Population Study

Town of Redcliff
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Introduction

Purpose
Population studies are a vital component of municipal planning. Population studies provide context to decision-makers by presenting an overview of the current demographic composition of a municipality. Often, such studies include multiple projections of what the future population of an area may look like. The most likely projection scenario for the future population is referred to as the forecast. Multiple forecasts are possible to reflect various growth scenarios which are tied to how the economy is generally performing.

Municipalities must plan and make decisions for the future. A population forecast may help a municipality decide how large its water treatment plant will be or what types of recreation spaces should be built today in order to serve a future population. Projects like a new recreation centre require significant investment from the municipality. A municipality does not want to make the wrong decision by building a facility that will be too small in 20 years and require extensive additions; they also do not want to construct a facility too large that is too costly to maintain and operate given the current tax-base. A population projection study provides information as to what the future population might be, so council and administration can make effective decisions about municipal finances, services and operations.

Municipalities, like Redcliff, operate on a long-term time scale, often looking decades ahead. The following population study provides population projections 40 years into the future, to the year 2056. The projections align with the 2009 Tri-Area Intermunicipal Development Plan which considers a 50 year planning time frame to the year 2059.

It is important to note that while the population projection scenarios attempt to predict what the future population of Redcliff will be, no scenario is 100% accurate. Population growth is affected by countless factors. The following projection scenarios and forecast are based on available knowledge and data to make assumptions about an unpredictable future.

Document Organization
The following report is organized into four parts. The first part provides an overview of historic population trends in the Town of Redcliff, and provides possible reasons for those trends. The second part describes the current population of Redcliff, as of the 2016 Canadian Census. The third part outlines the methods and results from two population projection techniques which project the Town of Redcliff 2056 population. Finally, the conclusion provides an overview of the report and a forecast of the most likely 2056 future
population of Redcliff, based on current knowledge of demographic and economic trends.

**Historical Trends**

Historical population trends can provide insight into future population change. It is important to look at historical population changes and the underlying causes of historical population changes to understand how Redcliff got to where it is today, and what trends may repeat themselves in the future. Figure 1 presents Redcliff’s population change from 1913 to 2016. Appendix A includes historical maps and air photos which provide a visual story of how Redcliff’s built environment has changed over time.

Redcliff’s population has grown steadily over the years, largely influenced by growth periods resulting in an upwards of 25% population increase per census period (5 years). A booming economy was the reason behind large growth periods in the early 1900s, 1970s, and early 2000s.

Originally First Nations territory of the Cree, Assiniboine, Gros Venture, Blood, and Peigan people that was ceded by Treaty 7, Redcliff was first settled by Europeans in the 1880s. Near the turn of the 20th Century many industrialists, manufacturers, and investors were attracted to the resource-rich area. Redcliff became known as the ‘Smokeless Pittsburgh of the West’ due to abundant oil and natural gas reserves and proximity to the railroad. Manufacturing of brick, glass, shoes, cigars, and furniture occurred during the boom years in the early 1900s. The first greenhouse in Redcliff, the Redcliff Rosery, was built in 1912 (Harth, 2011).

Growing industrial activity led to a population surge in the first years of the 20th Century. A growing population meant a Council and administration were needed to handle the affairs of the community, including safety and police services, sanitary inspection, and street light maintenance. Redcliff was first incorporated as a Village in 1910 upon recommendation from the Minister of Public Works.

Continued population growth during the boom years (early 20th Century) led Redcliff to quickly meet the Alberta definition of a Town, population greater than 1,000, only two years after it was first incorporated as a municipality. Following a petition by the ratepayers of the Village of Redcliff, Redcliff changed municipal status from Village to Town in 1912.

Shortly after gaining Town status, the boom years surged Redcliff’s population to 2,500. At the time, Redcliff and Medicine Hat were competing to see which would become bigger. However, the prosperity ended due to a tornado in 1915 which destroyed many industries, the first and second world wars, fire, epidemic, and the depression. Population growth was stagnant and the total
Population of Redcliff drastically declined to 1,000 due to increased death rates from the Spanish flu and outmigration caused by the declining economy. The population remained close to 1,000 through the 1920s, 30s, and 40s, slow to recover due to lack of industry and the depression (Harth 2011, Hall 1962, Cypress Courier 2015, Alberta Municipal Affairs 2017). Population decline led to Redcliff occupying a fraction of the urban footprint that was originally envisioned for the near future. The 1913 “Smokeless Manufacturing Centre of Canada” Town scheme envisioned Redcliff occupying an area many times larger than the 1949 aerial photo depicts in Appendix A.

The discovery of oil near Leduc, Alberta in 1947 ushered in a new era for all of Alberta. Rapid economic growth occurred in the oil and gas sector, and the spin-off effects were felt throughout the province. In addition to the discovery of oil, men and women were returning from World War II, and a building boom occurred in Redcliff to provide services and residences for veterans. From 1941 – 1961, Redcliff’s population nearly doubled, from just over 1,000 to just over 2,000 residents, though growth was slower than in the early 1900s (Harth, 2011).

Population growth ceased again in the 1960s, but was followed by another surge in population growth in the 1970s. The 1960s and 1970s brought new residential, commercial, and industrial subdivisions, and many greenhouse businesses were established. The population increasing by 25% every 5 years between 1971 and 1981, reaching nearly 4,000 in 1981.

Population growth slowed again throughout the 80s and at one point declined slightly, due to the crash of oil prices and onset of recession in Alberta and Canada. Around this time, the Town had created a master plan for the Lockwood Industrial Park NE of the Trans-Canada Highway to provide serviced industrial land to oil and gas companies. However, the economic slump resulted in the business park remaining largely empty until the 1990s when the oil and gas industry picked up and large greenhouses were constructed on the land (Harth, 2011).

During the 1990s, the population began to slowly increase as the national, provincial, and local economies recovered. Record-high oil prices in the 21st Century once again brought economic prosperity to Alberta and Redcliff, with the population increasing from 4,400 in 2001, to nearly 5,600 in 2011. The crash of gas, then oil prices in the 2010s led to slow population growth. In 2016, the population of Redcliff only increased by 12 people, or 0.2%, from 2011.
Current Demographics

Every five years Stats Canada conducts a national census. The most recent census was conducted in 2016, providing an accurate and recent database of population statistics for the Town of Redcliff.

Population Density

Population density represents the average number of people living within a defined geographic area. In this report population density is defined as the number of people per square kilometre of land area. Places with a lower population density tend to have sprawling development, whereas higher density areas generally have more compact development. In 2016 the population density of Redcliff was 344.6 persons per square kilometre. Redcliff’s population density reflects its small town identity, with a lower population density than Medicine Hat, but comparable to Alberta towns with a similar population.

<table>
<thead>
<tr>
<th>Jurisdiction</th>
<th>Population Density (persons/km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Redcliff</td>
<td>344.6</td>
</tr>
<tr>
<td>Medicine Hat</td>
<td>564.6</td>
</tr>
<tr>
<td>Stettler</td>
<td>798.5</td>
</tr>
<tr>
<td>Taber</td>
<td>537.9</td>
</tr>
<tr>
<td>Vegreville</td>
<td>405.4</td>
</tr>
</tbody>
</table>

Age-Sex Distribution

Population pyramids break down a population into age and sex categories called cohorts. Population pyramids are useful for visualizing a population and its future needs. For example, if the population of 45-55 year olds is high, one would assume there will be a demand for senior housing and amenities in the near future.

The 2016 population pyramid for the Town of Redcliff depicted in Figure 3 illustrates a fairly even age distribution for all cohorts under 65+ years of age, with the exception of 5-9 and 35-39 year olds being the largest cohorts. A high youth and 35-39 year old population suggests a high proportion of families. There are a large number of children, both male and female; however, there are fewer 15-24 year olds than children. The top of the pyramid decreases in population rapidly, due to old age. A large proportion of the population is aged 45-64, suggesting that the proportion of seniors will increase in the next 10-20 years.
Figure 3. 2016 Redcliff population pyramid. (Stats Canada 2017)
Fertility & Births

Fertility data is not available on the municipal level; therefore, provincial data on fertility and births was used in this section.

The age-specific fertility rates declined in Alberta for most female age groups from 2009-2013. Fertility rates are only observed to increase in 35-39 and 40-44 years olds. The total fertility rate and crude birth rate in Alberta also decreased from 2009-2013.

**Fertility Rate** refers to the number of births per 1,000 females in each age group.

**Crude Birth Rate** is the number of live births per 1,000 females.

**Total Fertility Rate** is an estimate of the average number of live births a female can be expected to have in her lifetime, based on the age-specific fertility rates per 1,000 females in a given year. The total fertility rate is a sum of all the age-specific fertility rates in a single year.

Figure 4. Age-specific fertility rates, crude birth rate, and total fertility rate for Alberta, 2009-2013. (Stats Canada 2017)

<table>
<thead>
<tr>
<th>Age</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females 15 to 19</td>
<td>20</td>
<td>18.3</td>
<td>17.3</td>
<td>16</td>
<td>15.2</td>
</tr>
<tr>
<td>Females 20 to 24</td>
<td>65.6</td>
<td>61.6</td>
<td>58.9</td>
<td>57.3</td>
<td>55</td>
</tr>
<tr>
<td>Females 25 to 29</td>
<td>115.6</td>
<td>109.7</td>
<td>107.8</td>
<td>104.9</td>
<td>102.2</td>
</tr>
<tr>
<td>Females 30 to 34</td>
<td>114.8</td>
<td>112</td>
<td>114.6</td>
<td>109.8</td>
<td>109.6</td>
</tr>
<tr>
<td>Females 35 to 39</td>
<td>52.6</td>
<td>53.8</td>
<td>53</td>
<td>54.9</td>
<td>54.6</td>
</tr>
<tr>
<td>Females 40 to 44</td>
<td>9.8</td>
<td>10.7</td>
<td>11</td>
<td>10.9</td>
<td>11</td>
</tr>
<tr>
<td>Females 45 to 49</td>
<td>0.6</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Crude Birth Rate</td>
<td>14.1</td>
<td>13.7</td>
<td>13.5</td>
<td>13.5</td>
<td>13.4</td>
</tr>
<tr>
<td>Total fertility Rate</td>
<td>1891.8</td>
<td>1827.9</td>
<td>1807</td>
<td>1761</td>
<td>1728.7</td>
</tr>
</tbody>
</table>

Households & Families

The Stats Canada census data provides details on households and families in the Town of Redcliff. These characteristics help us understand the composition of families and households in Redcliff, which can aid in planning residential areas and providing community services.

Redcliff’s 2016 population of 5,600 lived in 2,160 private households. Of those households, Figure 5 shows the majority had 2 persons, 39%, followed by 1 person, 21%. The average household size in Redcliff in 2016 was 2.6 persons (Stats Canada 2017). Figure 6 reveals the majority of private households were one-census-families with children, followed by one-census-families without children. One-person households were also common. Of non-census-family households, 85% were one-person.

A census family is defined as a married couple (with or without children of either and/or both spouses), a common-law couple (with or without children of either and/or both partners) or a lone parent of any marital status with at least one child living in the same dwelling. (Stats Canada 2017)
The majority of Redcliff's population aged 15 years or older were married, 54%, or never married, 22%, depicted in Figure 7.

The average size of a census family in Redcliff was 2.9 persons, and there were 1,655 census families in 2016 (Stats Canada 2017). Figures 8 and 9 show the majority of census families had 2 persons and were married couples. Of couples, those without children slightly outnumbered those with children. Lone-parent families were the smallest proportion of census families. There were nearly 4 times as many female lone-parent families in Redcliff than male lone-parent families. Figures 10 and 11 reveal that of couple families with children the highest proportion was 2, while the vast majority of lone-parent families had 1 child.
Figure 8. Redcliff’s census families by number of persons. (Stats Canada 2017)

Figure 9. Redcliff’s census families by type. (Stats Canada 2017)

Figure 10. Redcliff’s census-family couples by number of children. (Stats Canada 2017)

Figure 11. Redcliff’s census-family lone parents by number of children. (Stats Canada 2017)
Migration

2016 Stats Canada migration data provide insight into the number of people in Redcliff who moved within the past year and past 5 years.

In 2016, the number of people in Redcliff who had moved residences, communities, provinces, and/or countries within the past year was 705. Figure 12 shows of the 705 movers, the majority were non-migrants, those who remained in the same community. Intraprovincial movers, those who stayed within Alberta, were second most common. Those who moved provinces, interprovincial, and countries, external migrants, were least common.

Of the 1,902 people who had moved residences in the past 5 years, the majority once again stayed within Redcliff, with a greater proportion moving within Alberta, from a different province, and from abroad, as seen in Figure 13.

*The migration data used for this section was unable to be used in the population projection because it is not detailed by cohort.*
Population Projection

Projections are “if, then” statements that calculate future conditions that may exist as a result of adopting certain assumptions. For example, “if the average birth rate and migration rate from the last 10 years is applied, then municipality X’s population will be 20,000 in the year 2050.” Because there is no guarantee that the average birth rate and migration rate from the last 10 years will continue into the future, the projection represents one possible scenario of something that may happen.

There are many ways to project a future population. Two projection methods were used in this study, aggregate and cohort.

Aggregate Model

Introduction

The aggregate population projection model uses aggregate data from the past to predict future conditions in Redcliff. Aggregate projections consider the total population for the Town of Redcliff, and do not break the population into its subcomponents (cohorts) of age or sex. Aggregate projections do not attempt to account for underlying demographic and economic processes which caused the trends.

Though aggregate projections do not provide details of underlying trends, they are favourable because the data is easier to obtain and analyze. Oftentimes cohort data or data of underlying demographic and economic trends is not available at the Redcliff-specific scale.

Methods

Historical aggregate population data for Redcliff from 1966 - 2016 was plotted in a graph. The trend line of the historical data was compared to standard curves to determine which curve has the “best fit” – in other words, which curve best matches the historical data? Nine standard curves were used in the aggregate population for the Town of Redcliff (Linear Regression, Geometric, Parabolic, Modified Exponential, Modified Exponential with an upper limit, Gompertz, Gompertz with an upper limit, Logistic, Logistic with an upper limit). The equations for each curve and details on the methodology can be found in Appendix B.

Best fit can be determined by simply looking at the curves; however, statistics can also be used to determine the best fit. Three different statistical measures were considered when determining best fit, coefficient of relative variation (CRV), mean error (ME), and mean absolute percentage error (MAPE). The three statistics measured the difference between Redcliff’s historical population curve and each standard curve, presenting an error value, shown in Figure 14. The higher the value, the higher the error, and the larger the difference between the historical and standard curve. The four curves with the lowest error values were selected as possible future
population scenarios for Redcliff: Linear Regression, Geometric, Modified Exponential Upper Limit, and Gompertz Upper Limit. The average of the four best-fitting curves was also calculated to create an average scenario for Redcliff’s 2056 population.

Figure 14. Summary of error statistics for the 9 curves considered for best fit. Highlighted curves indicated best fit.

<table>
<thead>
<tr>
<th>Curve</th>
<th>CRV</th>
<th>ME</th>
<th>MAPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear Reg.</td>
<td>106.78</td>
<td>0.00</td>
<td>5.74%</td>
</tr>
<tr>
<td>Geometric</td>
<td>119.71</td>
<td>6.84</td>
<td>6.65%</td>
</tr>
<tr>
<td>Parabolic</td>
<td>114667.15</td>
<td>0.00</td>
<td>5.68%</td>
</tr>
<tr>
<td>Mod Exp</td>
<td>305.86</td>
<td>20.88</td>
<td>6.78%</td>
</tr>
<tr>
<td>Mod Exp UL</td>
<td>272.33</td>
<td>-3.54</td>
<td>6.13%</td>
</tr>
<tr>
<td>Gompertz</td>
<td>308.65</td>
<td>31.73</td>
<td>6.43%</td>
</tr>
<tr>
<td>Gomp UL</td>
<td>274.98</td>
<td>5.27</td>
<td>6.71%</td>
</tr>
<tr>
<td>Logistic</td>
<td>311.68</td>
<td>37.72</td>
<td>6.18%</td>
</tr>
<tr>
<td>Log UL</td>
<td>277.84</td>
<td>9.64</td>
<td>6.95%</td>
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Scenarios
The following five scenarios in Figures 15 and 16 represent possible future populations for the Town of Redcliff. Four are based on the best-fitting curves, while the fifth is based on the average of the four best-fitting curves. All scenarios predict constant population growth, with the highest projected 2056 population 12,546, and the lowest 7,369.

While there is a large difference in the 2056 projected population between the five curves, each scenario is plausible. If multiple population surges occur in Redcliff as they did during historical periods of growth, the Geometric scenario is likely.

If Redcliff experiences periods of growth followed by periods of stagnation, as in the last 10 years, the Average, Linear, or Gompertz Upper Limit scenarios are likely. If the current economic climate continues without any boom cycles, the Modified Exponential Upper Limit scenario is possible as it predict slower, gradual growth.
Figure 15. Chart - Actual Redcliff population from 1966 – 2016, and 5 projection scenarios for Redcliff’s population, 2016 – 2056, based on four curves of best-fit, and the average of the four curves.
Figure 16. Table- Actual Redcliff population from 1966 – 2016, and 5 projection scenarios for Redcliff’s population, 2016 – 2056, based on four curves of best-fit, and the average of the four curves.

<table>
<thead>
<tr>
<th>Year</th>
<th>Actual</th>
<th>Linear Reg.</th>
<th>Geometric</th>
<th>Mod Exp UL</th>
<th>Gompertz UL</th>
<th>Average</th>
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<tr>
<td>1966</td>
<td>2,247</td>
<td>2,264</td>
<td>2,406</td>
<td>2,251</td>
<td>2,318</td>
<td>2,328</td>
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<td>1971</td>
<td>2,255</td>
<td>2,606</td>
<td>2,637</td>
<td>2,619</td>
<td>2,925</td>
<td>2,626</td>
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<td>1976</td>
<td>3,006</td>
<td>2,948</td>
<td>2,890</td>
<td>2,975</td>
<td>3,582</td>
<td>2,932</td>
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<td>1991</td>
<td>3,768</td>
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<td>3,806</td>
<td>3,977</td>
<td>3,900</td>
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<td>1996</td>
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<td>4,172</td>
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<td>2001</td>
<td>4,372</td>
<td>4,660</td>
<td>4,573</td>
<td>4,594</td>
<td>4,626</td>
<td>4,597</td>
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<td>2006</td>
<td>5,096</td>
<td>5,002</td>
<td>5,012</td>
<td>4,889</td>
<td>4,981</td>
<td>4,964</td>
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<td>2011</td>
<td>5,588</td>
<td>5,344</td>
<td>5,494</td>
<td>5,174</td>
<td>5,338</td>
<td>5,344</td>
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<td>2016</td>
<td>5,600</td>
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<td>6,022</td>
<td>5,450</td>
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<td>2021</td>
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<td>5,717</td>
<td>6,047</td>
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<td>2026</td>
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Cohort Model

Introduction
Population is affected by births, deaths, and migration. While the aggregate model takes into account the total population, it does not account for the above three components that affect population change.

The cohort model divides the population data into its subgroups based on age and sex to project a future population. Births, deaths, and migration trends are applied to the subgroups in the hopes of creating a more accurate population projection.

Methods
Cohorts were created based on sex and five year age span (i.e. female 0-4, 5-9... male 0-4, 5-9...). Provincial data from Stats Canada for each cohort from 2011-2013 was used to calculate a survival rate. The survival rate was applied to each cohort in historical Redcliff population data from 2006, 2011, and 2016 to estimate a surviving population. An average migration rate from 2006-2016 was determined by calculating the difference between the surviving population of one cohort, and the initial population of the next cohort. Migration was assumed to be all population changes that were not accounted for by the survival rate. Additional model assumptions are listed in Appendix B.

Fertility rates for female cohorts were taken from provincial data from 2009-2013. The average fertility rate was calculated, and applied to each female cohort of reproduction age to project the number of births.

The final population projections were determined by applying the survival rate, migration rate, then birth rate to each cohort. Two projection scenarios were created. The first used the average migration and birth rates, while the second used the average birth rate and the highest five year migration rate from 2006-2016. The high migration cohort projection scenario was created to determine what the future population of Redcliff may be in the case that external factors such as the economy lead to a high influx of residents into the Town.

Scenarios
Average
The average scenario projects Redcliff’s population to increase moderately to 5,774 from 2016 to 2036, then decrease slightly to 5,436 by 2056, as seen in Figure 17. The pattern of slow growth followed by decline is attributed to the average migration rate, which was negative for most cohorts over the 2006-2016 time

Survival rate refers to the proportion of the population that survives on to the next year. For example, if there are 1,000 individuals aged 5 and 997 survive into the next year, the survival rate for 5-year-olds is 99.7% (Klosterman 1990).
period considered. The negative birth rate leads to eventual population decline because more people are moving out of each cohort than are being born every year. Along with population decline, Figure 18 shows the senior population is projected to increase and the youth population decrease. The largest projected age group in the average scenario for the year 2056 is 45-55 year olds. The average scenario projects a higher proportion of Redcliff’s population over 55 in 2036, when compared to 2016. The 40-49 year old population has declined. While the 25-29 year old population has increased, the 15-24 year old population has declined drastically. There is also a much higher proportion of male to female youth in 2036.

In 2056 the average scenario projects the majority of Redcliff’s population will be over 55 years of age, there are also many people aged 85+ when compared to previous years. Youth under 19 are one of the smallest age groups. The population increases slightly by cohort from birth to middle age. The male population is larger than the female population, especially for those 19 and under.

The average cohort scenario projects a very different 2056 Redcliff population than the aggregate scenarios, which indicated population growth. The average cohort scenario projects what may happen if migration rates in Redcliff remain negative over time.

![Figure 17. Average cohort scenario population projections for Redcliff, 2016 (actual data), and 2021 – 2056 (projected), divided by major age group.](image-url)
Figure 18. Population pyramid depicting the projected population changed in Redcliff by cohort from 2016 to 2036 to 2056, based on the average cohort scenario.
**High Migration**
The high migration scenario projects a constant population increase over time in Redcliff, as seen in Figure 19. The population of both seniors and youth also increases over time. The 2036 population under the high migration scenario is 7,273, and the 2056 projected population is 8,782.

Figure 20 shows the 25-40 year old age group is projected to be the largest in the year 2036, especially females. The 50-65 age group also has a high population.

Though a high proportion of the population is projected to be under 10 years of age, the 15-24 age group still remains the lowest. In 2056 the high migration scenario projects a high female population aged 50-65. The middle-aged population is larger than the youth population, and there are many more male than female youth. There is also a higher relative proportion of 15-24 year olds for both sexes when compared to previous years.

The high migration scenario projects a constant population increase, similar to the aggregate model scenarios.
Figure 20. Population pyramid depicting the projected population changed in Redcliff by cohort from 2016 to 2036 to 2056, based on the high migration cohort scenario.
Conclusion

Forecast

A population forecast represents the most likely future population for the Town of Redcliff. Based on recent economic and social trends, the high migration cohort scenario was selected as the forecasted for Redcliff’s future population. The high migration cohort scenario was chosen because the cohort model takes into account the underlying factors that contribute to population change – birth, death, and migration. The high migration scenario is the best representation of current trends, and therefore becomes the forecast. All of the scenarios can be seen together in Figure 21.

The high migration scenario used a constant average birth rate. According to Stats Canada, national birth rate and fertility rates have been declining over the past few decades. In 2016 the average Canadian fertility rate was 1.61 children per women, which is less than the 2.1 children per women fertility rate needed to ensure replacement of the existing population. The fertility rate in Canada has not been higher than 2.1 since the early 1970s. Fertility rates have decreased due to the increasing costs of having children, and societal changes of potential mothers and couples choosing to either delay having children to pursue a career, or not have children altogether (Stats Canada 2011). Though fertility is in decline, Canada’s population has still grown due to immigration. A constant birth rate based on provincial 2009-2013 rates creates an idealistic scenario in which the birth rate does not decline any further.

The high migration scenario used the highest of the two five-year migration rates between 2006-2016. The highest migration rate was used because the average rate included the 2011-2016 census period where little growth occurred, and is not reflective of large periods of population growth Redcliff has experienced in the past. In July 2017, the Conference Board of Canada released their Economic Outlook for Canadian Mid-Sized Cities, which projected Medicine Hat’s real GDP to expand by 2.7% in 2017 and 2.0% in 2018 due to economic recovery in the oil and gas industry (Conference Board of Canada 2017). Additionally, the Province of Alberta’s recent Economic Outlook noted the provincial economy has exceeded expectations for the first half of 2017 and recovery and growth are occurring in almost every sector (Government of Alberta 2017). Current and future economic growth expected in the region is predicted to increase migration into Redcliff, making the high migration scenario realistic.

Due to anticipated stagnant future birth rates and increased economic growth, the high migration scenario was determined to represent the future forecasted population for the Town of Redcliff, with a 2056 total population of 8,782, representing a population increase of over 55% from 2016.
Figure 21. All Redcliff future population projection scenarios from 2021 to 2056 from the aggregate and cohort models. The cohort high migration scenario was chosen as the forecast to represent the most likely future.
Appendix A

Historical Maps and Air Photos
Appendix B
Methods Details – Aggregate Model

Upper Limit
In the Aggregate Model, 14,000 was chosen as an upper limit for the population to calculate the three standard curves with upper limits. The upper limit was chosen because it reflects a more than doubling of the population, and was the predicted 2060 Redcliff population from the 2010 Tri-Area Intermunicipal Development Plan for Redcliff, Cypress and Medicine Hat.

Curve Equations

Linear Regression:

\[ Y_c = a + bX \]

Geometric:

\[ \log Y_c = \log a + \log b(X) \]

Parabolic:

\[ Y_c = a + b \times (X + c) \times X^2 \]

Where \( c = \frac{(N \times \text{Sum}X^2 \times Y - \text{Sum}X^2 \times \text{Sum}Y)/(N \times \text{Sum}X^4 - (\text{Sum}X^2)^2)}{\text{Sum}X^2} \)

\[ a = \frac{(\text{Sum}Y - c \times \text{Sum}X^2)/N}{(N \times \text{Sum}X^4 - (\text{Sum}X^2)^2)} \]

Modified Exponential:

\[ Y_c = c + ab^x \]

Where \( b = \frac{(\text{Sum} 9-12) - (\text{Sum} 5-8) / (\text{Sum} 5-8) - (\text{Sum} 1-4)}{\text{Sum} 5-8 - (\text{Sum} 1-4) \times ((b-1)/(b^n-1)^2)} \)

\[ a = \frac{(\text{Sum} 5-8) - (\text{Sum} 1-4) \times ((b-1)/(b^n-1)^2)}{\text{Sum} 5-8} \]

\[ c = \frac{(1/n) \times ((\text{Sum}1-4) \times (\text{Sum}9-12) - \text{Sum}5-8^2)/((\text{Sum}1-4) + (\text{Sum}9-12) - 2(\text{Sum} 5-8))}{\text{Sum} 5-8} \]

“1-12” represent the actual Redcliff census numbers for 12 census years, 1966 to 2021. 2021 population was needed for the model to create a number of observations divisible by 3. 2021 estimated population was estimated by applying the average census period population change from 1966 to 2016, +371 persons, to the 2016 actual census population. This was also used for the Gompertz and Logistic curves.

Modified Exponential, Upper Limit:

\[ \log (c-Y_c) = \log a + \log b \times (X) \]

Where a, b, and c are the same as in the Modified Exponential curve.

Gompertz:

\[ Y_c = c \times a \exp (b^x) \]
Where \( b = (\text{Sum } 9-12) / (\text{Sum } 5-8) - (\text{Sum } 1-4) \)
\[
a = (\text{Sum } 5-8) - (\text{Sum } 1-4) \times ((b-1)/(b^{n-1})^2) \quad \text{and,}
\]
\[
c = (1/n) \times ((\text{Sum } 1-3) \times (\text{Sum } 9-12) - \text{Sum } 5-8^2) / ((\text{Sum } 1-4) + (\text{Sum } 9-12) - 2(\text{Sum } 5-8))
\]

_Gompertz, Upper Limit:_

\[
\log (\log c - \log Y_c) = \log (\log a) + \log b (X)
\]

Where \( a, b, \) and \( c \) are the same as in the Gompertz curve.

_Logistic:_

\[
Y_c = (c + ab^X)^{-1}
\]

Where \( b = (\text{Sum } 9-12) / (\text{Sum } 5-8) - (\text{Sum } 1-4) \)
\[
a = (\text{Sum } 5-8) - (\text{Sum } 1-4) \times ((b-1)/(b^{n-1})^2) \quad \text{and,}
\]
\[
c = (1/n) \times ((\text{Sum } 1-4) \times (\text{Sum } 9-12) - \text{Sum } 5-8^2) / ((\text{Sum } 1-4) + (\text{Sum } 9-12) - 2(\text{Sum } 5-8))
\]

_Logistic, Upper Limit:_

\[
\log (Y_c^{-1} - c) = \log a + \log b (X)x
\]

_Assumptions_

- X-axis is the independent variable
- Y-axis is the dependent variable
- Population change is reflective of births, deaths, and migration, which vary through time
- Time is a proxy which reflects the net effect of a large number of unmeasured events (time does not directly impact population, but the demographic and economic events that occur through time do)

Methods Details – Cohort Model

_Assumptions_

- Redcliff survival rate is equal to the Alberta survival rate
- Survival rate is constant over time
- Canadian fertility rate is equal to the Redcliff fertility rate
- Birth rate is derived from fertility rate and is constant over time
- Only women 15-49 are giving birth
- Average female population over a census period (5 years) is used to predict births (Klosterman 1990)
- Any population change not accounted for in births or deaths is migration
- Average scenario – migration rate is constant over time, equal to the average migration over the last 10 years; high migration scenario – migration rate is constant over time, equal to the highest migration rate over the last 10 years
References


