Edmonton Alberta Landscape Transformation 1966-1976:

An Examination of Land Use Change Over time

Produced for the Municipality of Edmonton- Alberta

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Executive Summary

The population of Edmonton Alberta between the years of 1966 and 1976 increased by approximately 81,000 individuals, respectively from 380,000 in 1966 to 460,000 in 1976(City of Edmonton). Alongside this 18% increase in population was as well a shift in the dynamics of landscape usage. Notably changes can be examined to have occurred in areas of cropland, woodland, pasture and urban build up. Moreover as landscape usage shifted a prominent change in the rate of disjunct core areas occurred. As urbanization continues to increase it is important to consider the effects of urban build up towards pre-existing natural landscapes. As Edmonton expands outwards and a demand for resources and spaces increases it is crucial that proper measures be taken in order to preserve ecologically meaningful aspects of the landscape. Therefore it is recommended that steps be undergone in order to slow rates of removal in the landscapes of woodlands (both productive and unproductive) and swamps, marshes and bogs.

Introduction

Urbanization in Alberta has occurred at an unprecedented rate compared to the rest of Canada. As such, Edmonton has not been unaffected by these changes. The transformation from a rural setting to an every expanding urban sprawl has led to deleterious effects on the environment and in turn has reduced to functions of many environmental services. A seen in *map 1* the urban center of Edmonton expanded outwards dramatically between the years of 1966 and 1976. This pattern as noted by Agrawal (2016) still is presently continuing with Edmonton showing the largest growth of any CMA (Census Metropolitan Area) in Canada with a growth rate of 220% between the years of 1971 and 2011. Moreover, in order to allow for the room to expand large tracts of forest and wetlands have been disturbed. In turn these landscapes have been replaced by urban built up areas and their related landscapes such as horticulture and improved pasture. From the environmental perspective this shift has multiple negative notations. The increase in horticulture often involves large amounts of monocultures while the increase in improved pasture especially in the case of bovine leads to large amounts of methane emissions. Conversely the destruction of woodlands and wetlands cannot be overlooked. Both of the aforementioned landscapes are environmentally important for their respective ecosystem services of carbon sequestration and increase in water and air quality. Lastly, though water areas only showed slight reductions in landscape size between 1966 and 1976 their proximity to the city of Edmonton should be considered in terms of overall water quality.

Results and Discussion

As depicted in *map 1* and *figure 1* the total percentage of cropland across the measured landscape decreased between 1966 and 1976. When examining *map 1* there is a notable

decline in the area directly surrounding the Edmonton core. Moreover, western Alberta in turn shows an increase in cropland during the 1976 year of study. As well *figure 2* displays that the number of patches for cropland has increased. These results are important for two reasons. First an overall reduction in cropland appears illogical as an expanding city should require greater access to food sources. This of course may be solved through an increase in importation, increased pasture, increased horticulture or an effect that is beyond the scope of the report. More importantly, and relevant to this assessment is the conversion of cropland. Urban expansion onto agricultural soils has then shifted the need for agriculture to find new location. This then means that frequent relocation and soil erosion is occurring, which likely will lead to reduced crop yield and soil capability (Agrawal 2016)

Swamp, marshes and bogs are examples of ecosystems which fulfill the roles of regulatory ecosystem services. Moreover, due to their rarity and susceptibility to outside influences it is crucial that meaningful action is undergone in order to preserve these landscapes. Wetlands play important roles in regulation aquifers, carbon sequestration and the management of local and regional temperatures (Mclaughlin et al 2013). All of these aforementioned services are important to any population but increase in importance when considering the populace of an outwards expanding urban center. Yet, as portrayed in *figures 1,2 and 3* wetlands have been reduced in terms of size, number of patches and number of disjunct core areas.

Across all landscapes with exception of anthropocentric focused areas such as urban, improved pasture and outdoor recreation a notable reduction in edge area occurred. Compared to the previously mentioned issues this is a mark improvement. Though at the same time that edge area was reduced the number of patches was as well reduced in many of the same landscapes. This likely means that smaller patches of natural systems were being amalgamated into anthropocentric landscapes. Though the reduction of these systems may be harmful, the reduction in edge is an underlying positive. From an ecological perspective a system with a reduced edge effect is often more stable as the edges of any system are more frequently disturbed. Moreover, if only smaller patches are being removed and large patches are generally left untouched this can still support many of the species. Furthermore between 1966 and 1976

as referenced in *table 1* both Shannon's diversity index and evenness index increased meaning that across the landscape more overall evenness was present.

The expansion of urban area, outdoor recreation, horticulture and improved pasture undoubtedly shows that an increasing anthropocentric influence is occurring in the area surrounding Edmonton. Of course, this is to be expected in an ever growing metropolis yet at the same time many effects associated to these areas have being disregarded or are outside the scope of this report. Nonetheless though not outright in examination it is still important to reference them in an assessment of landscape change. Linked closely to all of the preceding land uses are their underlying infrastructure. Effects such as fertilizer, transportation networks and roads. Moreover as Edmonton continues to expand it is likely that these networks will then have to reach land further away. In this case of agriculture the surrounding area will become too expensive to farm and in turn conversion of landscapes further away will be necessary. This is already occurring when examining the western area of Alberta in *map 1.* More over as cities continue to grow along the North Saskatchewan River which can be seen in *map 1* both north east and south west of the Edmonton core, a greater risk of damage to the riparian zone is present.

Recommendations

From an environmental perspective it is important to consider the following recommendations as the urbanization of Edmonton continues.

- Increased monitoring of riparian zones
- Preservation of wetlands
- Studies to examine the effects of soil erosion on converted landscapes
- Examinations of water pollutants surrounding expanding urban sites
- Increased protection of woodlands
- Attempts to pair the increasing amount of outdoor recreation sites such as parks with areas that need protection.

Citations

- K. McGarigal. Landscape Metrics for Categorical Map Patterns [Powerpoint slides]
- McLaughlin, Daniel L., and Matthew J. Cohen. "Realizing Ecosystem Services: Wetland Hydrologic Function Along a Gradient of Ecosystem Condition." *Ecological Applications*, vol. 23, no. 7, 2013, pp. 1619-1631.
- Riitters, K. H., et al. "A Factor Analysis of Landscape Pattern and Structure Metrics." *Landscape Ecology*, vol. 10, no. 1, 1995, pp. 23-39.
- Sandeep Agrawal "Urban, Suburban, Regional and Wet Growth in Alberta" *Urban and Regional Planning Program Department of Earth and Atmospheric Sciences University of Alberta,*2016, pp.1-84.
- CLUMP land use codes- http://www.lib.uwaterloo.ca/locations/umd/digital/clump_classes.html
- Edmonton population growth- https://www.edmonton.ca/city_government/facts_figures/population-history.aspx

Year	Number of Patches	Patch Density	Total Edge (km)	Shannon's Diversity Index	Shannon's Evenness Index
1966	8513	1.3125	35281.6	1.6923	0.6412
1976	8311	1.2907	32473.2	1.7665	0.6694

Table 1- Changes of five landscape measures between the years of study 1966 and 1976.

CLUMP LAND USE CODES	Canada Land Use Monitoring Program
B	Urban built-up area
E	Mines, quarries sand and gravel pits
O	Outdoor recreation
H	Horticulture
G	Orchards and vineyards
A	Cropland
P	Improved pasture and forage crops
K	Unimproved pasture and range lands
T	Productive woodland
U	Non-productive woodland
M	Swamp, marsh or bog
S	Unproductive land-sand
L	Unproductive land-rock
8	Unmapped areas
Z	Water areas

Appendix 1- CLUMP land use codes for areas of study.

Class Metrics		The individual properties of a class spread across a landscape.
CA	Total Area	Sum of area per a class- measured in hectares
PLAND	Percentage of Landscape	Percentage of class based on sum of landscape CA/Landscape(Area)=PLAND
TE	Total Edge	Total length or edge of a patch-measured in meters
CV	Coefficient of Variation	Measure of relative variability
Shape_MN	Shape Index-Mean Shape	Patch area normalized for comparison among landscape
TCA	Total Core Area	Area further than depth of edge distance
CPLAND	Core Area % of Landscape	Percentage of landscape that is core area
NDCA	Number of disjunct core areas	Number of core areas disjoined across the landscape
NP	Number of Patches	Total number of patches per a class
PD	Patch Density	Number of patches divided by sum of landscape area
SHDI	Shannon's Diversity Index	Measures diversity among a community- as well accounts for relative abundance
SHEI	Shannon's Evenness Index	Measures diversity across a landscape based on a 0-1 scale wherein 0=lowest diversity and 1=highest diversity

Appendix 2- Class metric definitions retrieved from K. McGarigal lecture on landscape metrics

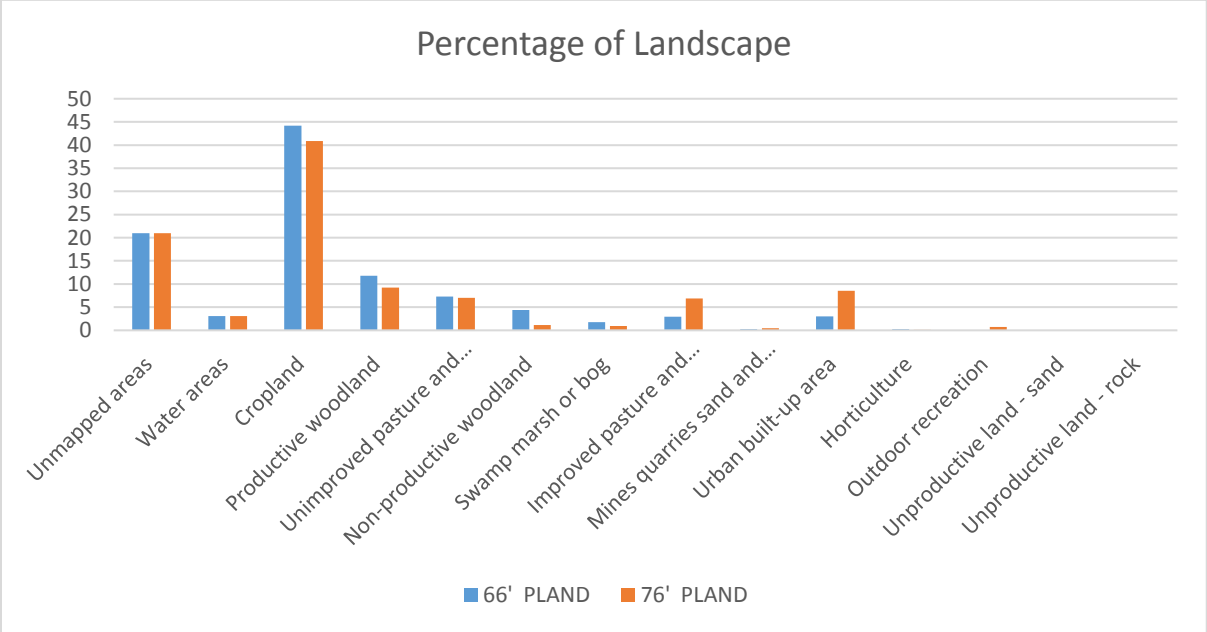

Figure 1- Percentage of each class across total area of landscape

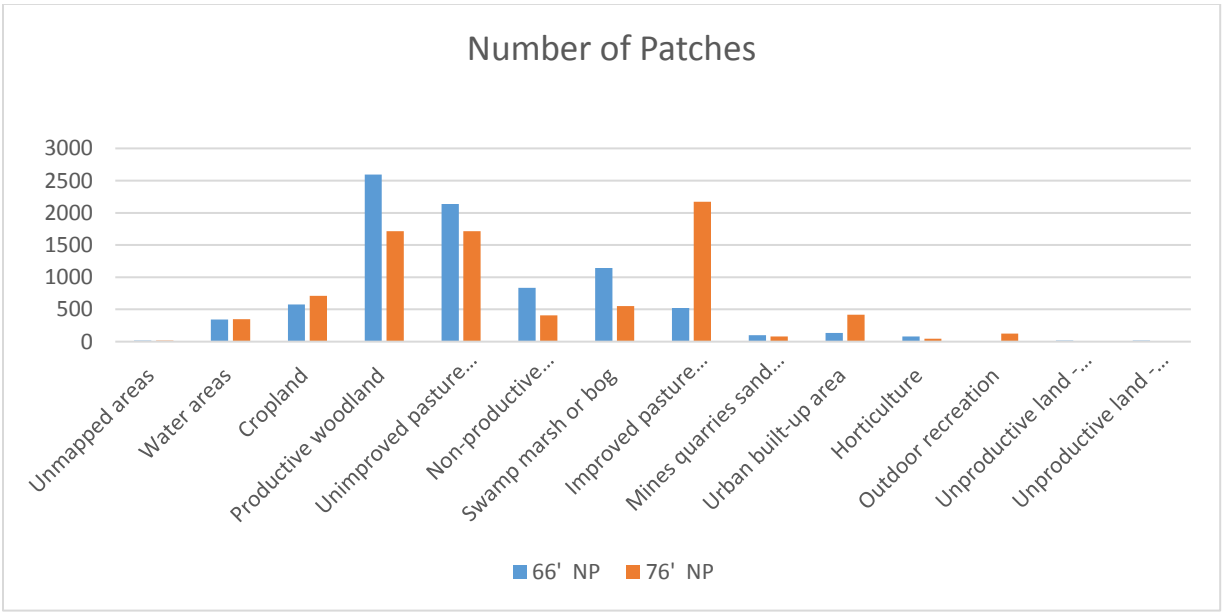

Figure 2- Number of patches of each class measured for years 1966 and 1976

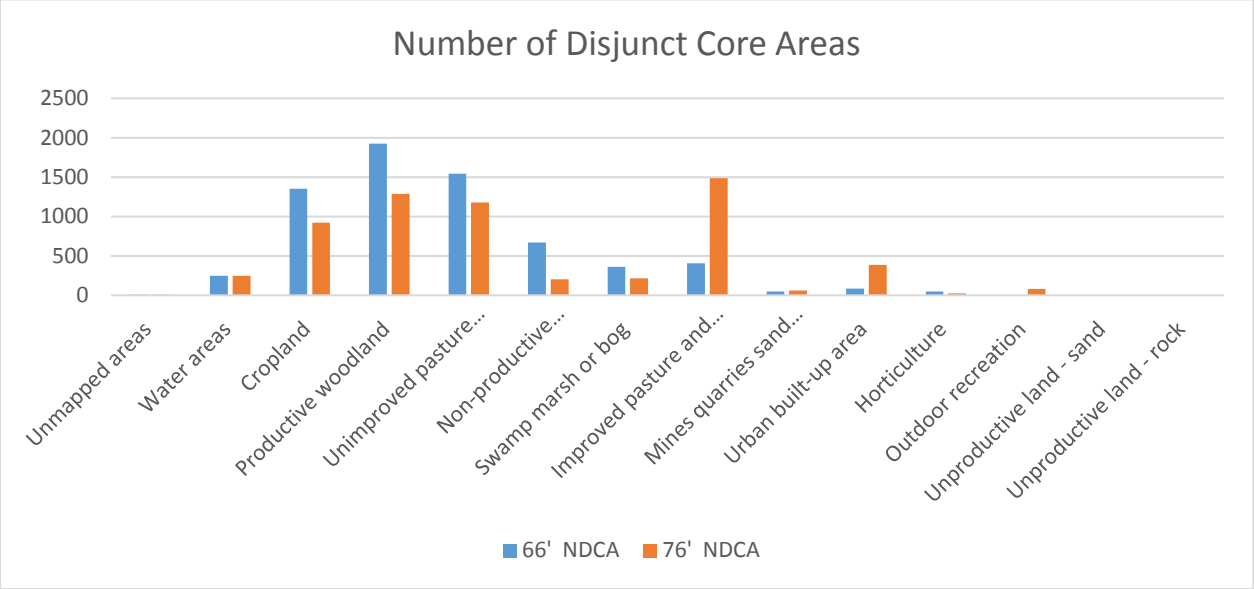

Figure 3-Number of disjunct core areas present in the landscape of Edmonton for 1966 and 1976

1966/1976	Cropland	Horticulture	Improved pasture and forage crops	Mines quarries sand and gravel pits	Non-productive woodland	Outdoor recreation	Productive woodland	Swampmarsh or bog	Unimproved pasture and range land	Unmapped areas	Unproductive landrock	Unproductive landsand	Urban built-up area	Water areas	Grand Total
Cropland	0.363693996	0.000980462	8.70141E-05	0.003071908	0.001171582	0.000947832	0.007492534	0.001651714	0.029381237	0	0	0	0.033219179	0	0.441697458
Horticulture	0	1.86459E-05	0	0	0	0	0	0	0	0	0	0	0	0	1.86459E-05
Improved pasture and forage crops	0.000693005	0	0.06863391	9.32294E-05	0.00020351	0	0.000553161	0.000114983	0.001561592	0	0	0	0.000747389	0	0.07260082
Mines quarries sand and gravel pits	0.000114983	0	0	0.001106322	0.000102552	0.000141398	0.000239289	0	0.000344949	0	0	0	0.000550053	0	0.002599546
Non-productive woodland	0.003738498	0	0	7.76911E-05	0.0025405	0.000680574	0.015294279	0.000136736	0.003937387	0	0	0	0.003197767	0	0.029603433
Outdoor recreation	0	0	0	0	0	0.002308981	0	0	0	0	0	0	0.0003824	0	0.002691221
Productive woodland	0.006577332	0	0	0.000175582	0.000626191	0.000916755	0.028173916	0.000118091	0.003238167	0	0	0	0.004285443	0	0.044111477
Swampmarsh or bog	0.003113861	0	0	0	0.001370472	0.000184905	0.002268581	0.004959803	0.0046008	0	0	0	0.001058153	0	0.017556645
Unimproved pasture and range land	0.030846492	0.000111875	0.000166259	0.000285903	0.005348258	0.00182885	0.038104398	0.002660145	0.02705361	0	0	0	0.011534027	0	0.117939817
Unmapped areas	0	0	0	0	0	0	0	0	0	0.209682181	0	0	0	0	0.209682181
Unproductive landrock	0	0	0	0	0	0	0.000192674	0	0	0	0	0	0	0	0.000192674
Urban built-up area	0	0	0	0	0	0	0	0	0	0	0	0	0.030430067	0	0.030430067
Water areas	0	0	0	0	0	0	0	0	0	0	0	0	0	0.030876014	0.030876014
Grand Total	0.408778167	0.001110983	0.068887183	0.004810636	0.011363107	0.007008295	0.092318832	0.009641471	0.070117811	0.209682181	0	0	0.08540432	0.030876014	1

Table 3- Transition matrix showing values of matrices divided by sum of 1976 class values. Depicts change in landscape from 1966 to 1976.

1966/1967	Cropland	Horticulture	Improved pasture and forage crops	Mines quarries sand and gravel pits	Non-productive woodland	Outdoor recreation	Productive woodland	Swamp marsh or bog	Uninproved pasture and range land	Unmapped areas	Unproductive landrock	Unproductive landsand	Urban built-up area	Water areas	Grand Total
Cropland	0.895709335	0.002398519	0.000212864	0.007514853	0.002866059	0.002318695	0.018329095	0.004040611	0.071875748	0	0	0	0.081264563	0	1.080530843
Horticulture	0	4.56137E-05	0	0	0	0	0	0	0	0	0	0	0	0	4.56137E-05
Improved pasture and forage crops	0.001695308	0	0.167900136	0.000228088	0.000497549	0	0.001353206	0.000281284	0.003820145	0	0	0	0.001828348	0	0.177604446
Mines quarries sand and gravel pits	0.000281284	0	0	0.002706411	0.000250875	0.000345904	0.000585375	0	0.000843853	0	0	0	0.001345803	0	0.006359307
Non-productive woodland	0.008145342	0	0	0.000150057	0.006214863	0.001648899	0.037414617	0.000033345	0.009632088	0	0	0	0.007822745	0	0.072419311
Outdoor recreation	0	0	0	0	0	0.005648493	0	0	0	0	0	0	0.000993508	0	0.006642001
Productive woodland	0.001609224	0	0	0.000429529	0.001531859	0.002242672	0.088922263	0.000288887	0.007921575	0	0	0	0.010483543	0	0.107910552
Uninproved pasture and ran	0.075460223	0.000273682	0.000406722	0.000699141	0.013085522	0.004473941	0.093215346	0.006507551	0.066181641	0	0	0	0.028215859	0	0.288517898
Unmapped areas	0	0	0	0	0	0	0	0	0	0.512948582	0	0	0	0	0.512948582
Unproductive landrock	0	0	0	0	0	0	0.000471341	0	0	0	0	0	0	0	0.000471341
Unproductive landsand	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Urban built-up area	0	0	0	0	0	0	0	0	0	0	0	0	0.074441518	0	0.074441518
Water areas	0	0	0	0	0	0	0	0	0	0	0	0	0	0.075532445	0.075532445
Grand Total	1	0.002717815	0.168519722	0.011768328	0.027797734	0.017146941	0.225840907	0.023586071	0.171530225	0.512948582	0	0	0.208925836	0.075532445	2.446314605

Table 4- Transition matrix showing values of matrices divided by sum of 1966 class values. Depicts differences per class between the years of 1966 and 1976.