POPULATION ESTIMATES & PROJECTIONS

P2011-1: Evaluation of OFM's 2010 Population Estimates

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Executive Summary

The Office of Financial Management's (OFM) 2010 estimates are more accurate than those produced in 2000 at state, county, and city levels. Mean absolute percent error, a measure of accuracy calculated using OFM's 2010 state estimate and the 2010 Census count for Washington State, is 0.1 percent as compared to 1.5 percent in 2000. The accuracy for county level estimates has also improved from 2.4 percent to 1.9 percent in 2010. At the city level, the mean absolute percent error decreased from 7.1 percent in 2000 to 5.5 percent in 2010. OFM's estimates are most accurate for larger counties and cities and for counties and cities with low to moderate growth. Counties and cities with near zero or negative growth tend to be overestimated, whereas counties and cities with fast growth tend to be underestimated. A review of the relationship between OFM and Census housing differences and population estimate error found that the majority of estimates with large errors are associated with housing differences in the same direction. This leads us to believe that improved housing data would improve some of the estimates with large errors. As a next step, OFM plans to work with local jurisdictions to develop a more standard data collection procedure for tracking changes to the housing stock. In addition, OFM plans to investigate other factors that are affecting estimate error, such as occupancy rates and persons per household.

General Discussion

About estimate accuracy: The Washington State Legislature tasks OFM to produce annual April 1 population estimates for revenue disbursement purposes. OFM uses standard and well-tested methods to fulfill this task. However, it is important to distinguish estimates from actual counts or censuses. Estimates are approximations based on direct or indirect indicators and cannot be expected to be as accurate as a census. A detailed discussion about the nature of estimates and the methods used can be found in OFM's research brief: About Population Estimate Accuracy. Due to their financial impacts on local jurisdictions, OFM periodically evaluates the estimates it produces. In this brief, OFM's 2010 population estimates are evaluated against the 2010 Census counts.

There are multiple ways to evaluate estimates. Accuracy, defined as the degree of closeness of a calculated quantity to its actual or true value, represents the most important dimension used to evaluate a methodology and the resulting estimates. In demography, researchers usually consider census counts as the gold standard and determine estimate accuracy by comparing their degree of closeness to census values.

The differences between 2010 Census and OFM estimates are referred to as estimate errors for analysis purposes. However, readers should keep in mind that differences in the 2010 Census

counts and OFM's estimates may also be at least partially attributed to census enumeration errors, differences in the definition of housing, and boundary differences due to annexations and other factors. A detailed discussion about these differences can be found in OFM's research brief: About Population Estimate Accuracy.
The 2010 Census population and housing counts used in this analysis are adjusted by OFM to reflect annexations that occurred from January 2 to April 1, 2010, since the boundaries used to tabulate the 2010 Census city data were current as of January 1, 2010.

About accuracy and bias measures: There are a variety of measures that can be used to identify the degree of closeness of the estimate to its standard. The most basic measures are the numeric difference between the estimate and the census count and the percent error (i.e. the difference between OFM's population estimate and the census count divided by the census count). In addition, we use the five following summary measures based on the percent error to evaluate accuracy and bias:

- Mean absolute percent error (MAPE)
- Mean algebraic percent error (MALPE)
- Percent of counties or cities with positive errors (PPOS)
- Percent of counties or cities with absolute estimate errors under a threshold (two percent for counties, five percent for cities)
- Percent of counties or cities with absolute estimate errors over a threshold (five percent for counties, 10 percent for cities)

While MAPE shows the magnitude of the estimation error in each group of counties or cities, MALPE shows the direction of the errors. A positive MALPE indicates that the estimates in the category tend to be overestimated, and a negative MALPE indicates that the estimates in the category tend to be underestimated. Since outliers in a group can influence the sign of the MALPE, the percent of positive errors (PPOS) is included as a descriptive measure. Thresholds for absolute percent errors are used to further describe the performance of the estimates.

Accuracy Evaluations

Trends in accuracy and bias: Compared to the prior two decennial census years, OFM has made improvements in the accuracy of its population estimates at the state, county, and city level.

Table 1: Comparison of OFM population estimates against federal census: 1990, 2000, and 2010

	1990 MAPE	2000 MAPE	2010 MAPE
State Level (1 case)	1.4%	1.5%	0.1%
Counties (39 cases)	1.9%	2.4%	1.9%
Cities (cases vary)*	6.1%	7.1%	5.5%

* The number of cities may vary because of new incorporations and because cities that conduct a state-certified census in the same year as the federal census are excluded from the analysis.

Table 1 shows the MAPE values for OFM's 1990, 2000 and 2010 state, county, and city level estimates. The difference between OFM 2010 estimates from the 2010 Census is 0.1 percent, a substantial decline from 1.5 percent in 2000 and 1.4 percent in 1990. With a MAPE value of 1.9 percent, OFM's 2010 population estimates for counties are better than the 2000 estimates. The accuracy of the 2010 estimates for cities also improved. The overall MAPE for cities in 2010 is 5.5 percent compared to 7.1 percent in 2000 and 6.1 in 1990.

Table 2 lists the counties that have absolute percent errors greater than or equal to 3 percent compared to their corresponding census values. While 10 OFM county estimates in 1990 and 12 in 2000 have absolute percent errors at or above three percent, the number of counties declined to seven in 2010.

Table 2. Counties with estimate absolute percent errors greater than or equal to three percent

1990	Absolute % Error	2000	Absolute % Error	2010	Absolute % Error
Grant	3.0%	King	3.0%	Island	3.3%
Snohomish	3.3%	Island	3.7%	Franklin	3.4%
Kittitas	3.5%	Adams	3.8%	Ferry	4.0%
Okanogan	3.7%	Yakima	3.9%	Wahkiakum	4.3%
Clark	3.9%	Stevens	3.9%	San Juan	4.6%
Chelan	4.1%	Clallam	3.9%	Pacific	5.6%
Pacific	4.1%	Garfield	4.0%	Mason	5.9%
Skagit	4.3%	Grant	4.3%		
Wahkiakum	5.2%	Pend Oreille	4.5%		
Franklin	7.7%	Chelan	6.0%		
		Franklin	7.0%		
		San Juan	9.8%		

In Table 3, we arbitrarily choose a 3,000 or greater numeric difference between OFM's estimate and the census count as a criteria for outliers regardless of the county size. The number of counties meeting this criterion declined from nine in 2000 to five in 2010. In addition, while outliers in prior censuses tended to be underestimated (five out of six in 1990 and eight out of nine in 2000), the outliers in 2010 are more balanced with two counties overestimated and three counties underestimated.

Table 3. Counties where absolute difference in population is greater than or equal to 3,000

1990	Difference	2000	Difference	2010	Difference
King	-24,505	King	-51,446	Whatcom	-5,640
Snohomish	-15,442	Snohomish	-12,524	Yakima	-4,131
Pierce	-11,703	Yakima	-8,581	Mason	-3,599
Clark	-9,353	Chelan	-4,016	Clark	10,237
Skagit	-3,455	Franklin	-3,447	Pierce	19,375
Spokane	5,867	Whatcom	-3,326		
		Grant	-3,198		
		Thurston	-3,055		
		Pierce	5,182		

Table 4 shows additional detail for the counties listed in the 2000 and 2010 columns in Table 3. For seven of the 11 counties, the 2010 estimates are more accurate than the 2000 estimates. OFM's estimate for King, in particular, improved from a difference of 51,446 in 2000 to a difference of only 2,151 in 2010. Even though the difference between Yakima's estimate and the 2010 Census count is relatively high at 4,131, the 2010 difference represents a large improvement over 2000's difference of 8,581. On the other hand, there are four county estimates in 2010 where the absolute difference between the OFM's estimate and the 2010 Census is greater than the difference in the 2000. Those four counties, Pierce, Clark, Whatcom, and Mason, are investigated further in a later section of this brief.

Table 4: Counties where absolute difference in population is greater than or equal to 3,000

Accuracy Trend	County	2000 Census	Difference (OFM-Census)	% Error	2010 Census	Difference (OFM-Census)	% Error
Improved over 2000							
	King	1,737,046	-51,446	-3.0%	1,931,249	2,151	0.1%
	Snohomish	606,024	-12,524	-2.1%	713,335	-2,235	-0.3%
	Yakima	222,581	-8,581	-3.9%	243,231	-4,131	-1.7%
	Chelan	66,616	-4,016	-6.0%	72,453	847	1.2%
	Franklin	49,347	-3,447	-7.0%	78,163	-2,663	-3.4%
	Grant	74,698	-3,198	-4.3%	89,120	-1,420	-1.6%
	Thurston	207,355	-3,055	-1.5%	252,264	136	0.1%
Declined over 2000							
	Whatcom	166,826	-3,326	-2.0%	201,140	-5,640	-2.8%
	Clark	345,238	-238	-0.1%	425,363	10,237	2.4%
	Mason	49,405	-105	-0.2%	60,699	-3,599	-5.9%
	Pierce	700,818	5,182	0.7%	795,225	19,375	2.4%

Detailed comparisons of the OFM city estimates over time are not shown here, but more information on how OFM's city estimates performed relative to prior censuses can be found in OFM's research brief: [About Population Estimate Accuracy](#).

Detailed evaluation of county population estimates: In Table 5 the counties are grouped into six categories according to size. Five summary measures of population estimate error are presented. The precision measure MAPE for all counties combined are 1.9 percent. The 0.1 percent MALPE value for all counties indicates a small bias towards over estimation. The PPOS value indicates that population is over estimated in 51.3 percent of the counties.

OFM estimates are more precise for counties with population sizes larger than 250,000 (MAPE of 0.9 percent), and less precise for counties smaller than 10,000 (MAPE of 2.9 percent). Excepting counties whose population size is between 100,000 and 250,000, the majority of counties in all other county size groups have absolute percent error less than two percent. In addition, four of the six size groups have no counties with absolute percent errors of five percent or more.

Table 5. Accuracy and bias by county size

Population Size	Number of Counties	Population Estimation Error				
					Percent of Absolute % Errors	
		MAPE	MALPE	PPOS	<2%	>5%
<10,000	4	2.9%	2.9%	100%	50.0%	0%
10,000-24,999	8	2.1%	1.0%	62.5%	62.5%	12.5%
25,000-49,999	6	1.3%	-0.7%	33.3%	83.3%	0%
50,000-99,999	9	2.3%	-0.9%	44.4%	66.7%	11.1%
100,000-249,999	5	2.0%	-1.2%	20.0%	40.0%	0%
250,000+	7	0.9%	0.5%	57.1%	71.4%	0%
Total	39	1.9%	0.1%	51.3%	64.1%	5.1%

The accuracy and bias of OFM's estimates also vary by population growth. Table 6 shows a U-shaped pattern for the MAPE values, with larger errors for counties with negative growth or high growth (over 50 percent) and lower errors for counties with low to moderate growth (zero to 15 percent) and moderate growth (15 to 25 percent). While negative and high growth counties share similar MAPE values, the MALPE values show a different pattern. According to the MALPE values, the direction of the bias changes from overestimating counties with negative and low to moderate growth, to underestimating counties with moderate and high growth. See Table A1 in the Appendix for individual county detail.

Table 6. Accuracy and bias by county growth rate

Population Growth Rate 2000-2010	Number of Counties	Population Estimation Error				
					Percent of Absolute % Errors	
		MAPE	MALPE	PPOS	<2%	>5%
<0%	2	3.6%	3.6%	100%	50.0%	50.0%
0%-15%	26	1.8%	0.5%	57.7%	65.4%	0%
15%-25%	10	1.8%	-1.2%	30.0%	70.0%	10.0%
25%-50%	0	.	.	.	.	.
50%-99%	1	3.4%	-3.4%	0%	0%	0%
Total	39	1.9%	0.1%	51.3%	64.1%	5.1%

Detailed evaluation of city population estimates: As with counties, the city estimates are evaluated by size and growth rate categories using the five accuracy and bias measures. Two cities that incorporated since 2000 (Liberty Lake and Spokane Valley) and eight cities that conducted special censuses in 2010 are excluded from the evaluation. The summary measures for all 271 cities in Table 7 shows that although the MAPE is 5.5 percent, 56 percent of the cities have absolute percent errors less than five percent and less than 15 percent have absolute percent errors over 10 percent. The MALPE value of 0.1 percent and the PPOS value of 49.8 percent indicate that OFM estimates are roughly evenly split between positive and negative bias compared to the census.

Table 7: Accuracy and bias by city size

Categories of Population Size	Number of Cities	Population Estimation Error				
					Percent with Absolute % Errors	
		MAPE	MALPE	PPOS	<5%	>10%
0-99	1	25.0%	25.0%	100%	0.0%	100%
100-499	41	7.0%	4.0%	68.3%	46.3%	29.3%
500-999	34	6.7%	4.5%	76.5%	47.1%	17.6%
1,000-2,499	48	5.8%	1.0%	54.2%	47.9%	14.6%
2,500-4,999	33	5.9%	-2.7%	39.4%	48.5%	9.1%
5,000-9,999	37	5.5%	-3.4%	32.4%	48.6%	16.2%
10,000-24,999	38	3.8%	-1.4%	39.5%	78.9%	7.9%
25,000-49,999	21	3.5%	-2.2%	33.3%	76.2%	9.5%
50,000-99,999	12	3.7%	-3.0%	16.7%	66.7%	0.0%
100,000+	6	1.4%	1.0%	83.3%	100%	0.0%
Total	271	5.5%	0.1%	49.8%	56.1%	14.8%

The 271 cities are divided by population size into 10 categories for evaluation. The MAPE values for those 10 size categories indicate a strong inverse relationship between the population size and the average absolute percent errors. For cities with population less than 1,000, the MAPEs are over six percent. As the cities' sizes increase to between 1,000 and 10,000, the MAPEs drop just below six percent. For cities with a population size between 10,000 and 100,000, the MAPEs fall between three and four percent. The MAPE values continue to decline to 1.4 percent when the cities' population size increases to over 100,000.

The MALPE and percent positive errors (PPOS) measures show that smaller cities are more likely to be overestimated, whereas cities with populations between 2,500 and 99,999 people are, on average, likely to be underestimated. Of the six largest cities (Bellevue, Everett, Seattle, Spokane, Tacoma, and, Vancouver), only Spokane is underestimated.

In Table 8, estimate error is examined for cities according to their population growth over the last decade. The populations of three-quarters of Washington's cities and towns grew over the decade. Sixty-seven cities lost population. On average, the magnitude of the estimation error is U-shaped, where the cities with the largest decline or growth have larger estimate errors than those with moderate growth. Positive MALPE values for cities with less than 15 percent growth over the decade indicate overestimation. When growth rates are over 15 percent, the MALPE values become negative indicting bias towards underestimation.

Table 8: Accuracy and bias by city growth rate

Growth Rate 2000-2010	Number of Cities	Population Estimation Error			Percent of Absolute % Errors	
		MAPE	MALPE	PPOS	<5%	>10%
<-10%	14	14.4%	14.4%	100%	7.1%	78.6%
-10%-0%	53	6.0%	5.4%	90.6%	41.5%	15.1%
0%-15%	105	3.5%	0.2%	53.3%	77.1%	3.8%
15%-25%	38	5.3%	-3.1%	23.7%	55.3%	10.5%
25%-50%	32	5.5%	-4.8%	15.6%	53.1%	15.6%
50%-99%	19	6.9%	-6.5%	10.5%	36.8%	21.1%
100%+	10	8.9%	-7.2%	10.0%	30.0%	40.0%
Total	271	5.5%	0.1%	49.8%	56.1%	14.8%

On average, estimate error is greatest for cities with negative population growth greater than 10 percent. Cities with zero to 15 percent growth have the smallest MAPE and MALPE values, indicating that the estimates for this group of cities are more accurate. Cities with growth rates exceeding 15 percent tend to underestimated. The MAPE values steadily increase and the MALPE values decrease as growth rates exceeds 15 percent. The majority of those cities with any growth, even those cities that more than doubled in size, have estimation error under 10 percent.

Impacts of housing data on county and city estimates: While OFM population estimates at the county and state level employ multiple approaches (see Overview of City, Town, and County Annual Estimation Process for more details), city level estimates are produced solely with the Housing Unit Method (HUM), which can be expressed with the following formula:

$P = HU * OR * PPH + GQ$ where:

  P: population estimate,
  HU: total housing units,
  OR: occupancy rate,
  PPH: average household size (persons per occupied housing unit), and
  GQ: count of population living in group quarters.

As the first of a planned series of HUM evaluations, this section focuses on the impact of housing counts on OFM's county and city population estimates. OFM tracks housing unit growth in all cities and counties and uses that data in the HUM to estimate the population of counties, cities, and towns. These housing data may not always agree with the counts enumerated in 2010 Census for a number of reasons. For example, OFM housing units are defined by completion certificates. The Census Bureau counts new housing when "all exterior windows and doors are installed and final usable floors are in place." As a result, some housing that OFM considers incomplete may be counted in the housing stock in the 2010 Census. In addition, OFM recognizes boundary changes due to annexations according to OFM approval date, whereas the Census Bureau accepts new annexation boundaries by their effective date.

Regardless of the reasons behind the differences between OFM and Census housing counts, we want to know how these differences are related to population estimate error. Housing differences are first examined for counties with population estimate errors greater than two percent. Qualifying counties are grouped as follows:

1. Counties where both OFM housing counts and population are greater than their census counterparts;
2. Counties where both OFM housing counts and population are less than their census counterparts;
3. Counties where OFM overestimated the population and its housing counts are lower than those enumerated by the census;
4. Counties where OFM underestimated the population and its housing counts are higher than those enumerated in the census.

Fourteen of Washington's 39 counties have absolute population estimate errors over two percent (see Table 9). The population estimate errors and housing differences in eight of these 14 counties show a consistent relationship. For Mason, Franklin, Whatcom, Whitman, and Cowlitz counties, population is underestimated and OFM's housing units are lower than the 2010 Census counts. In contrast, Wahkiakum, Pierce, and Clark counties are overestimated and OFM's housing units are higher than the 2010 Census counts. Holding other factors, such as occupancy rates, persons per household, and group quarters, constant, more consistent housing data would increase the accuracy of the population estimates produced by the HUM for these eight counties.

There are six counties with population estimate errors that track in the opposite direction of the housing differences. Future evaluation of occupancy rates and average household sizes may shed some additional light on the reasons behind the population estimate errors in these six counties.

Table 9: Counties with absolute population estimate error greater than two percent

County	Population			Housing		
	2010 Census	Difference (OFM-Census)	% Error (Difference / Census)	2010 Census	Difference (OFM-Census)	% Difference (Difference/ Census)
Population underestimated: population estimate error and housing differences in same direction						
Mason	60,699	-3,599	-5.9%	32,518	-1,731	-5.3%
Franklin	78,163	-2,663	-3.4%	24,423	-408	-1.7%
Whatcom	201,140	-5,640	-2.8%	90,665	-1,301	-1.4%
Whitman	44,776	-1,176	-2.6%	19,323	-96	-0.5%
Cowlitz	102,410	-2,410	-2.4%	43,450	-90	-0.2%
Population overestimated: population estimate error and housing differences in same direction						
Wahkiakum	3,978	172	4.3%	2,067	53	2.6%
Pierce	795,225	19,375	2.4%	325,375	3,515	1.1%
Clark	425,363	10,237	2.4%	167,413	1,556	0.9%
Population underestimated and OFM housing units greater than 2010 Census						
Adams	18,728	-428	-2.3%	6,242	242	3.9%
Population overestimated and OFM housing units less than 2010 Census						
Pacific	20,920	1,180	5.6%	15,547	-123	-0.8%
San Juan	15,769	731	4.6%	13,313	-1,530	-11.5%
Ferry	7,551	299	4.0%	4,403	-212	-4.8%
Island	78,506	2,594	3.3%	40,234	-1,220	-3.0%
Skagit	116,901	2,399	2.1%	51,473	-1,150	-2.2%

The relationship between population error and housing differences is examined for cities with absolute estimate error over five percent. One hundred nineteen cities meet those criteria. Table 10 provides summary level results. Detailed information can be found in Tables A2-A5 in the Appendix. Among those 119 cities, 84 or 71 percent have housing differences in the same direction as the population estimate errors. Holding the other factors constant (i.e. group quarters, persons per household, and occupancy rates), and regardless of whether a city is under- or over-estimated, if OFM's housing counts were more consistent with the Census counts for these 84 cities, the accuracy of OFM's population estimates would increase.

Table 10: Cities with population estimate errors greater than five percent

	Population Underestimated	Population Overestimated	Total
Population estimate error and housing unit difference same direction	45	39	84
Population estimate error and housing unit error different direction *	13	22	35
Total	58	61	119

* Includes cities with OFM housing unit counts that are the same as the 2010 Census.

For 35 or 29 percent of cities the population differences go in the opposite direction as the housing differences. While housing differences may still be a contributing factor in the population estimate, changes in occupancy rates or household size can probably better explain the population estimation error in these cities.

Conclusion and next steps

In general, OFM April 1, 2010 population estimates are more accurate and less biased compared to those in 1990 and 2000. This is true at state, county and city levels. Nonetheless, this analysis also reveals areas where improvements are needed. The HUM, as solid as it is in estimating population in Washington and its counties and cities, still shows weakness in estimating population for small entities and for counties and cities where growth is negative or greater than 50 percent.

The majority of cities and counties with larger estimation errors would see improvements in the quality of their estimates if the accuracy of the housing data is improved. In this regard, OFM plans to work with local jurisdictions to develop a more standard data collection procedure for tracking changes to the housing stock.

As the next step OFM will evaluate the other two components of the HUM: occupancy rates and average household size. The results of those evaluations will be used to develop additional methods to adjust occupancy rates and persons per households so that HUM can better estimate areas where changes in occupancy rates and/or persons per household result in large population estimate errors.

Appendix

Table A1: Comparison of OFM county population estimates with federal census counts

	1990 Census	1990 Estimate	Difference	% Error	2000 Census	2000 Estimate	Difference	% Difference	2010 Census	2010 Estimate	Difference	% Error
State	4,866,663	4,798,100	-68,563	-1.41%	5,894,121	5,803,400	-90,721	-1.54%	6,724,540	6,733,250	8,710	0.13%
Adams	13,603	13,600	-3	-0.02%	16,428	15,800	-628	-3.82%	18,728	18,300	-428	-2.29%
Asotin	17,605	17,700	95	0.54%	20,551	20,000	-551	-2.68%	21,623	21,700	77	0.36%
Benton	112,560	110,000	-2,560	-2.27%	142,475	140,700	-1,775	-1.25%	175,177	172,900	-2,277	-1.30%
Chelan	52,250	50,100	-2,150	-4.11%	66,616	62,600	-4,016	-6.03%	72,453	73,300	847	1.17%
Clallam	56,204	57,000	536	0.95%	64,179	66,700	2,521	3.93%	71,404	70,100	-1,304	-1.83%
Clark	238,053	228,700	-9,353	-3.93%	345,238	345,000	-238	-0.07%	425,363	435,600	10,237	2.41%
Columbia	4,024	4,000	-24	-0.60%	4,064	4,100	36	0.89%	4,078	4,150	72	1.77%
Cowlitz	82,119	83,500	1,381	1.68%	92,948	94,900	1,952	2.10%	102,410	100,000	-2,410	-2.35%
Douglas	26,205	26,500	295	1.13%	32,603	32,200	-403	-1.24%	38,431	38,500	69	0.18%
Ferry	6,295	6,400	105	1.67%	7,260	7,300	40	0.55%	7,551	7,850	299	3.96%
Franklin	37,473	34,600	-2,873	-7.67%	49,347	45,900	-3,447	-6.99%	78,163	75,500	-2,663	-3.41%
Garfield	2,248	2,300	52	2.31%	2,397	2,300	-97	-4.05%	2,266	2,300	34	1.50%
Grant	54,758	53,100	-1,658	-3.03%	74,698	71,500	-3,198	-4.28%	89,120	87,700	-1,420	-1.59%
Gig Harbor	64,175	64,200	25	0.04%	67,194	67,100	-94	-0.14%	72,797	71,600	-1,197	-1.64%
Island	60,195	59,200	-995	-1.65%	71,558	74,200	2,642	3.69%	78,506	81,100	2,594	3.30%
Jefferson	20,146	20,000	-146	-0.72%	26,299	26,800	501	1.91%	29,872	29,300	-572	-1.91%
King	1,507,305	1,482,800	-24,505	-1.63%	1,737,046	1,685,600	-51,446	-2.96%	1,931,249	1,933,400	2,151	0.11%
Kitsap	189,731	188,800	-931	-0.49%	231,969	230,200	-1,769	-0.76%	251,133	248,300	-2,833	-1.13%
Kittitas	26,725	25,800	-925	-3.46%	33,362	32,500	-862	-2.58%	40,915	40,500	-415	-1.01%
Klickitat	16,616	16,800	184	1.11%	19,161	19,600	439	2.29%	20,318	20,500	182	0.90%
Lewis	59,358	59,200	-158	-0.27%	68,600	69,000	400	0.58%	75,455	75,600	145	0.19%
Lincoln	8,864	8,800	-64	-0.72%	10,184	10,000	-184	-1.81%	10,570	10,500	-70	-0.66%
Mason	38,341	38,300	-41	-0.11%	49,405	49,300	-105	-0.21%	60,699	57,100	-3,599	-5.93%
Okanogan	33,350	32,100	-1,250	-3.75%	39,564	38,500	-1,064	-2.69%	41,120	40,900	-220	-0.54%
Pacific	18,882	18,100	-782	-4.14%	20,984	21,300	316	1.51%	20,920	22,100	1,180	5.64%
Pend Oreille	8,915	9,000	85	0.95%	11,732	11,200	-532	-4.53%	13,001	13,100	99	0.76%
Pierce	586,203	574,500	-11,703	-2.00%	700,818	706,000	5,182	0.74%	795,225	814,600	19,375	2.44%
San Juan	10,035	10,100	65	0.65%	14,077	12,700	-1,377	-9.78%	15,769	16,500	731	4.64%
Skagit	79,555	76,100	-3,455	-4.34%	102,979	102,300	-679	-0.66%	116,901	119,300	2,399	2.05%
Skamania	8,289	8,100	-189	-2.28%	9,872	9,900	28	0.28%	11,066	10,900	-166	-1.50%
Snohomish	465,642	450,200	-15,442	-3.32%	606,024	593,500	-12,524	-2.07%	713,335	711,100	-2,235	-0.31%
Spokane	361,333	367,200	5,867	1.62%	417,939	415,000	-2,939	-0.70%	471,221	470,300	-921	-0.20%
Stevens	30,948	30,600	-348	-1.12%	40,066	38,500	-1,566	-3.91%	43,531	44,300	769	1.77%
Thurston	161,238	161,800	562	0.35%	207,355	204,300	-3,055	-1.47%	252,264	252,400	136	0.05%
Wahkiakum	3,327	3,500	173	5.20%	3,824	3,900	76	1.99%	3,978	4,150	172	4.32%
Walla Walla	48,439	49,100	661	1.36%	55,180	54,200	-980	-1.78%	58,781	59,600	819	1.39%
Whatcom	127,780	126,400	-1,380	-1.08%	166,826	163,500	-3,326	-1.99%	201,140	195,500	-5,640	-2.80%
Whitman	38,775	38,300	-475	-1.23%	40,740	41,300	560	1.37%	44,776	43,600	-1,176	-2.63%
Yakima	188,823	191,600	2,777	1.47%	222,581	214,000	-8,581	-3.86%	243,231	239,100	-4,131	-1.70%

Table A2: Cities with absolute population estimate error >5 percent where population is underestimated and housing differences are in same direction (n=45)

City or Town	Population			Housing		
	2010 Census Population	Difference (OFM-Census)	% Error (Difference/ Census)	2010 Census Housing Units	Difference (OFM-Census)	% Difference (Difference/ Census)
Housing difference <= -5 percent (n=24)						
Mattawa	4,437	-1,032	-23.3%	843	-105	-12.5%
Moxee	3,308	-613	-18.5%	1,032	-54	-5.2%
Grandview	10,862	-1,572	-14.5%	3,136	-252	-8.0%
Kittitas	1,381	-199	-14.4%	579	-29	-5.0%
Eatonville	2,758	-353	-12.8%	1,059	-103	-9.7%
Sequim	6,606	-776	-11.7%	3,767	-355	-9.4%
Ocean Shores	5,569	-629	-11.3%	4,758	-342	-7.2%
Camas	19,355	-2,145	-11.1%	7,072	-562	-7.9%
Issaquah	30,434	-3,274	-10.8%	13,914	-1,341	-9.6%
Sammamish	45,780	-4,710	-10.3%	15,736	-1,438	-9.1%
Prosser	5,714	-574	-10.0%	2,129	-222	-10.4%
Tenino	1,695	-160	-9.4%	740	-73	-9.9%
Shelton	9,834	-859	-8.7%	3,847	-212	-5.5%
Stanwood	6,231	-526	-8.4%	2,584	-286	-11.1%
Airway Heights	6,114	-514	-8.4%	1,727	-146	-8.5%
Cusick	207	-17	-8.2%	101	-5	-5.0%
La Center	2,800	-225	-8.0%	981	-71	-7.2%
North Bonneville	956	-76	-7.9%	459	-36	-7.8%
Metaline	173	-13	-7.5%	103	-14	-13.6%
Index	178	-13	-7.3%	116	-11	-9.5%
Mesa	489	-34	-7.0%	128	-8	-6.3%
Milton	6,968	-428	-6.1%	3,081	-202	-6.6%
Chewelah	2,607	-157	-6.0%	1,284	-143	-11.1%
McCleary	1,653	-88	-5.3%	759	-101	-13.3%
Housing difference between -5 percent and 0 percent (n=21)						
Duvall	6,695	-705	-10.5%	2,315	-112	-4.8%
East Wenatchee	13,190	-1,320	-10.0%	5,275	-142	-2.7%
Montesano	3,976	-371	-9.3%	1,684	-64	-3.8%
Ridgefield	4,763	-393	-8.3%	1,695	-82	-4.8%
Woodway	1,307	-107	-8.2%	466	-19	-4.1%
Nooksack	1,338	-108	-8.1%	457	-22	-4.8%
Algona	3,014	-239	-7.9%	1,018	-11	-1.1%
Quincy	6,750	-530	-7.9%	2,020	-47	-2.3%
Snoqualmie	10,670	-820	-7.7%	3,761	-112	-3.0%
Othello	7,364	-564	-7.7%	2,185	-15	-0.7%
Ephrata	7,664	-584	-7.6%	3,086	-143	-4.6%
Orting	6,746	-501	-7.4%	2,361	-59	-2.5%
Kennewick	73,917	-5,347	-7.2%	28,507	-1,302	-4.6%
Everson	2,483	-178	-7.2%	865	-17	-2.0%
Yakima	91,196	-6,156	-6.8%	34,887	-381	-1.1%
Pullman	29,799	-1,879	-6.3%	11,966	-246	-2.1%
Zillah	2,964	-174	-5.9%	1,105	-44	-4.0%
Pasco	59,781	-3,481	-5.8%	18,782	-701	-3.7%
Medical Lake	5,060	-275	-5.4%	1,835	-88	-4.8%
Lacey	42,393	-2,263	-5.3%	18,493	-420	-2.3%
Mabton	2,286	-121	-5.3%	548	-5	-0.9%

Table A3: Cities with absolute population estimate error >5 percent where population is overestimated and housing differences are in same direction (n=39)

City or Town	Population			Housing		
	2010 Census Population	Difference (OFM-Census)	% Error (Difference / Census)	2010 Census Housing Units	Difference (OFM-Census)	% Difference (Difference/ Census)
Housing difference >=5 percent (n=9)						
Krupp	48	12	25.0%	28	3	10.7%
Soap Lake	1,514	276	18.2%	977	57	5.8%
Kahlotus	193	32	16.6%	114	6	5.3%
George	501	49	9.8%	168	22	13.1%
Kalama	2,344	166	7.1%	1,070	80	7.5%
Albion	579	41	7.1%	302	16	5.3%
Beaux Arts Village	299	21	7.0%	118	10	8.5%
Coulee	562	38	6.8%	331	23	6.9%
Raymond	2,882	183	6.3%	1,279	116	9.1%
Housing difference between 0 percent and 5 percent (n=30)						
Hunts Point	394	76	19.3%	181	7	3.9%
Ilwaco	936	179	19.1%	567	24	4.2%
Leavenworth	1,965	360	18.3%	1,241	9	0.7%
Bucoda	562	98	17.4%	243	9	3.7%
Rosalia	550	90	16.4%	270	10	3.7%
Uniontown	294	46	15.6%	149	5	3.4%
Darrington	1,347	158	11.7%	644	9	1.4%
Westport	2,099	246	11.7%	1,561	17	1.1%
Winthrop	394	46	11.7%	300	11	3.7%
Rock Island	788	87	11.0%	277	8	2.9%
Sprague	446	49	11.0%	236	6	2.5%
LaCrosse	313	32	10.2%	181	6	3.3%
Goldendale	3,407	323	9.5%	1,635	71	4.3%
Cathlamet	532	48	9.0%	296	9	3.0%
Castle Rock	1,982	168	8.5%	863	39	4.5%
Dayton	2,526	214	8.5%	1,200	47	3.9%
Entiat	1,112	93	8.4%	495	22	4.4%
Twisp	919	76	8.3%	524	23	4.4%
Colville	4,673	372	8.0%	2,221	28	1.3%
Burlington	8,388	597	7.1%	3,419	27	0.8%
Pomeroy	1,425	100	7.0%	723	20	2.8%
Buckley	4,354	271	6.2%	1,669	57	3.4%
Pe Ell	632	38	6.0%	290	3	1.0%
Endicott	289	16	5.5%	165	6	3.6%
Gig Harbor	7,126	394	5.5%	3,560	70	2.0%
Odessa	910	50	5.5%	460	13	2.8%
Steilacoom	5,985	315	5.3%	2,793	22	0.8%
Northport	295	15	5.1%	168	2	1.2%
Puyallup	37,022	1,878	5.1%	16,171	177	1.1%
Metaline Falls	238	37	15.5%	206	4	1.9%

Table A4: Cities with absolute population estimate error >5 percent where population is underestimated and OFM housing > Census housing (n=13)

City or Town	Population			Housing		
	Census 2010 Population	Difference (OFM-Census)	% Error (Difference/ Census)	Census 2010 Housing Units	Difference (OFM-Census)	% Difference (Difference/ Census)
Yelm	6,848	-948	-13.8%	2,523	11	0.4%
Nespelem	236	-31	-13.1%	77	5	6.5%
Bridgeport	2,409	-309	-12.8%	745	40	5.4%
Fife	9,173	-963	-10.5%	3,895	53	1.4%
Forks	3,532	-337	-9.5%	1,374	52	3.8%
Mossyrock	759	-64	-8.4%	302	16	5.3%
Wapato	4,997	-392	-7.8%	1,293	22	1.7%
Farmington	146	-11	-7.5%	65	1	1.5%
Republic	1,073	-78	-7.3%	536	4	0.7%
Millwood	1,786	-126	-7.1%	793	1	0.1%
Coulee Dam	1,098	-68	-6.2%	534	0	0.0%
Brewster	2,370	-140	-5.9%	730	33	4.5%
Renton	90,927	-4,697	-5.2%	38,930	216	0.6%

Table A5: Cities with absolute population estimate error >5 percent where population is overestimated and OFM housing <= Census housing (n=22)

City or Town	Population			Housing		
	Census 2010 Population	Difference (OFM-Census)	% Error (Difference/ Census)	Census 2010 Housing Units	Difference (OFM-Census)	% Difference (Difference/ Census)
Wilson Creek	205	45	22.0%	116	-4	-3.4%
Riverside	280	50	17.9%	154	-8	-5.2%
Roslyn	893	122	13.7%	648	-16	-2.5%
Skykomish	198	27	13.6%	168	-8	-4.8%
Washtucna	208	27	13.0%	126	-6	-4.8%
Reardan	571	59	10.3%	255	-2	-0.8%
Long Beach	1,392	143	10.3%	1,564	-204	-13.0%
Hatton	101	9	8.9%	40	-2	-5.0%
Roy	793	67	8.4%	326	-24	-7.4%
South Cle Elum	532	43	8.1%	271	-5	-1.8%
Creston	236	19	8.1%	130	-1	-0.8%
Langley	1,035	80	7.7%	678	-30	-4.4%
Enumclaw	10,669	821	7.7%	4,683	-27	-0.6%
Carnation	1,786	129	7.2%	665	-6	-0.9%
Brier	6,087	403	6.6%	2,220	-55	-2.5%
Anacortes	15,778	1,022	6.5%	7,680	-76	-1.0%
South Bend	1,637	103	6.3%	780	0	0.0%
Oak Harbor	22,075	1,345	6.1%	9,553	-140	-1.5%
Friday Harbor	2,162	128	5.9%	1,273	-73	-5.7%
Garfield	597	33	5.5%	311	-11	-3.5%
Chelan	3,890	215	5.5%	2,517	-11	-0.4%
Mountlake Terrace	19,909	1,051	5.3%	8,602	-52	-0.6%

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