to higher resolutions. Figure 5 displays the PSMP new housing data using chloropleth symbology.
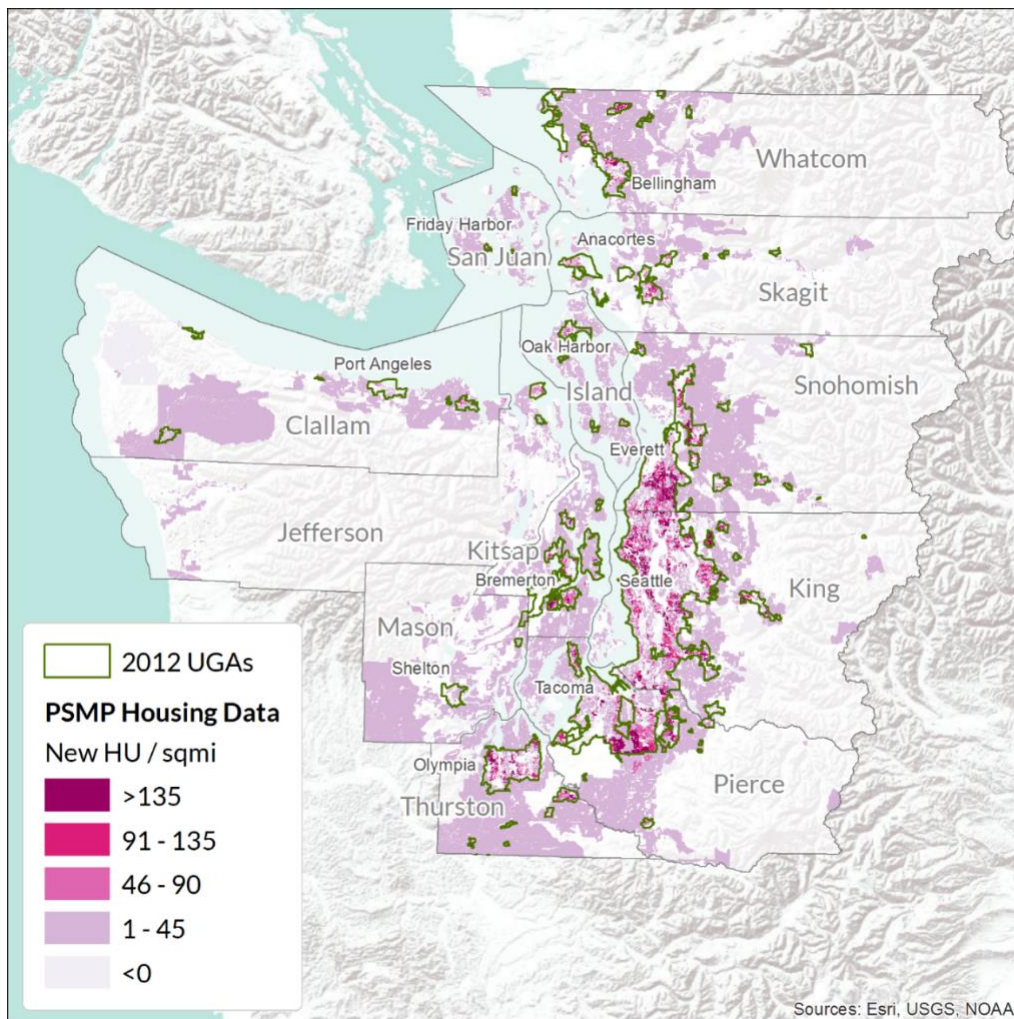
Figure 5. PSMP housing data displayed using choropleth symbology.

DOT DENSITY SYMBOLOGY

Another way to display the PSMP housing data is through dot density symbology. This technique breaks down housing units from a set of polygons into dots that represent a given number of units, and then distributes those dots randomly within the boundaries of the respective polygon. For example, 1 dot could be set to represent 5 housing units, so a polygon having a total of 50 housing units would have 10 dots distributed within its bounds. The challenge with dot density symbology is that, again, the units are randomly distributed across their associated polygons, and therefore do not represent actual locations of new units, but rather, generalized growth trends for the region. Figure 6 displays the PSMP housing data using dot density symbology
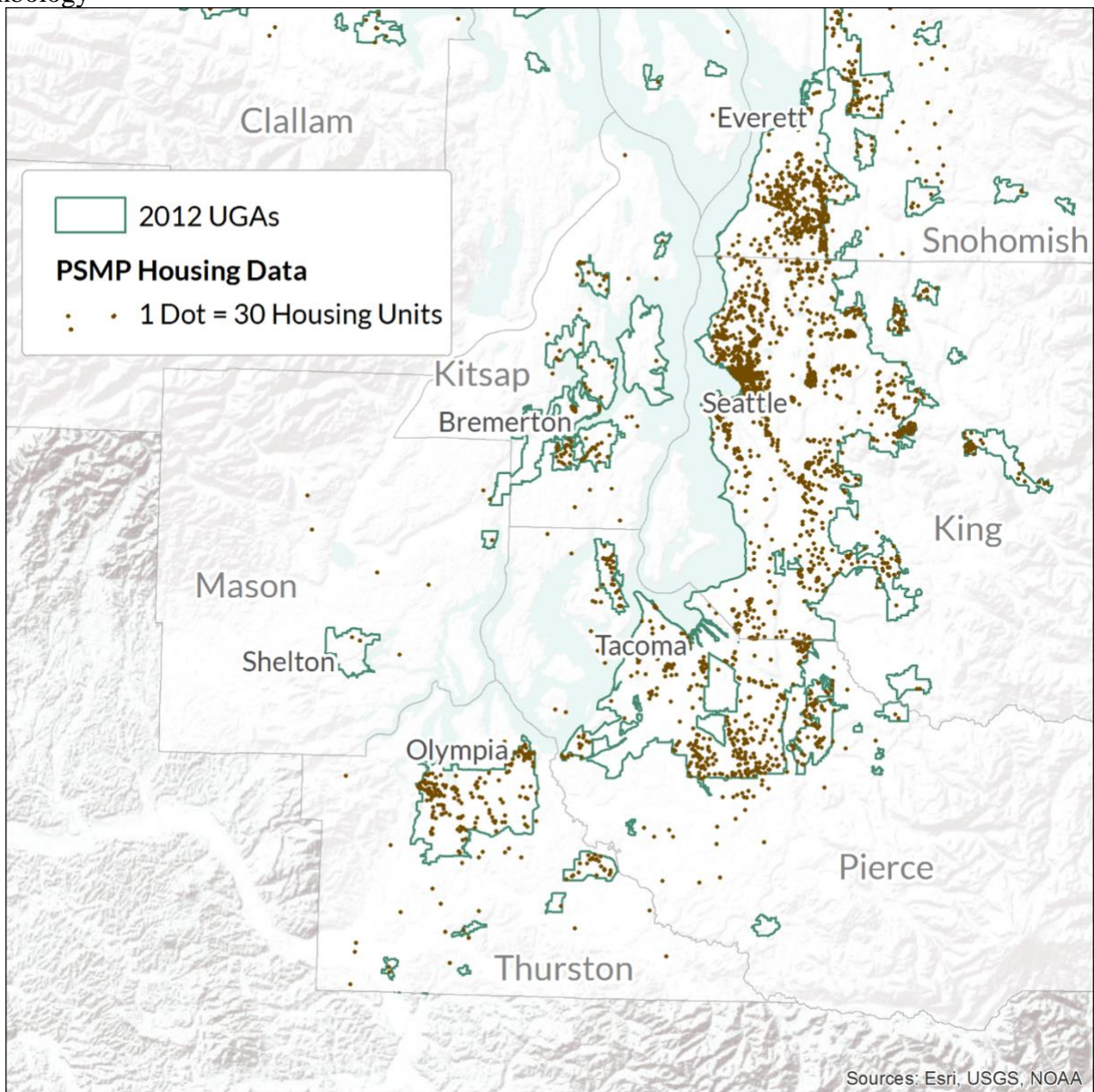
Figure 6. PSMP housing data displayed using dot density symbology.

DIVISION INTO SUBSETS

It became clear early into exploring the data that it would need to be subdivided, as the huge amount of growth in King County relative to other areas washes out most other growth. The data was broken down by inside versus outside UGAs and then, after doing some additional assessment, further broken down by county. Dividing the data into county and UGA/exUGA subsets should allow for a more useful analysis, as counties have their own policies that affect growth, and the patterns of growth inside the UGAs are different than those outside.

PSMP OUTLIERS

Extreme outliers in the PSMP dataset were removed for density calculations (described in the Calculating the Top 20th Percentile exUGA Density section). There are polygons in the PSMP dataset that have very small areas compared to their new housing counts. An example of such an outlier is shown in Figure 7 below, where the new unit density is 1.9×10^6 units per square mile. These are likely artifacts of the original data process that need some additional clean-up.
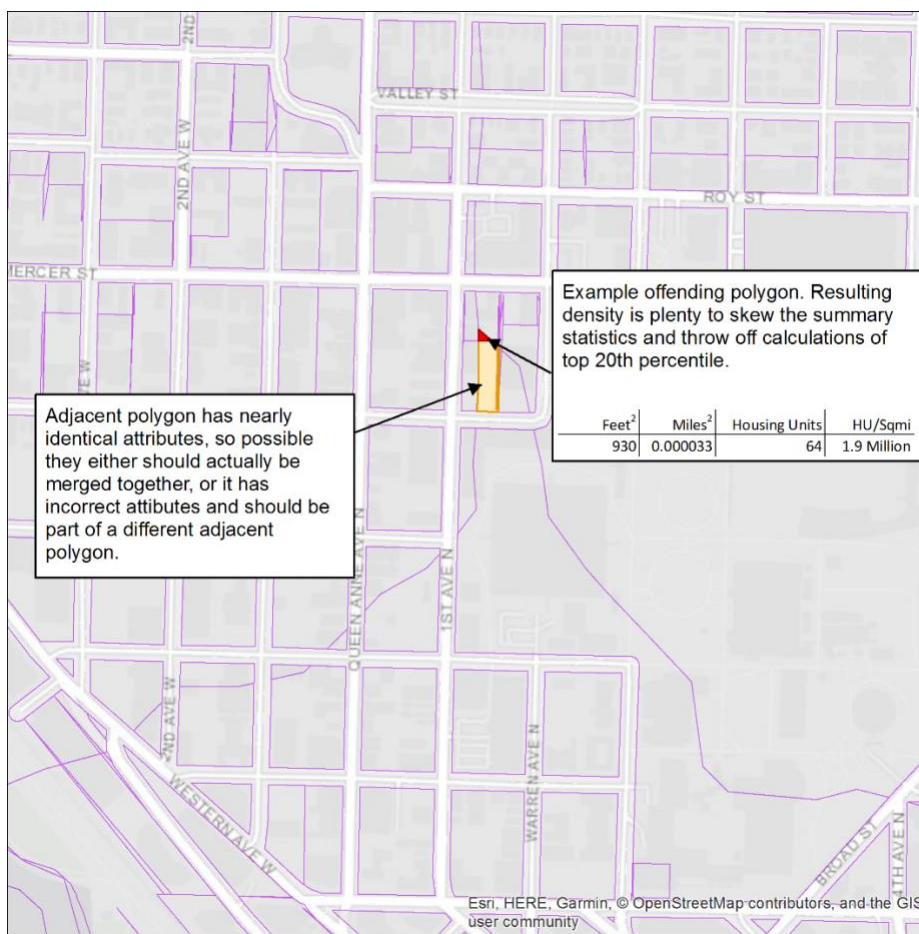
Figure 7. Example of an extreme outlier that was removed from the PSMP dataset.

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It is not always appropriate to remove outliers. However, in this case, the outlier values were extreme enough that they overwhelmed the rest of the data, resulting in the map essentially looking blank. The extreme new housing unit density outliers were therefore removed before further assessing density values in order to account for this issue.

Extreme outliers were calculated using the standard formula. In this formula, quartiles are determined for the data. The interquartile range (IQR) is then calculated by subtracting the lower quartile (Q1) from the upper quartile (Q3):

IQR = Q3 - Q1

Next, the outer fences of the data were calculated:

Upper fence: Q3 + 3*IQR
Lower fence: Q1- 3*IQR

Extreme outliers are those values that lay outside the outer fences. Python scripting was used to facilitate performing these calculations for each county subset of data. Results are presented in Table 3.

Table 3. Fences for extreme outliers of density values

Layer	Lower Outer Fence	Upper Outer Fence
PSMP_Clallam_Urban	-64.54556481	191.8024523
PSMP_Clallam_exUrban	-10.87008084	34.59098275
PSMP_Clallam_All	-21.00726901	63.29483859
PSMP_Island_Urban	-115.4465093	326.2455235
PSMP_Island_exUrban	-17.94211817	59.70872135
PSMP_Island_All	-30.5477576	93.80111172
PSMP_Jefferson_Urban	-85.4283928	296.8963234
PSMP_Jefferson_exUrban	-13.48938736	45.12559287
PSMP_Jefferson_All	-19.17277264	62.5298076
PSMP_King_Urban	-425.9399376	1167.285763
PSMP_King_exUrban	-5.184733318	15.3945057
PSMP_King_All	-329.7501554	888.0691454
PSMP_Kitsap_Urban	-95.10632978	259.7329377
PSMP_Kitsap_exUrban	-7.961054187	26.73266548
PSMP_Kitsap_All	-34.24587316	97.00709502
PSMP_Mason_Urban	-33.33034092	64.42528938
PSMP_Mason_exUrban	-9.911256622	31.45333279
PSMP_Mason_All	-10.39074098	32.18362105
PSMP_Pierce_Urban	-174.1009547	486.2158019
PSMP_Pierce_exUrban	-9.099983062	29.95524242
PSMP_Pierce_All	-98.41107391	271.4007789
PSMP_San_Juan_Urban	-55.78593724	278.9479105

PSMP_San_Juan_exUrban	-11.15630898	38.19136074
PSMP_San_Juan_All	-20.4053737	63.62444609
PSMP_Skagit_Urban	-109.1948051	328.0147767
PSMP_Skagit_exUrban	-8.033739274	22.28465212
PSMP_Skagit_All	-40.28768691	110.3476338
PSMP_Snohomish_Urban	-273.2244645	780.1947487
PSMP_Snohomish_exUrban	-6.95677494	22.33496643
PSMP_Snohomish_All	-167.6282717	457.5717447
PSMP_Thurston_Urban	-235.0595826	654.2899484
PSMP_Thurston_exUrban	-14.77231696	49.73496127
PSMP_Thurston_All	-82.1435201	231.0573781
PSMP_Whatcom_Urban	-212.935946	637.5554383
PSMP_Whatcom_exUrban	-13.00740749	38.93628556
PSMP_Whatcom_All	-95.07983608	262.6474843

PSRC FILTERS

Per recommendation from PSRC, *Permit Situation (PS)* codes 2 and 4 were filtered out to remove permits that have net zero housing unit change[18] and cancelled permits. An additional 261 points were removed that showed up well outside of Washington, likely due to bad coordinate information.

62,325 permits remained, representing a total of 119,615 net housing units across the four-county PSRC region.

DETERMINING HIGH DENSITY EXUGA GROWTH

"High growth" for the purposes of this project has been defined as the top 20th percentile density for exUGA housing units/permits, calculated for and applied to each data subset. Methods used to identify high-growth areas are described in the next two sections. Results for each housing dataset follow.

VISUAL SELECTION

Initially, PSMP dot density display was used to visually select high growth areas. Using 1:1 dot density, visually apparent clusters of high density growth were outlined, as shown in the purple polygons in Figure 8 below.

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18 For example, a demolition and its replacement would not be counted as new development—
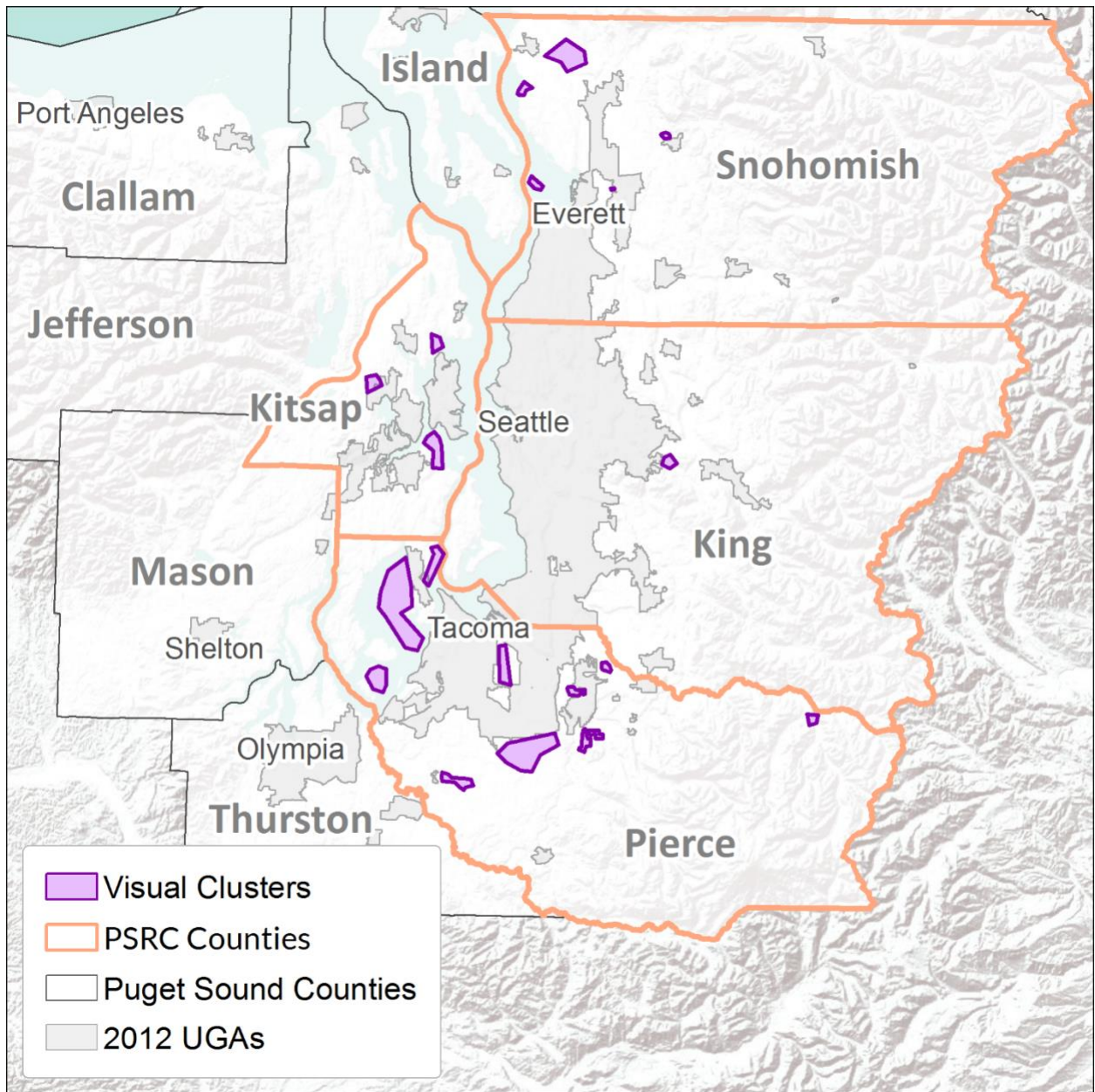
Figure 8. Overview of visually delineated areas of high exUGA growth (identified using PSMP, 1:1 dot density display).

These same polygons were then compared to the calculated high growth PSRC rasters, shown in red in Figure 9 below. (The creation of the high growth rasters is explained later in this section.)
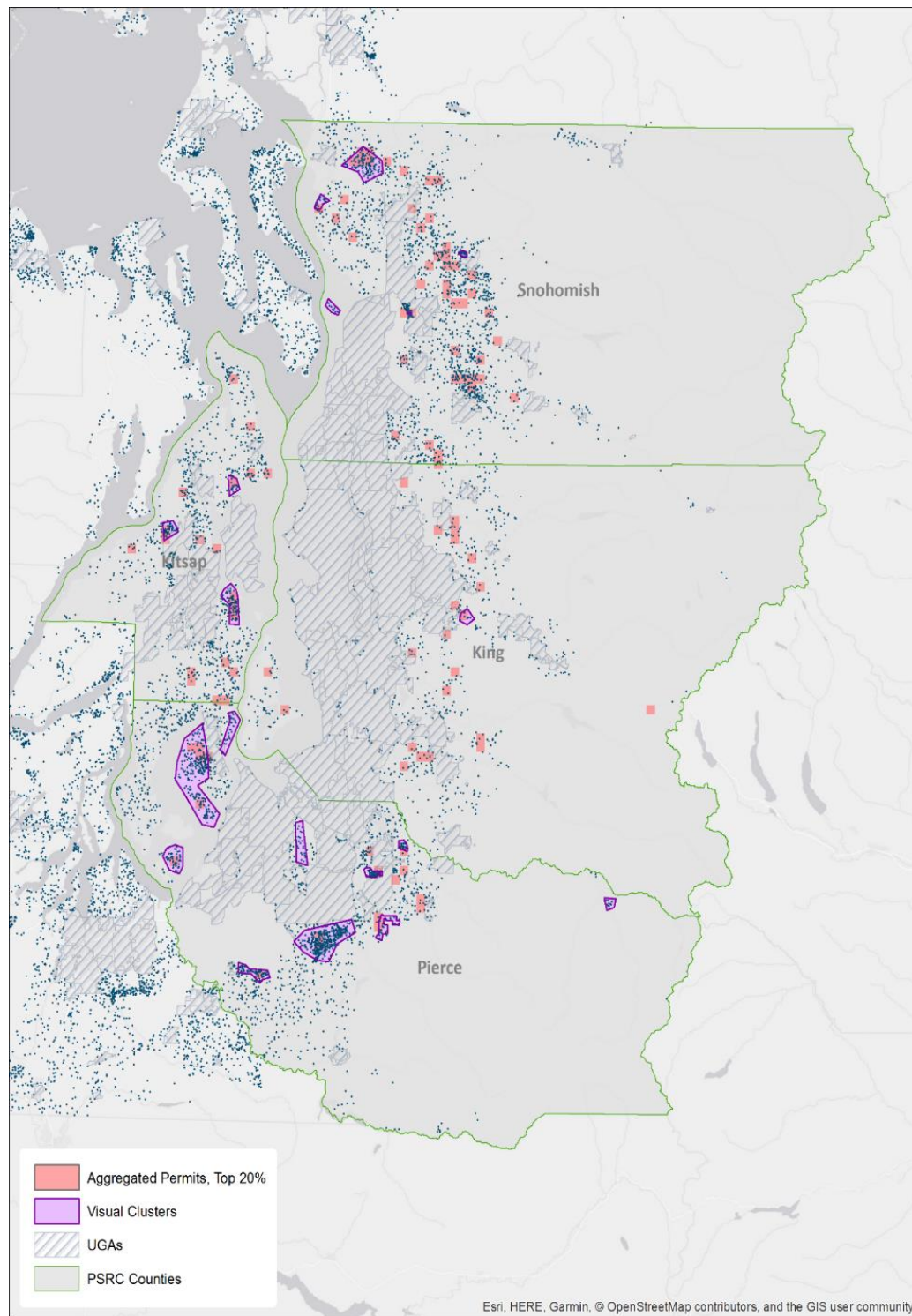
Figure 9. Visual delineations and PSRC aggregation rasters with PSMP 1:1 dot density (exUGA only).

It can be seen that the visually delineated areas are generally larger than the areas picked out by the rasters. This is due to the dot density spreading dots across an entire polygon. Essentially, entire polygons are being displayed as high growth versus the more localized clustering seen in the permit data. The following section will cover some of the issues encountered in visually displaying these data in more depth.

ISSUES WITH MAUP

The Modifiable Areal Unit Problem (MAUP) is the term used to reference how aggregation of data into polygons can introduce significant statistical bias in the results of spatial analyses. Both the shape and scale of aggregation units can influence the resulting summarization of the data, with even subtle shifts in boundaries potentially producing very different results[19]. As such, the PSMP data in particular is subject to MAUP issues, and care must be taken with interpreting it.

Figure 10 below highlights two areas in Pierce County where MAUP issues can be seen. Using the PSMP data the high growth in these polygons appears spread out over a much larger area than it actually is, as evident in the PSRC permits, where a series of subdivisions are clearly driving the density for the entire polygon. This may not be an issue when looking at regional trends, but without location specific information such as that provided in the permit data, it would be difficult to identify that specific subdivisions are the primary source of the density reported for the polygon.

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[19] Openshaw, S. (1984). *Ecological fallacies and the analysis of areal census data.* Environment & Planning A, 16(1), 17–31. https://doi.org/10.1068/a160017
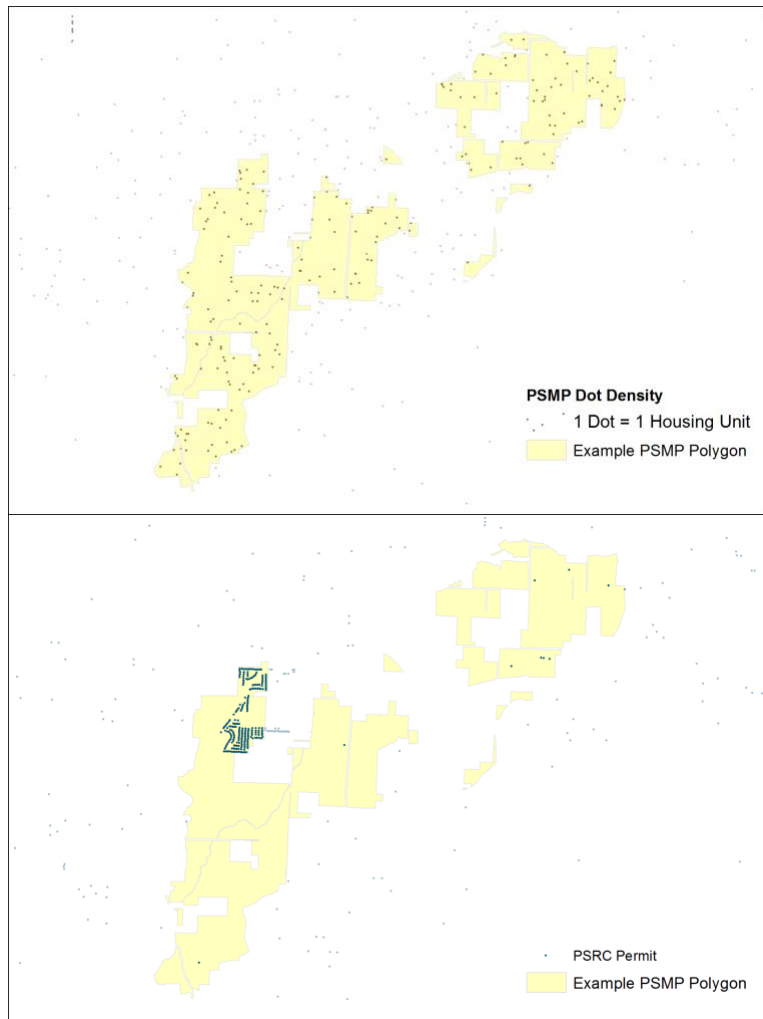
Figure 10. PSMP polygons with high density (above), and same polygons with PSRC permit points (below).

The aggregation of permits to rasters also can suffer from MAUP, and in some cases visual delineation actually can pick up clustering of growth the aggregation misses, as shown in Figure 11.
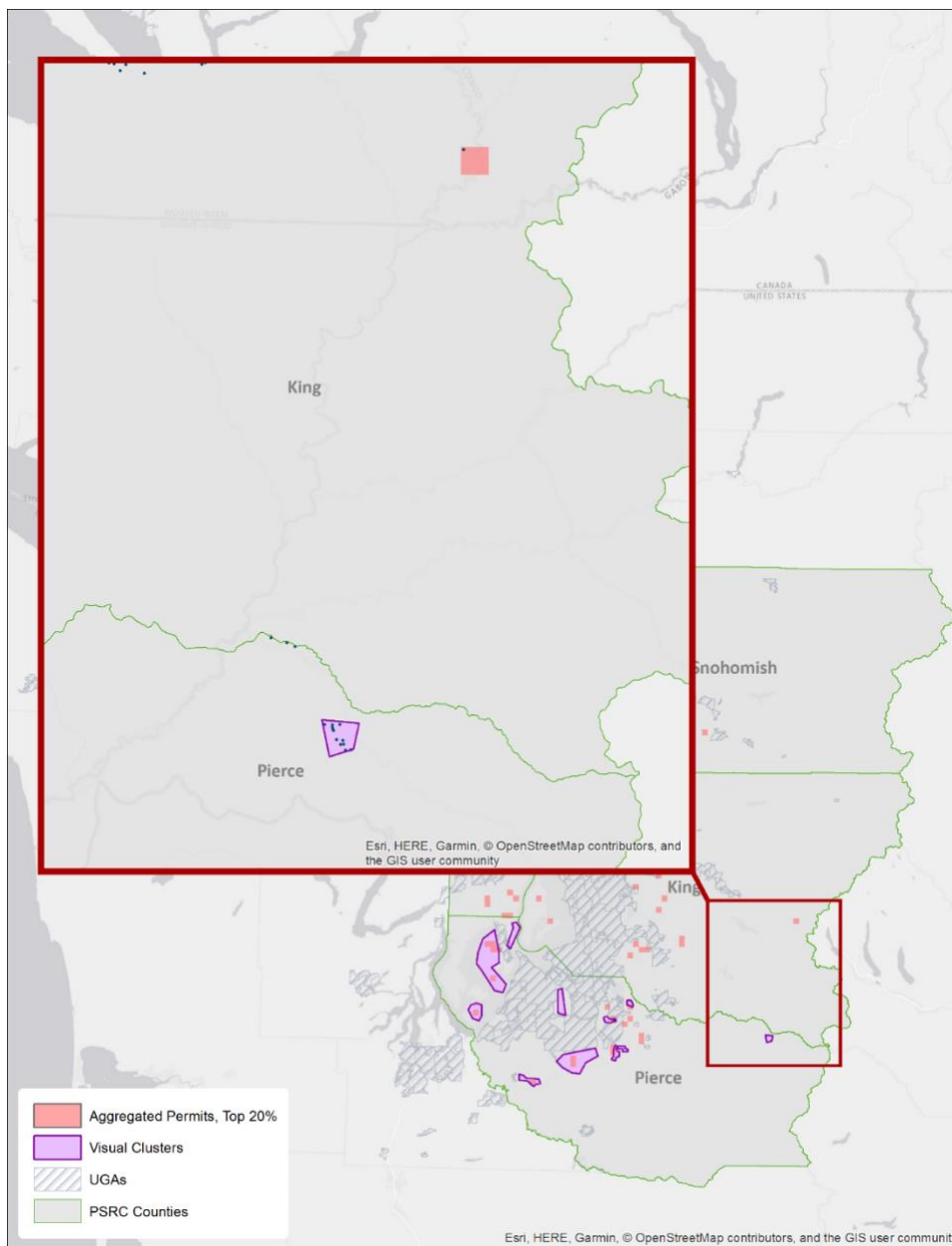
Figure 11. Both the PSMP and PSRC aggregations have victims of MAUP. (Permit points displayed for reference in inset.)

In Figure 11, above, to the north a densely clustered set of permits representing significant net housing is captured in the aggregated permit raster, but is not as apparent visually. To the south, a cluster that stands out visually is spread out enough that it doesn't make the top 20th percentile high growth density threshold (captured in the red aggregated permit cells). While

MAUP still affects the permit data, the smaller, more regular nature of the raster cells at least visually *appear* to produce fewer MAUP issues.

Because the visual determination of high growth can be misleading, a more precise, quantitative means to identify high growth was needed. Data were analyzed for relative spatial distribution and for unit/permit density per exUGA area.

DISTANCE BAND ANALYSIS

The "Calculate Distance Band from Neighbor Count" tool from Esri was used to assess how dispersed new exUGA development projects typically are. This Esri tool performs point-to-point calculations to get the average distance to the nearest number of points specified, as shown in Figure 12 below. (Note that for PSRC, each point represents a permitted project, not necessarily an individual housing unit.)

Calculate Distance Band from Neighbor Count

Returns the minimum, the maximum, and the average distance to the specified Nth nearest neighbor (N is an input parameter) for a set of features. Results are written as tool execution messages.

1 Neighbor
Distance Band - 5.2 miles

2 Neighbors
Distance Band - 9.5 miles

3 Neighbors
Distance Band - 12.1 miles
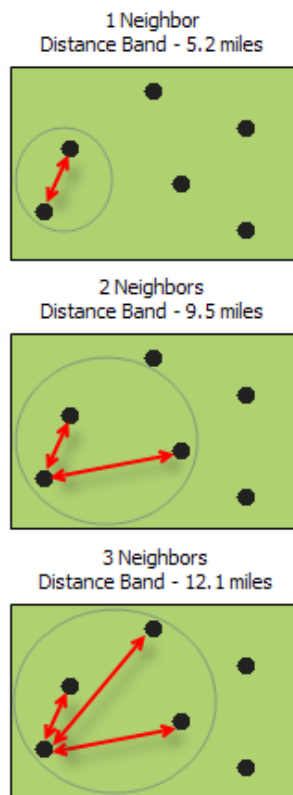
Figure 12. Explanation of Calculate Distance Band from Neighbor Count tool (from Esri Arc GIS help feature).

Distance band calculations were not performed for the PSMP housing units, as their generalized distribution across census block groups would render point distance comparisons meaningless.

The distance band tool was applied to the PSRC permit data. It was set to report for the nearest 20 neighboring permit points.[20] This analysis was performed for UGA and exUGA permits for each PSRC county as well as the full PSRC dataset (Table 4).

Table 4. Distance (in feet) to the nearest 20 permit locations, 2011-2016 PSRC permits (bold font indicates lowest and highest max and min values).

| Permit Set	Min		Avg		Max	
	UGA	exUGA	UGA	exUGA	UGA	exUGA
King	100	1,076	1,112	10,008	13,658	**163,153**
Kitsap	154	346	1,426	7,328	8,761	36,565
Pierce	152	**259**	1,092	5,634	41,079	144,290
Snohomish	**42**	279	985	6,009	**125,971**	51,968
All Permits	42	259	1154	6,497	125,971	144,290
Four-county average	112	490	1,154	7,245	47,367	98,994

Across the full dataset the average distance between the nearest 20 permit points is 1,154ft for UGAs and 6,497ft for exUGAs. The average distance between permit points for individual counties ranges from 985ft to 1,426ft for UGAs and 5,634f to 10,008ft for exUGAs.

PSRC PERMITS CONVERSION TO RASTERS

Using the average exUGA results from the distance bands as a rough guide for size, the PSRC permit data were aggregated into one square mile cells using the Esri "Points to Raster" tool. This tool essentially draws a grid across the map, converting each gridded section into a cell of a specified size, in this case one square mile was used. The tool then calculates a value for each grid cell based on a chosen attribute, in this case net housing units. Thus, the permit data was converted into a grid, with each grid cell representing the total sum of net housing units within. The resulting one square mile cells (or rasters) were used to calculate high growth areas for the PSRC data.

CALCULATING THE TOP 20TH PERCENTILE EXUGA DENSITY

Determining what constituted high growth was somewhat open-ended. For our study we chose to define high growth as the top 20th percentile exUGA density values for each county. determined using Esri Arc GIS summary statistics. As mentioned previously, breaking the data into county subsets was necessary in order to prevent King County from dominating the entire

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[20] Note that one point in our dataset represents a permit, not an individual housing unit—thus the term "neighbor" is somewhat misleading here, as permits for multi-family structures could represent many neighbors, but only one permit point.

dataset, as its growth is much higher than other counties. The data distributions were assumed to be normal, although in reality they generally skew slightly right (within one standard deviation).

The minimum density of the 20th percentile was estimated by summing the mean with 0.84 (determined from statistics complimentary cumulative z table for normal distribution) standard deviation ($\mu + 0.84\sigma$) or each county exUGA subset. Results are provided in the following sections for each housing dataset.

PSMP DENSITY RESULTS

The top 20th percentile was calculated in order to assess "high growth" for each county's exUGA under the PSMP data. Results are provided in Table 5 below.

Table 5. PSMP top 20th percentile exUGA density per county, in housing units/square mile.

County	Top 20%
Clallam	>14
Island	>24
Jefferson	>17
King	>6
Kitsap	>10
Mason	>11
Pierce	>11
San Juan	>15
Skagit	>8
Snohomish	>9
Thurston	>20
Whatcom	>14

The exUGA thresholds were also applied to the UGA polygons and mapped for comparison, shown in Figure 13.
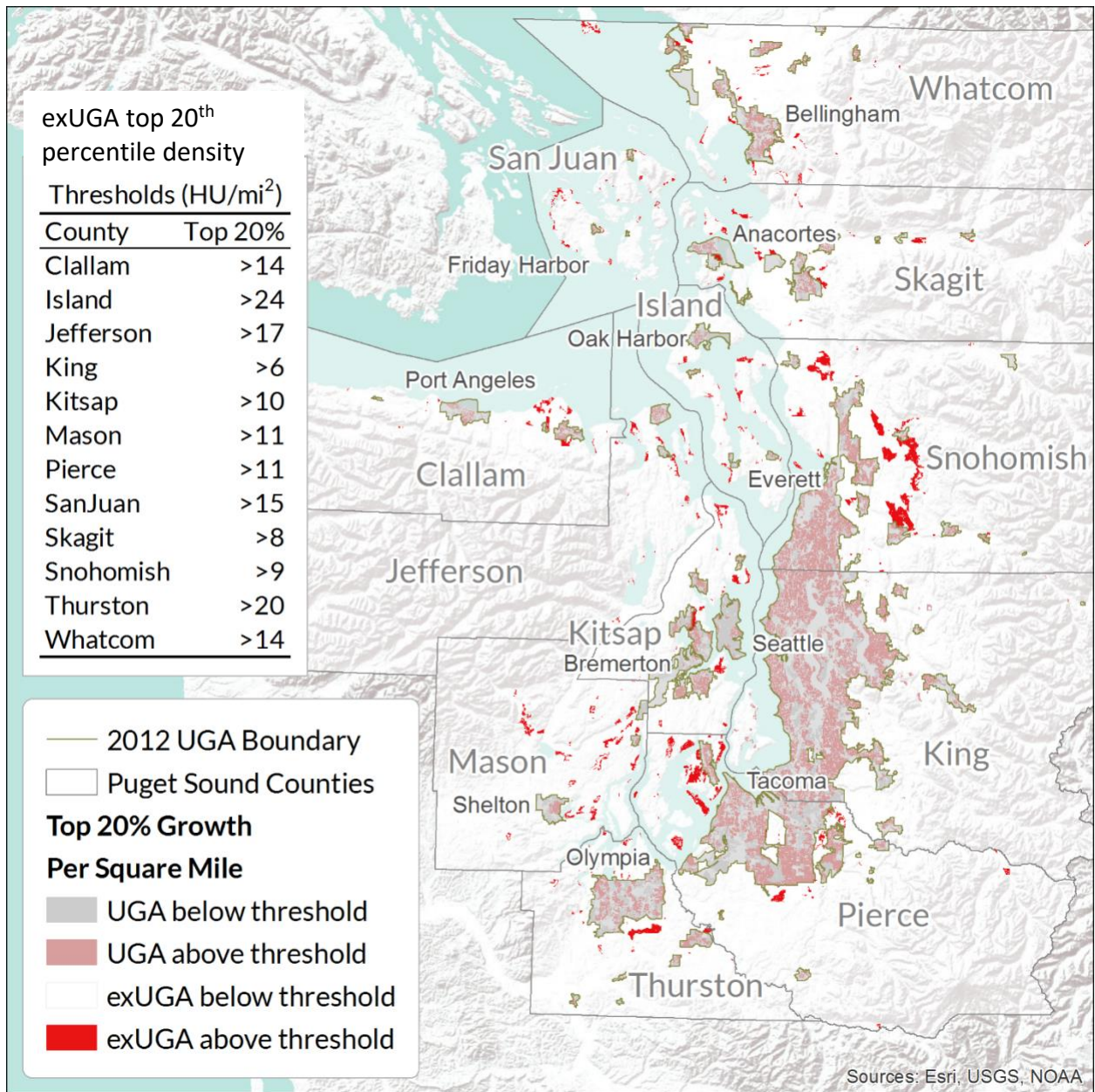
Figure 13. Top 20th percentile high growth thresholds for PSMP data. (Threshold values represents the top 20th percentile exUGA new housing unit density for each county.)

Looking at Figure 13 (above) allows visual identification of areas where exUGA growth is highest, based on each individual county's growth patterns. While King County has maintained most of its growth within its UGA, it is apparent that other areas, such as in central Snohomish and western Pierce outside of Gig Harbor, are seeing fairly widespread, high density exUGA growth. There is also a fair bit of high density growth directly outside the UGAs in Skagit County and elsewhere. Again, the high growth numbers are county-specific, and based on the top 20th percentile exUGA growth density for each county.

PSRC DENSITY RESULTS

The top 20th percentile density values for PSRC counties are given in Table 6, below.

Table 6. PSRC exUGA minimum top 20th percentile permitted new housing unit density, by county (in net housing units permitted per square mile).

County	Top 20th percentile exUGA density
King	>4.7
Kitsap	>7.2
Pierce	>16.5
Snohomish	>10.5

King County, with a top 20th percentile density of >4.7 newly permitted exUGA units per square mile, has the lowest density exUGA permitted growth of the four PSRC counties. Pierce, with >16.5 units, has the highest density exUGA growth, followed by Snohomish, then Kitsap.

Table 7 provides density statistics for each PSRC county in more detail.

Table 7. PSRC County exUGA permit density statistics.

Value	King	Kitsap	Pierce	Snohomish
Min	-5	-1	-14	-2
Max	37	53	253	84
Mean	1.979	3.068	4.394	4.406
Standard Deviation	3.241	4.912	14.398	7.25
0.84 Z value*	2.72244	4.12608	12.09432	6.09
Top 20th Percentile	4.70144	7.19408	16.48832	10.496
Square Miles in Top 20th Percentile	32	20	17	46

*0.84 x Standard Deviation

Again, we have defined high growth as anything in the top 20th percentile density value for each county exUGA. While King County has the lowest exUGA high growth density (>4.7 units/mile^2), it has the second-most area with high exUGA growth, at 32 square miles. Snohomish has the most high-growth exUGA area, at 46 square miles. Pierce, though boasting the highest high exUGA growth density value (>16.5 new units per square mile), has the lowest high growth exUGA area, at 17 square miles.

Figure 14 visually displays the top 20th percentile exUGA growth areas for the PSRC permits.
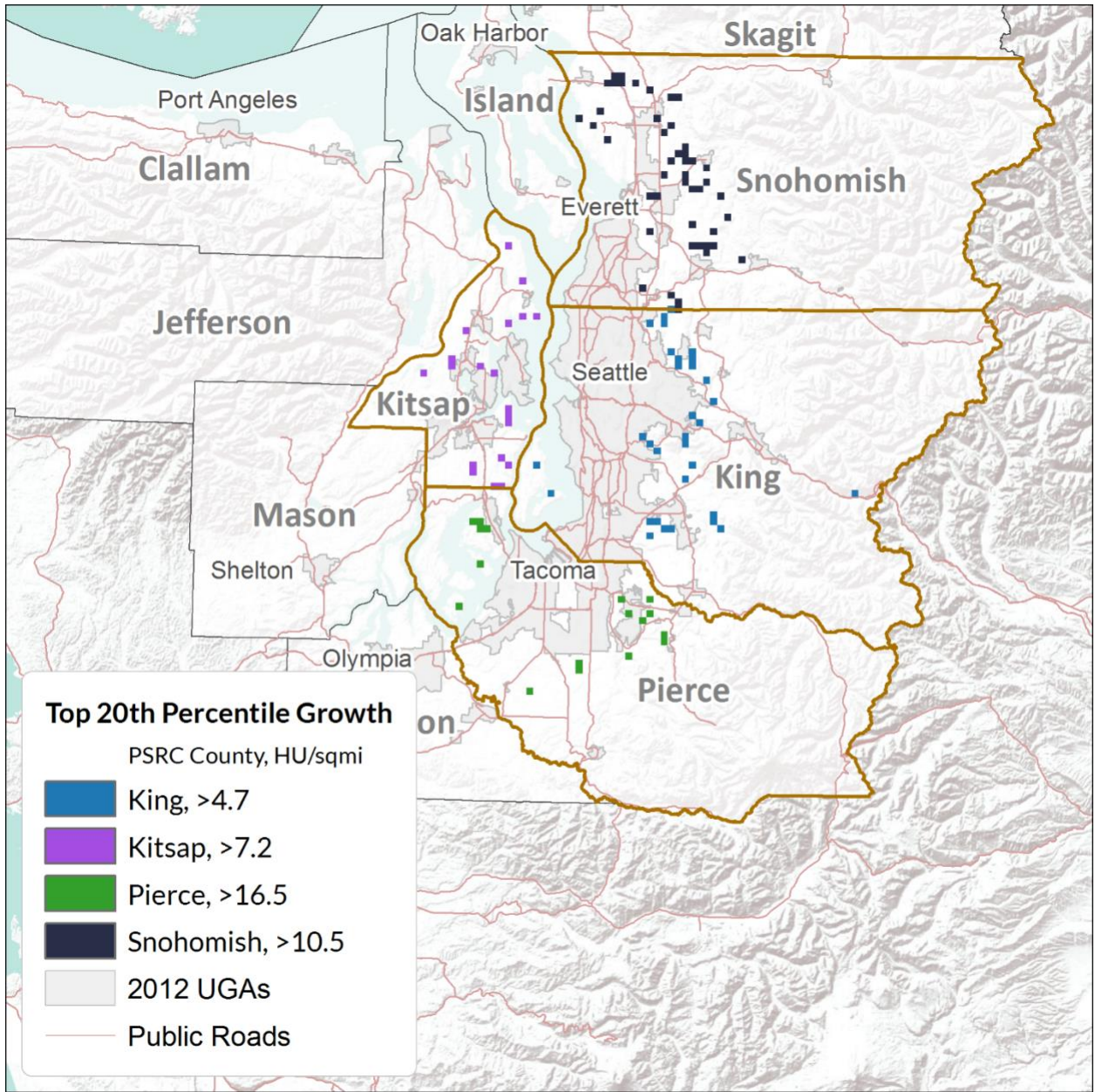
Figure 14. Top 20th percentile exUGA growth areas for each PSRC county.

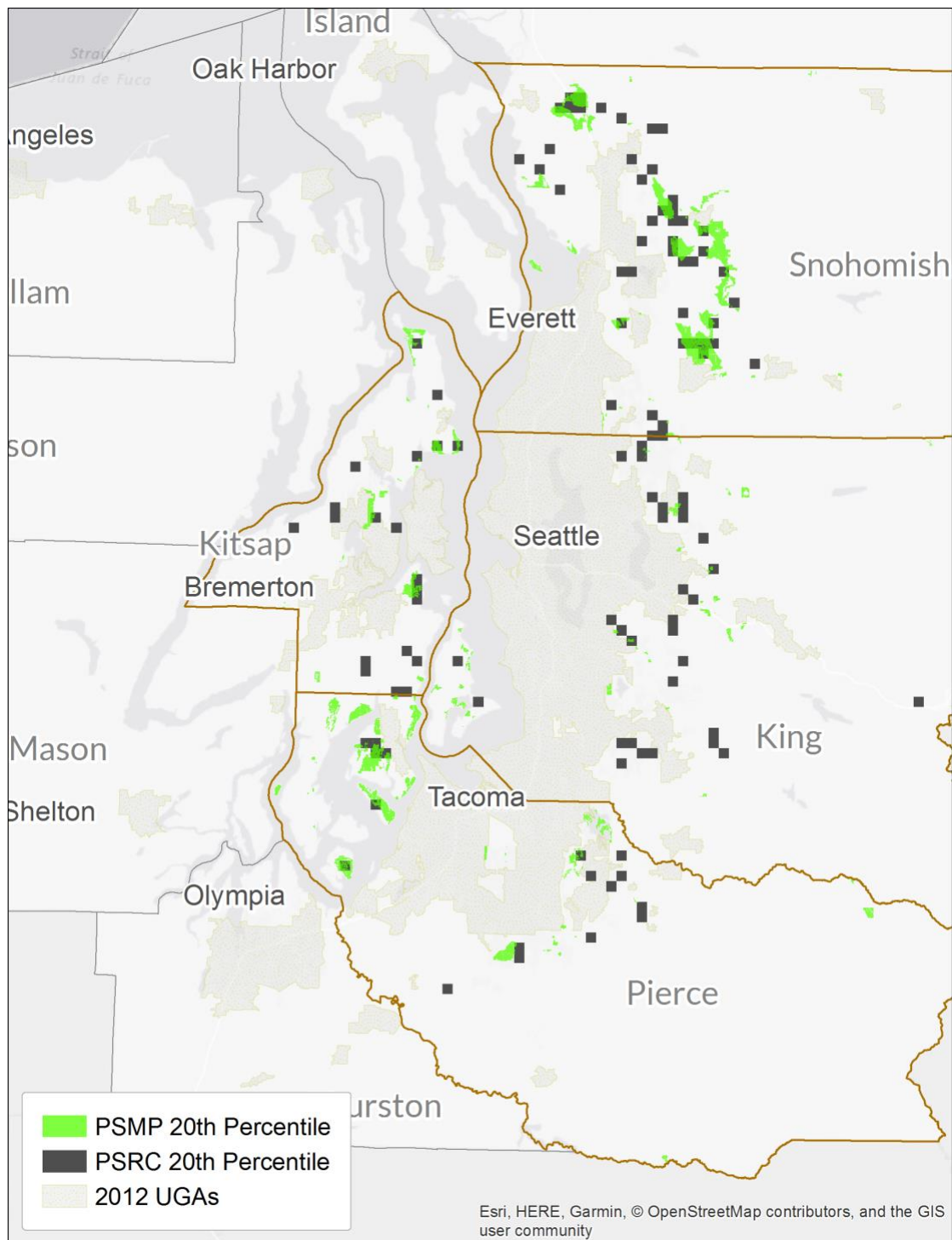Figure 15 shows both PSMP and PSRC exUGA high growth areas for comparison.

Figure 15. PSMP and PSRC top 20th percentile exUGA density (PSRC counties only).

Figure 15 displays areas of high exUGA growth calculated from both datasets. Areas shown in one dataset are not always picked up in the other. The nature of the PSMP polygons also means that they display data differently than the PSRC rasters. As discussed previously, the PSMP polygons disperse growth areas across an associated polygon, causing the extent of the areas that are high growth in PSMP to differ from that generated with the PSRC permit rasters.

Nevertheless, areas identified as high exUGA growth are fairly consistent across the two datasets, with some exceptions. Again, for higher resolution local scale analysis, the permit data allows greater precision.

ADDITIONAL AND ALTERNATIVE APPLICATIONS FOR PSMP DATA

While the MAUP issues and the randomized display of the housing data over large tracts of areas make the PSMP less applicable for identifying high resolution growth patterns than the permit data, the PSMP housing data provides appropriate resolution for large regional scale analysis. It is also the only known housing dataset that can be applied across the entire Puget Sound region.

Furthermore, the PSMP land use classifications offer unprecedented detail for the region. That level of detail allows better understanding of local and regional development trends. For example, identifying the kinds of land use the hotspots of growth have, looking at which classifications are seeing the most growth, identifying where specific classifications are seeing higher growth, etc. The wider PSMP coverage area also allows for a more holistic view of the region, although subdividing the data may still be a prudent step to take.

For a more comprehensive analysis of localized building patterns, combining the PSMP data with permit data may be desired. Expanding this beyond the PSRC counties would require gathering additional county permit datasets and curating them to either correspond with that provided by PSRC, or gathering all Puget Sound counties permit data and crafting a regional permit dataset.

DISCUSSION

The following describes several different avenues taken to identify spatial trends in the data. The first compares relative UGA sizes to exUGA growth in order to determine if smaller UGAs are the cause of higher exUGA growth. The second explores development one-mile outside of UGA borders in order to assess UGA-creep. UGA creep refers to the occurrence of high density growth that is creeping outward, directly beyond UGAs. UGA-creep effectively expands the UGA and may be an indicator of long-term UGA expansion.

COMPARATIVE UGA AREA AND EXUGA GROWTH BY COUNTY

Based off PSMP figures, five counties had more than half their growth occurring outside UGAs: Mason, San Juan, Island, Jefferson, and Clallam. However, they are also less populous counties and collectively account for only 4% of the regional 2011-2016 housing growth.

In order to assess if UGA size influences the rate of exUGA development, the area for each county and its respective UGAs were calculated. The National Hydrologic Dataset Major Features water data was used to erase ocean and lake areas from the county and UGA layers, leaving an estimation of only the land area in each county and its respective UGAs. PSMP

housing growth data was then compared to UGA, exUGA, and total land areas for each county in order to assess the relationships between area and growth, shown in Table 8.[21]

Table 8. Growth contributions (2011-2016, PSMP housing units) and land area, by county (top five values for each column in bold).

County	UGA Net Units (PSMP)	exUGA Net Units (PSMP)	% Growth from exUGA	Portion of regional exUGA growth (%)	Portion of total regional growth (%)	UGA (sq. miles)	exUGA (sq. miles)	Total Land (sq. miles)	exUGA Area. %	UGA Area, %	Ratio exUGA to UGA area
King	**55016**	429	0.8%	4.0%	**50.6%**	**460.0**	1675.7	**2135.7**	78.5%	**21.5%**	4
Kitsap	2524	822	24.6%	7.6%	3.1%	**100.4**	295.6	395.9	74.7%	**25.3%**	3
Pierce	**13615**	**1849**	12.0%	**17.1%**	**14.1%**	**252.9**	1423.9	1676.9	84.9%	**15.1%**	6
Snohomish	**15814**	**1723**	9.8%	**16.0%**	**16.0%**	**185.3**	**1910.4**	**2095.7**	91.2%	**8.8%**	10
Clallam	399	683	**63.1%**	6.3%	1.0%	33.8	**1706.8**	1740.6	**98.1%**	1.9%	**51**
Island	282	**940**	**76.9%**	**8.7%**	1.1%	16.0	191.3	207.3	92.3%	7.7%	12
Jefferson	205	425	**67.5%**	3.9%	0.6%	9.0	**1804.8**	1813.8	**99.5%**	0.5%	**200**
Mason	76	783	**91.2%**	7.2%	0.8%	19.2	943.4	962.6	**98.0%**	2.0%	**49**
San Juan	103	421	**80.3%**	3.9%	0.5%	2.7	172.5	175.3	**98.4%**	1.6%	**63**
Skagit	1135	379	25.0%	3.5%	1.4%	53.7	**1689.5**	**1743.2**	96.9%	3.1%	**31**
Thurston	**6221**	**1293**	17.2%	**12.0%**	**6.9%**	**94.4**	634.8	729.2	87.1%	**12.9%**	7
Whatcom	**3308**	**1054**	24.2%	**9.8%**	**4.0%**	80.5	**2047.4**	**2127.9**	96.2%	3.8%	25
Total	98698	10801	9.9%	--		1307.8	14496.2	15804.1	--	--	--

Data are ranked for easier comparison in Table 9.

Table 9. County land area ordered by size, with UGA and exUGA size, ranking and ratios (top five values for each column in bold).

County	Total Land (sq. miles)	UGA (sq. miles)	Rank	exUGA (sq. miles)	Rank	exUGA:UGA (ratio)	Rank
King	**2135.7**	**460.0**	**1**	1675.7	6	**4**	**2**
Whatcom	**2127.9**	80.5	6	**2047.4**	**1**	25	7
Snohomish	**2095.7**	**185.3**	**3**	**1910.4**	**2**	**10**	**5**
Jefferson	**1813.8**	9.0	11	**1804.8**	**3**	200	12
Skagit	**1743.2**	53.7	7	**1689.5**	**5**	31	8
Clallam	1740.6	33.8	8	**1706.8**	**4**	51	10
Pierce	1676.9	**252.9**	**2**	1423.9	7	**6**	**3**
Mason	962.6	19.2	9	943.4	8	49	9
Thurston	729.2	**94.4**	**5**	634.8	9	**7**	**4**
Kitsap	395.9	**100.4**	**4**	295.6	10	**3**	**1**
Island	207.3	16.0	10	191.3	11	12	6
San Juan	175.3	2.7	12	172.5	12	63	11

While King County has the largest overall area, and the largest UGA, it has the 6th largest exUGA, meaning that a larger portion of King County is set aside for UGA. Only Kitsap has a higher relative amount of land set aside for UGA; Kitsap has a ratio of 3:1 exUGA:UGA, versus 4:1 for King County.

Figure 16 compares exUGA growth, by county and for the region.
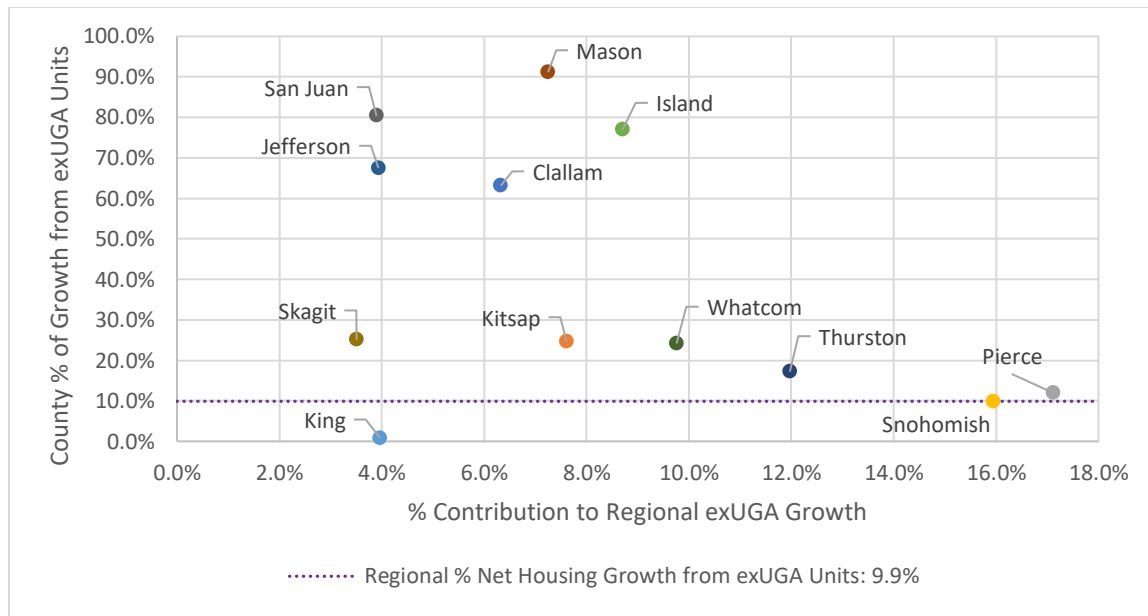
Figure 16. Percent exUGA growth by county and for the region (from PSMP housing units 2011-2016).

Pierce County contributed the highest percent to regional exUGA growth, however, it is among the lowest in county specific exUGA percentages.

Figure 17 and 18 compare exUGA growth and the ratio of exUGA to UGA land area for each county. Linear trend lines and associated R^2 values were calculated.[22]
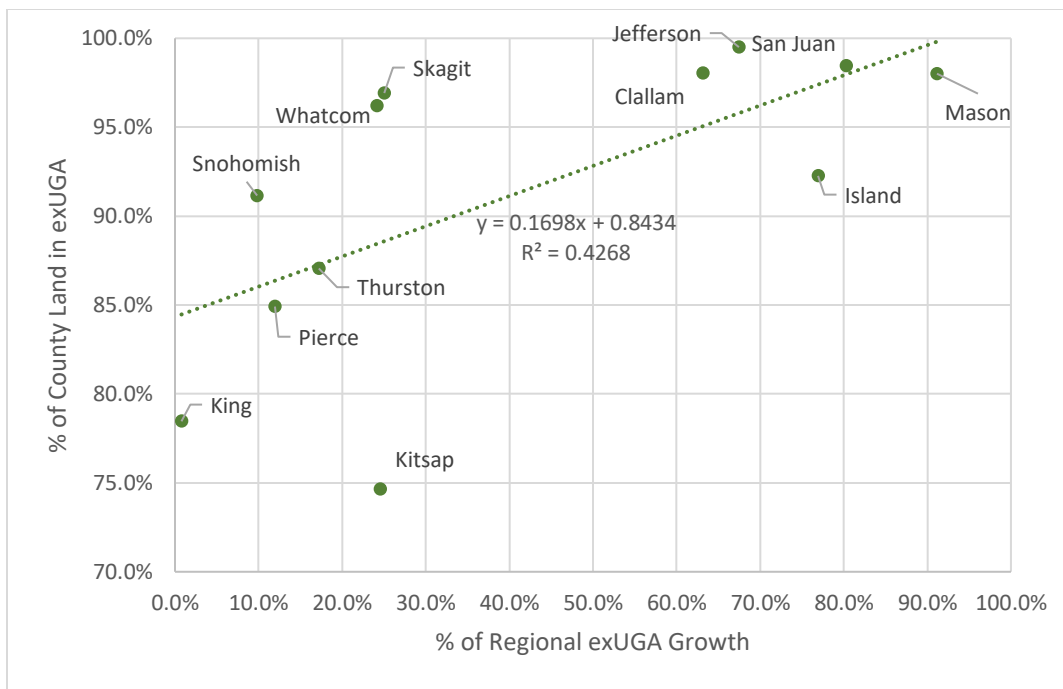
Figure 17. Percent of regional exUGA growth (2011-2016) vs land area in exUGA, by county.

While the correlation is not perfect, the five counties with the highest percentage of exUGA contribution regionally (Clallam, Island, Jefferson, Mason, and San Juan) are also among those counties with the highest percent of their land in exUGA status. Again, King County has the second highest ratio of UGA:exUGA land, or the second lowest percent of land in exUGA status, (with Kitsap having the most). King County also had the lowest exUGA growth contributions regionally, at >1%. This may be a result of available sites already being built, county policies, or both.

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[22] R^2 is an indicator of how well the data fits the trend line; and are therefore correlating factors, the closer it is to a value of 1.0, the better the fit, and the more correlation.
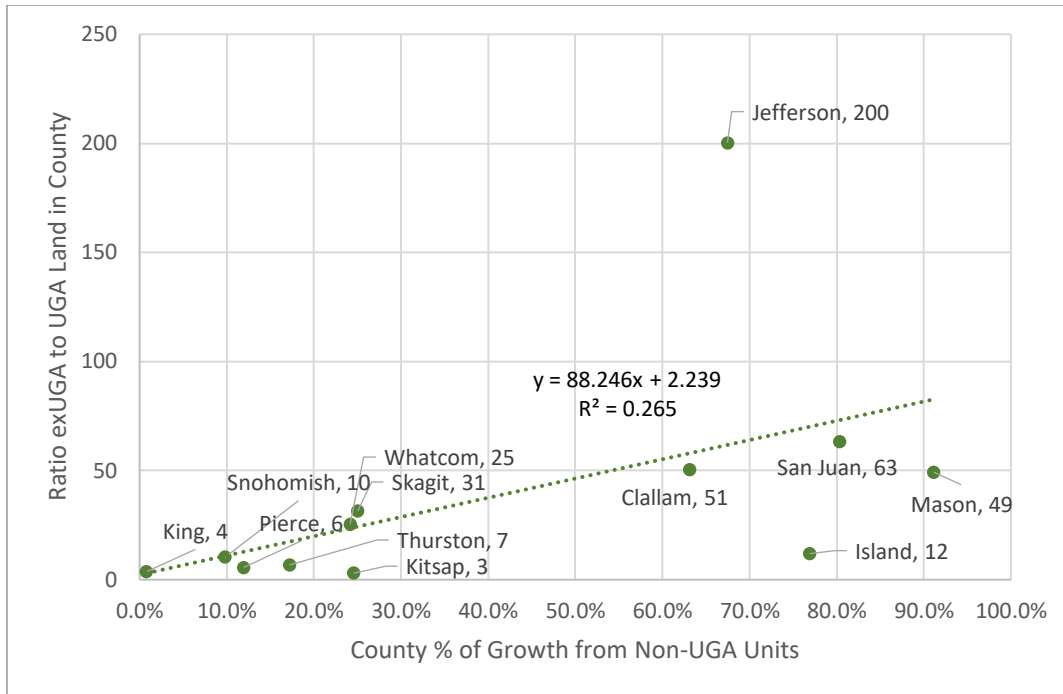
Figure 18. Ratio of exUGA land compared to percent of growth from exUGA Units for counties

In both cases, there is something of a trend visible, but with R^2 values of ~0.43 and ~0.27, the fit is very weak. Thus, there may be something to this line of reasoning, but it is probably not the whole story. Local geographic factors,[23] availability of buildable land, and local policy that affects development could all play a role. This suggests that caution should be used when trying to compare housing growth figures across counties. For example, directly comparing the percent of growth from exUGA development between Mason and King assumes the measuring stick should be the same, however this may not be an appropriate assumption. Determining the reasons behind these differences in growth patterns between counties could help clarify how to better view growth in the region.

NET HOUSING WITHIN ONE MILE OF UGA BORDERS

During project scoping interest was expressed in development patterns within one mile of the UGA border. This interest arose in response to observations from the PSMP team that a large proportion of growth seems to be happening directly outside UGAs. In order to explore this, total growth for both housing datasets were determined within one mile of the UGA borders using a simple buffer.

In this case, there are far more variables between the PSMP and PSRC data. This is likely due to the nature of the area selected with the buffer. The PSRC data are points which can be selected more precisely by the buffer, whereas PSMP polygons that only slightly intersect the buffer are fully included in the total, likely inflating the PSMP numbers.

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[23] For example, Olympic National Park occupies a large portion of Jefferson County, helping to inflate the amount of exUGA land in the county.

Net housing growth within one mile of UGAs was also compared to the total number of respective net UGA/exUGA growth. The two housing datasets result in very different values; for example, the PSMP exUGA values are roughly double that of the PSRC ones. Again, this is likely heavily influenced by using only a simple buffer selection process in the GIS analysis. However, the PSRC exUGA proportions still show that a significant portion of exUGA growth-- roughly a third of all exUGA growth in the four PSRC counties--happened within one mile of the border. The comparison of UGA proportions is less useful, somewhat depending on the size of the UGAs in a county. If a UGA is smaller, a 1-mile buffer inside the boundary will select all or most of the UGA, resulting in the comparison essentially being the same as the total net housing. Results are presented in Table 9.

Table 9. Net housing growth (2011-2016) within one mile of UGA borders.

	County	1mi Inside UGA PSMP	1mi Inside UGA PSRC	1mi Outside UGA PSMP	1mi Outside UGA PSRC	Total PSMP	Total PSRC	PSMP and PSRC Difference Total *PSRC-PSMP	PSMP and PSRC Difference % *(PSRC-PSMP)/PSRC	% total UGA PSMP	% total UGA PSRC	% total exUGA PSMP	% total exUGA PSRC
PSRC Counties	King	35811	31641	304	283	36115	31924	4191	-13.1%	99.2%	99.1%	0.8%	0.9%
	Kitsap	2524	2528	506	275	3030	2803	-227	-8.1%	83.3%	90.2%	16.7%	9.8%
	Pierce	12267	9290	1277	691	13544	9981	-3563	-35.7%	90.6%	93.1%	9.4%	6.9%
	Snohomish	9223	8412	1071	619	10294	9031	-1263	-14.0%	89.6%	93.1%	10.4%	6.9%
	Subtotal	59825	51871	3158	1868	62983	53739	-9244	-17.2%	95.0%	96.5%	5.0%	3.5%
	Clallam	398	--	341	--	739	--	--	--	53.9%	--	46.1%	--
	Island	282	--	238	--	520	--	--	--	54.2%	--	45.8%	--
	Jefferson	205	--	99	--	304	--	--	--	67.4%	--	32.6%	--
	Mason	76	--	171	--	247	--	--	--	30.8%	--	69.2%	--
	San Juan	103	--	73	--	176	--	--	--	58.5%	--	41.5%	--
	Skagit	1135	--	210	--	1345	--	--	--	84.4%	--	15.6%	--
	Thurston	5053	--	867	--	5920	--	--	--	85.4%	--	14.6%	--
	Whatcom	3219	--	598	--	3817	--	--	--	84.3%	--	15.7%	--
	Subtotal	10471	--	2597	--	13068	--	--	--	80.1%	--	19.9%	--
	All 12 Counties	70296	--	5755	--	76051	--	--	--	92.4%	--	7.6%	--

INSIGHTS AND PERSPECTIVES FROM THE DEVELOPMENT COMMUNITY

Several professionals from the building industry assisted our analysis. Two housing developers responded to a list of questions via email, as provided in the appendix. General questions on development factors and regulatory impacts were answered by Art Castle of the Washington State Building Industry Association.

A number of factors that drive development patterns were cited (Castle, personal communications, summer 2018). Of the factors discussed, the one perhaps most relevant to infill stems from state condo regulations. The Washington Condo Act (WCA) provides a key disincentive to the development of condos for private ownership, versus rental units by placing a

higher degree of liability on developers of condos than other building types, making it a preferable business choice to develop rental units rather than condos.[24] While not everyone desires to live in a high-rise, a key component of achieving infill density (and housing affordability) is a portfolio of multi-unit buildings.

If ownership options are limited to single family homes due to regulatory disincentives that effectively limit the number of private condo units for sale, regulations inadvertently drive outfill by swaying ownership options toward single family homes. This also inadvertently drives up the cost of home ownership.[25]

Another key influence on building choices is the cost of land, particularly within UGAs. While zoning determines what type of unit/s can be built on a given lot, the cost of most remaining lots within UGAs forces builders to construct higher end, or luxury homes, in order to generate a profit on the project (Castle, personal communication, summer 2018). Ultimately housing construction is a business decision. It is not possible to construct an entry level single-family home in a scarce land market and make a profit; developers must build luxury homes in order to generate enough return to stay in business.

A final factor influencing the industry, one that is echoed in many other industries as well, is the loss of a number of smaller firms. Many smaller firms were unable to survive the 2008 recession, thus the industry consolidated into a smaller number of larger firms (Castle, personal communication, summer 2018). Additionally, regulations and permit approval times have increased so that only larger firms have the financial wherewithal to carry projects to approval, which can often take years.

While these patterns certainly influence the building industry overall, and limit the options available to consumers, with the exception of the condo disincentive, they don't necessarily represent a barrier to infill.

Developer interviews provided another avenue through which information on siting drivers was obtained. Developers were identified by looking at high-growth exUGA areas and finding the associated developers. Not all developers were identified, however, several were contacted and two responded. The two respondents were given a list of questions via email. Their responses are transcribed in the Appendix, with personal identifiers removed for confidentiality.

Reponses and follow up discussions with building industry professionals revealed that market drivers truly dictate site selection choices, and that building within the UGAs doesn't really cost any more, and may actually cost less than building in exUGA areas.[26] Although each site and project varies, respondents said that there was no significant cost factor driving the decision to build inside or outside UGAs, rather, the availability of land and the potential for profitability drive siting and development choices. In light of the developer feedback, the merit of investigating cost factors that may function as drivers for exUGA development seems questionable.

Developers would prefer to meet higher density per acre in order to generate higher financial returns (citing 6-8 single family homes per acre is the desired aim for affordability), however, exUGA zoning typically does not allow for more than 1 home per acre, or in any cases, per 5 or

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[24] David (2016) provides an overview of condo laws and compares Seattle condo trends to those of other western cities; Morales (2017) compares condo markets, regulations, and trends in Seattle and Vancouver.

[25] Realtors have lobbied for changes to the Condo Act that would lessen the disincentives for developers, however, such bills have yet to pass the legislature.

[26] Respondent 1 did say that it has become increasingly more difficult to develop inside UGAs, but not that it was more expensive.

more acres. King County, which has low relative exUGA growth, typically has even larger exUGA lot sizes. Because of the lack of density allowed outside UGAs, exUGA rural zoning restrictions on the number of housing units per so many acres may actually be promoting exUGA sprawl, as developers would prefer to construct denser development if allowed to do so. Thus, a 5 acre exUGA parcel that is presently zoned to allow only one home, would likely contain 30-40 single family homes in a master planned community if zoning permitted it.

NEXT STEPS

Assessing housing growth using either dataset can provide valuable insight into development patterns, either on a regional scale, using PSMP, or an a finer, local scale, using permit data.

To be of meaning, the temporal scale of analysis should be expanded beyond that provided here. 2017 and 2018 were exceptionally active years for the real estate market and the resulting growth may look very different across the region with these more recent years included.

Furthermore, assessing development patterns in relation to ecosystem functions would be informative.

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APPENDIX: ANCILLARY INVESTIGATIONS

Two developers working in the Puget Sound answered a set of interview questions via email. Their direct input follows. Names of companies and individuals have been removed.

Q: Years of building/development experience?
Respondent 1: 60 years combined experience between partners.
Respondent 2: [Redacted] have been in business 30+ years in both residential homes, multi-family development and ownership, and commercial property development and management.

Q: Number (or estimate) of developments/homes built?
R1: 6,000+.
R2: [Redacted] has probably built 2000+ apartment units and 1000 + homes.

Q: How have growth management regulations affected your building practices and choices?
R1: Its become exponentially more difficult to develop land inside the UGA. Increased regulation, environmental protections, and no growth politics all come into play.
R2: Driven up acquisition cost due to diminishing supply of buildable land. Due to cost of acquisition, engineering, permitting, and developing, national builders are by far the largest acquirers of lots now. The top 5-6 builders in each Puget Sound Region County are generally national builders. The number of small builders has been cut by 50% since 2007 primarily due to cost of land and ability to compete. With land supply, it used to be that local builders could acquire and develop lots. with diminished supply of smaller projects, locals have limited options to buy. In many cases, jurisdictions and regulatory agencies have put so many roadblocks, requirements, and complexity into the process that projects take years (2-4) from land identification to buildable lot. In many cases, the "red tape" and road blocks do little to really enhance the projects. There is little risk / reward or cost / benefit analysis done to determine value of many regulations. Best practices are not being developed by the brightest people

Q: What market drivers influence what is built?
R1: Consumer demand. Not everyone wants to live in high rise development, let alone raise a family in one. Its not the American way for the majority. These is an imbalance to the ability to provide building lots in a timely and cost effective way. Regulation, scarcity of land, etc. have the Puget sound on a path to San Francisco pricing for all the same reasons.

Q: What are some of the primary considerations when deciding to build one site versus another?
R1: The actual ability to with the availability of utilities and unconstrained developable area. We don't get to choose A, B and C locations anymore. We simply try to buy and develop land that can actually be developed when there is a willing seller at a price that is palatable.

Q: Do regulatory and/or permitting concerns affect the site choice?
R1: Yes, in the context of zoning and environmental protections. I.e.: if you need an Army Corps permit you have 10 years of post construction liability for survival of the plantings. A risk that most try to steer clear of. Jurisdictions that are not developer friendly have less activity than those that are fair in their approach to open and transparent government.

R2: Wetlands, buffers, replanting all impact project costs, especially on smaller projects. Small infill projects of under 20 lots are nearing impossible to affordably develop and bring to market. the cost borne by the developer for adding utilities, improvements, etc….coupled with requirements of development and time to develop all add costs to finished lots which can make them not economically viable. Interest carry is one of the largest non-value added costs we have to cover that delivers zero benefit to end user or homeowner. The longer projects take for review and approval, the more cost added. Additionally as [Respondent 1] stated, some costs would be better to have "pay and go" versus required for projects. Frontage improvements are examples where sidewalks are built that go to nowhere and never will

Q: How have stormwater regulations impacted your building decisions and practices?
R1: Driven up costs, absorbed more land etc. We must comply, its not a choice, therefore cost go up. The sad part is that DOE will acknowledge that what we are doing now for new development is just the tip of the iceberg. The real issue is dealing with the pre-develop condition where water quality does not exist in the storm systems and flow control may not even exist. The smarter approach would be to stop increasing regulation that has no measurable benefit in the already developed world, and loosen up the regulations to create a "fee in lieu" mitigation bank of dollars to allow developers to do less onsite by paying a fee to the bank that can be tapped by properties where no flow control or detention exists today to get 100 fold the impact. Ponds built in the 1990s are functioning just fine today at less than 1/2 of the size. DOE IS OUT OF CONTROL and having no fiscal impact notes required for implementation of their regulations leads extreme development cost increases with no real oversight. There are a select few that make the Kool aide in Olympia and decide how its dispensed.
R2: there is a power struggle between DOE and jurisdictions. DOE seems to have little accountability to justify the benefits of many of their regulations. There is little balance in cost benefit. Many of the inspectors have little consultative skills and manage with badge and heavy hand

Q: What are the primary cost factors that influence siting decisions (e.g. permits/fees, infrastructure install/upgrade, site preparation)?
R1: They all play a factor. Fees and improvements extorted out of the land use process are the only real costs that local government can affect. Again, with the scarcity of land, we are forced to play regardless of these issues and pass those costs on to the market.

Q: What are some of the biggest differences cost wise between building relatively similar housing inside versus outside the UGAs? Are there differences in time to get approvals?
R1: Building inside and outside the line are apples and oranges comparisons.

Outside there is no sewer, just septic drainfield use. The costs to develop are actually more per lot outside in many cases because you can not get the density. Density is a huge piece of housing affordability/attainability across all market segments.

The house construction costs don't vary. (other than some mitigation permit fees are lower outside). It's the infrastructure costs that add up. outside many times wells are the only way to serve a parcel with water. This can range from $10-$50k for a single family well depending on depth needed.

Timing for approval is not really different inside or out either.

The key here is availability of buildable land for single family lot development of densities between 6 and 8 units per acre.

ANCILLARY DATASETS

Our initial goal was to determine which ancillary datasets are most useful and create an analysis model that could be applied elsewhere. Initially, due to the relatively high exUGA growth, and a robust amount of data shared online through the state geodata portal, Pierce County seemed like a good pilot selection. To this end, we attempted to gather data on electric distribution lines, water service areas, sewer service areas, roads, schools, and other amenities, as well as construction and permit costs with the intent of identifying factors that might encourage exUGA development. Several electric utilities were contacted about acquiring electric system data, however we received data from only one with which an author had a personal connection.

Water and sewer main line, water and sewer service areas, and school centroid points were available from the Pierce County GIS data portal. Pierce County and Washington State (via the state open geodata portal) also have road data available.

Amenities, such as grocery stores, which are not directly tracked by local government agencies are more difficult to acquire. The most promising option found was the geographic feature data extracted from openstreetmap.org, provided online for free from a German company called Geofabrik. Grocery store data was successfully extracted from this dataset; however, it is unclear how complete it is.

In addition, an infrastructure/amenity analysis would need to be able to determine the state of the ancillary data *prior* to the housing units of interest being constructed in order to determine if proximity could have been an incentive. Depending on the attributes maintained and how a given entity tracks changes to their system, this may require detailed analyses and cooperation from a number of entities. Public records requests may also be required, which could increase the length of time needed to prepare for the analysis. Available data also may not be in a GIS-friendly or even electronic format. Given enough time and commitment of help from the associated record keepers, this could be feasible to accomplish, but it was not compatible with the timeframe of this project. Hopefully, our initial investigatory work will help assist any future analyses.

COST COMPARISON

Initially there was a goal of doing a cost comparison of developing UGA vs exUGA via looking at the various building fees. However, discussions with Building Industry Professionals and a review of local permit fee schedules, it became clear that beyond base building permit costs things become very situational. In addition, because respondents stated that overall building costs are typically more expensive outside UGAs [because of the additional septic and well infrastructure required, and the lack of density to provide financial returns on a project], the value in undertaking a detailed analysis seemed questionable. Developer responses indicate that the differences in permitting costs do not affect which side of the UGA line a developer decides

to build in. Siting decisions are based more on land availability and consumer demand, whereas development choices (such as the housing type) are based on zoning and profit margins.

PERMIT FEES

Because permit and impact fees were one of the costs considered as a potential driver of exUGA development, such fees were investigated. Schedules for permits and fees can be acquired from the county and each city online. Discussions with personnel from the City of Tacoma Planning and Development Department helped to frame the various costs associated with developing from their perspective. However, it became clear that attempting to assemble all these costs would be quite labor intensive, as each group within the permitting departments oversees separate portions; beyond the base building fee cost, things become very situational very quickly. Collecting a fully holistic view would require working with multiple departments and personnel on specific projects.

A next step for such an inquiry might be to assemble a list of specific projects of interest and compare them to a permit database. This can currently be done online for each permit or parcel. Conducting a review of a larger volume of projects would require obtaining permit fee data directly from the associated jurisdiction/s.

Pierce County base building permit fees, along with Tacoma and Puyallup, are compared in Figure 18. While the City of Tacoma costs exceed those of Pierce County and its neighboring municipality, Puyallup, these are just one tier of the permit and impact fees imposed on a new housing unit. Estimating the full suite of fees requires site and building specific information.
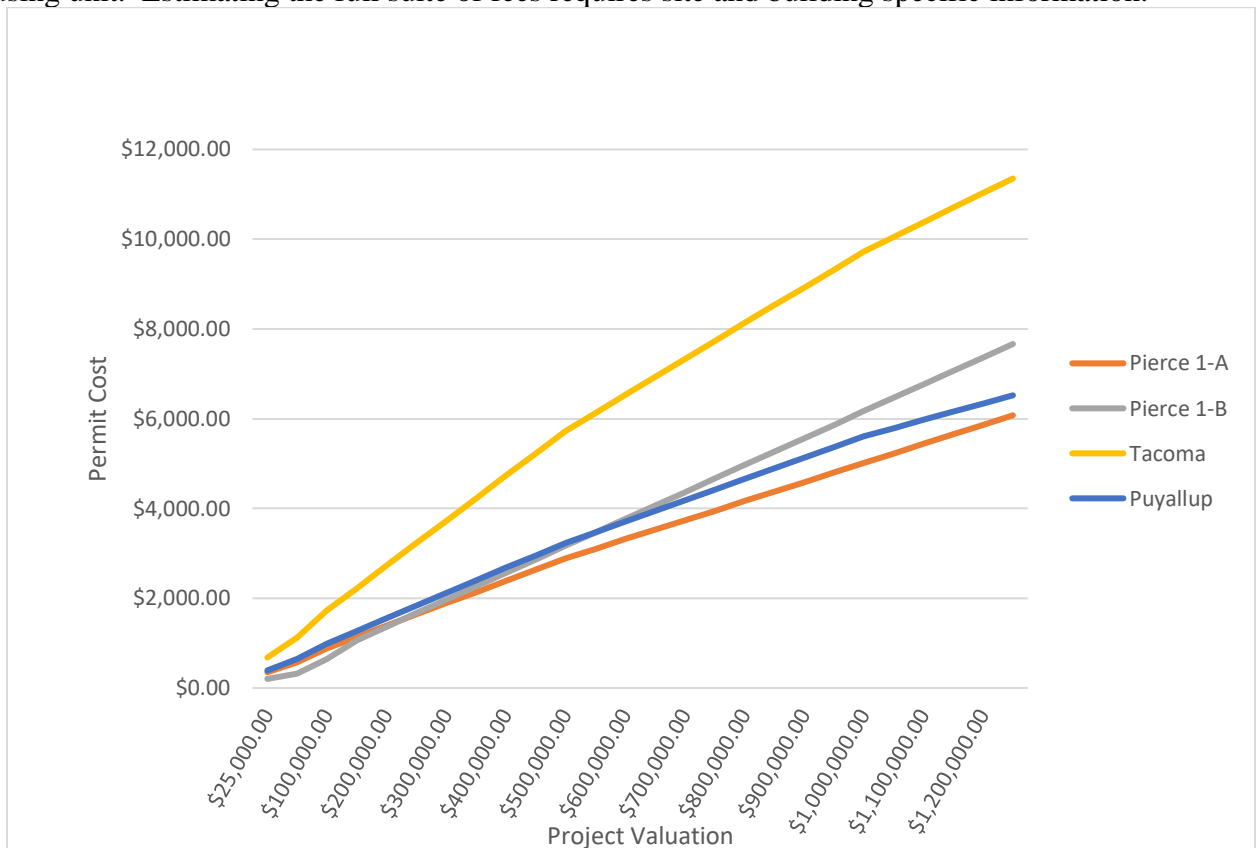
Figure 19. Base Building Permit Cost by Project Valuation for Pierce County, Tacoma, and Puyallup

An example of the total costs that can be applied are given in a fact sheet form Pierce County, copied here in Table 10 below.

Table 10. Cost to Permit a Single Family Home in Pierce County, 2018 fee schedule.

	Square feet of Home				Notes
	1,500	**2,000**	**2,500**	**3,000**	
Building Permit, Plumbing, and Mechanical Review	$2,535	$3,089	$3,633	$4,188	Includes Fire Plan Review & State Surcharge
Driveway Approach	$200	$200	$200	$200	Only applicable when accessing onto a Public Road
Sewer Connection	~ $3,500	~ $3,500	~ $3,500	~ $3,500	Applies only to sites served by public sewer. Fee is approximate and may vary.
Site Development and Drainage	~$700	~$700	~$700	~$700	Fees vary due to site conditions and new and existing impervious area
Traffic Impact Fees	~ $1,758	~ $1,758	~ $1,758	~ $1,758	Average based on the current TIF schedule
Park Impact Fees	$2,629	$2,629	$2,629	$2,629	Includes an administrative fee of $76.57
School Impact Fees	$3,577	$3,577	$3,577	$3,577	
Administrative Fees	$50	$50	$50	$50	
Total	Approximately **$14,949**[1]	Approximately **$15,503**[1]	Approximately **$16,047**[1]	Approximately **$16,602**[1]	This estimate does not include fees that may be required for environmental constraints and other agencies.[2]

The full document is available at: https://www.co.pierce.wa.us/DocumentCenter/View/58053/Cost-of-house-building-permits