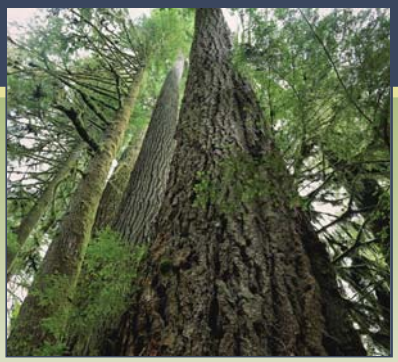
CAPITAL REGIONAL DISTRICT LAND COVER MAPPING - 1986, 2005 AND 2011



Summary Report

March 2013

Prepared by:

CASLYS CONSULTING

CAPITAL REGIONAL DISTRICT LAND COVER MAPPING
1986, 2005 AND 2011
SUMMARY REPORT

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EXECUTIVE SUMMARY

The Urban Forest Stewardship Initiative (UFSI) is a program of Habitat Acquisition Trust (HAT). It is a partnership of individuals, organizations and governments dedicated to the conservation, restoration and sustainable use of Greater Victoria's urban forest. Urban forests are treed landscapes found within a community. They include old-growth remnants, backyard fruit trees, urban parks and trail systems, Garry oak meadows, and treed boulevards.

In 2007, HAT sponsored a project to map the region's tree cover and impervious surface densities. To evaluate change over time this project considered two time periods – 1986 and 2005. As part of an ongoing effort to manage the region's tree cover, HAT identified the need to update dataset using 2011 imagery to quantify the impacts of recent development activities. In addition, the extent of the mapping was expanded beyond the original study area (the Core Municipal Study Area (CMSA)) to include the entire Juan de Fuca Electoral Area (mapped for only one time period). The portion of the Electoral Area falling outside the CMSA is subsequently referred to as Juan de Fuca West (JDFW). This report presents the updated results.

Land Cover

Table E1details the changes in the amount of area covered by both treed and impervious land covers. The results indicate a 2.9% increase in impervious surface over the six year time period with a 2.0 percent decrease in the amount of tree cover in the CMSA. The majority of JDFW consists of treed land cover (84.5%).

Table E1. Percentage of Tree Cover and Impervious Surface in the CMSA and JDFW

Major Land Cover Class	2005 Area (ha)	2005 % of CMSA	2011 Area (ha)	2011 % of CMSA/JDFW	Difference Area (ha)	% Change 2005 to 2011	% Difference 2005 to 2011
Core Municipal Area							
Treed	30,659.2	59.4%	29,621.4	57.4%	-1,037.8	-3.4%	-2.0%
Impervious	6,752.3	13.1%	8,254.5	16.0%	1,502.2	22.2%	2.9%
Juan de Fuca West							
Treed	-	-	124,446.1	84.5%	-	-	-
Impervious	-	-	812.7	0.6%	-	-	-

*Negative numbers indicate a decrease and positive an increase in the number of hectares within each class over the six year time period. Percent change quantifies change in the class (i.e., the difference between two time periods divided by the area of that class in the earlier time period), whereas percent difference compares the class to the overall composition in the area of interest (i.e., a 2011 % of CMSA value is subtracted from the 2005 value).

Tree Cover Density

The tree cover density statistics are based on the percentage of tree cover in each one-hectare grid cell. For interpretation purposes, the density values have been grouped into the following classes: 0-5, >5-10, >10-25, >25-50, >50-75, and >75. The tree cover density values were summarized for: the CMSA; each municipality; and for the parks within the study area. When interpreting the statistics it is important to consider the percent change in the context of the change in area – classes with small areas can have a large percentage changes.

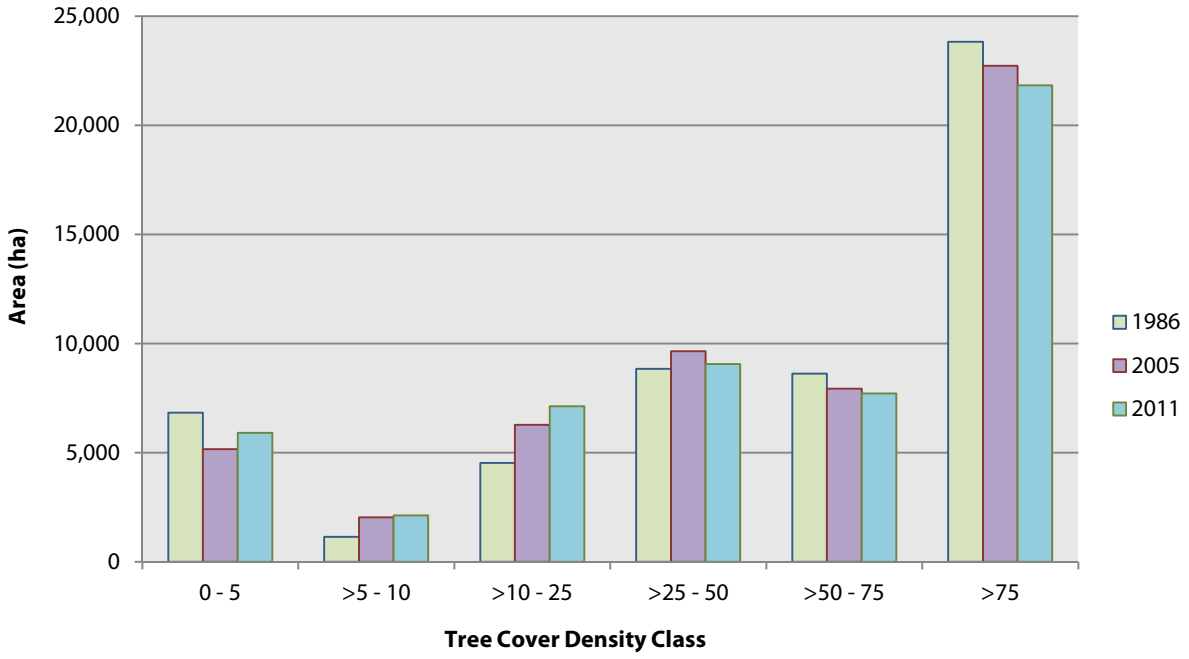
Tree cover density values in the CMSA for the three time periods are presented in Table E2 and illustrated in Figure E1.

Table E2. Tree Cover Density in the Core Municipal Study Area – 1986, 2005 and 2011

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of CMSA	Hectares	Percent of CMSA			Hectares	Percent of CMSA		
0 - 5	6,833	12.7%	5,159	9.6%	-1,674	-24.5%	5,906	11.0%	747	14.5%
>5 - 10	1,147	2.1%	2,034	3.8%	887	77.3%	2,129	4.0%	95	4.7%
>10 - 25	4,523	8.4%	6,270	11.7%	1,747	38.6%	7,118	13.2%	848	13.5%
>25 - 50	8,835	16.4%	9,643	17.9%	808	9.1%	9,063	16.9%	-580	-6.0%
>50 - 75	8,623	16.0%	7,931	14.8%	-692	-8.0%	7,709	14.3%	-222	-2.8%
>75	23,835	44.3%	22,729	42.3%	-1,106	-4.6%	21,841	40.6%	-888	-3.9%
Total	**53,796**	**100.0%**	**53,766**	**100.0%**			**53,766**	**100.0%**		

*Negative numbers indicate a decrease and positive an increase in the number of hectares within each class over the six year time period. Percent change quantifies change in the class (i.e., the difference between two time periods divided by the area of that class in the earlier time period), whereas percent difference compares the class to the overall composition in the area of interest (i.e., a 2011 % of CMSA value is subtracted from the 2005 value).

Figure E1. Tree Cover Density Class Frequency in the Core Municipal Study Area – 1986, 2005 and 2011



Between 1986 and 2005, the results indicate that:

- The number of cells that are primarily unforested (0-5% tree cover) are decreasing by 24.5% which could be a result of an increase in the number or trees planted or regrowth in urban or rural cleared areas, however, an inspection of the results indicates that this is primarily due to resolution issues associated with the 1986 imagery.

- The number of very high density forest cells (>75% tree cover) is decreasing during this time period by 4.6% (1,106 ha). These areas represent the removal of relatively intact forest from the landscape generally due to urban and agricultural expansion.

The changes between 2005 and 2011 indicate a trend toward lower density tree stands in the CMSA:

- The three higher density classes are all decreasing while the three lower density classes are all increasing.
- The rate of change in the highest density class (>75% tree cover) appears to be increasing – in the 19 years between 1986 and 2005 the loss was 58.2 ha per year, whereas in the six years between 2005 and 2011 the rate of loss was 148.0 ha per year

As indicated in Table E3, the vast majority of JDFW falls within the top two tree cover density class – 83.3% of the land base has a tree cover greater than 75% and 8.6% of the land base falls in the >50-75% class.

Table E3. Tree Cover Density in Juan de Fuca West

Tree Cover Density Class (%)	Hectares	Percent of JDFW
0 - 5	2,715	1.8%
>5 - 10	1,182	0.8%
>10 - 25	2,776	1.9%
>25 - 50	5,299	3.6%
>50 - 75	12,683	8.6%
>75	122,891	83.3%
Total	**147,546**	**100.0%**

The two most densely treed classes (>50–75% and >75%) were grouped to examine the change in tree cover density between the three time periods within each of the municipalities. As indicated in Table E4 and Figure E2, the municipalities with the largest absolute change in these two classes were: Saanich (a loss of 585 ha); Langford (a loss of 452 ha); and Colwood (a loss of 429 ha). The three municipalities with the highest percentage change from 1986 in tree cover density are Colwood (a 24.2% decrease), View Royal (a 11.3% decrease); and Langford (a 11.0% decrease). The change in Colwood is potentially more significant because it represents both a relatively large absolute and high percentage change. The results indicate a total reduction of 2,025 ha in the two most densely treed classes between 1986 and 2011 within the municipalities.

Table E4. Change in Tree Cover Densities Greater than 50% by Municipality – 1986 to 2011

Municipality	Area of the Municipality (ha)	1986 Tree cover density >50% (ha)	2005 Tree cover density >50% (ha)	2011 Tree cover density >50% (ha)	Difference 1986 to 2011	% Change from 1986 to 2011
Central Saanich	4,167	1,164	1,141	1,072	-92	-2.2%
Colwood	1,770	1,057	679	628	-429	-24.2%
Esquimalt	705	70	87	74	4	0.6%
Highlands	3,814	3,467	3,577	3,534	67	1.8%
Juan de Fuca EA (in CMSA)	4,315	4,039	4,121	4,105	66	1.5%
Langford	4,099	2,984	2,694	2,532	-452	-11.0%
Metchosin	6,978	5,800	5,727	5,685	-115	-1.6%
North Saanich	3,721	1,739	1,659	1,582	-157	-4.2%
Oak Bay	1,045	250	239	196	-54	-5.2%
Saanich	10,708	4,775	4,602	4,190	-585	-5.5%
Sidney	514	20	15	14	-6	-1.2%
Sooke	5,079	3,988	3,983	3,888	-100	-2.0%
Victoria	1,946	107	140	105	-2	-0.1%
View Royal	1,503	1,143	1,014	973	-170	-11.3%
TOTAL	**50,364**	**30,603**	**29,678**	**28,578**	**-2,025**	

*Negative numbers indicate a decrease and positive an increase in the number of hectares within each class over the six year time period. Percent change quantifies change in the class (i.e., the difference between two time periods divided by the area of that class in the earlier time period).

Figure E2. Area of Tree Cover Density Greater than 50% within each Municipality – 1986, 2005 and 2011

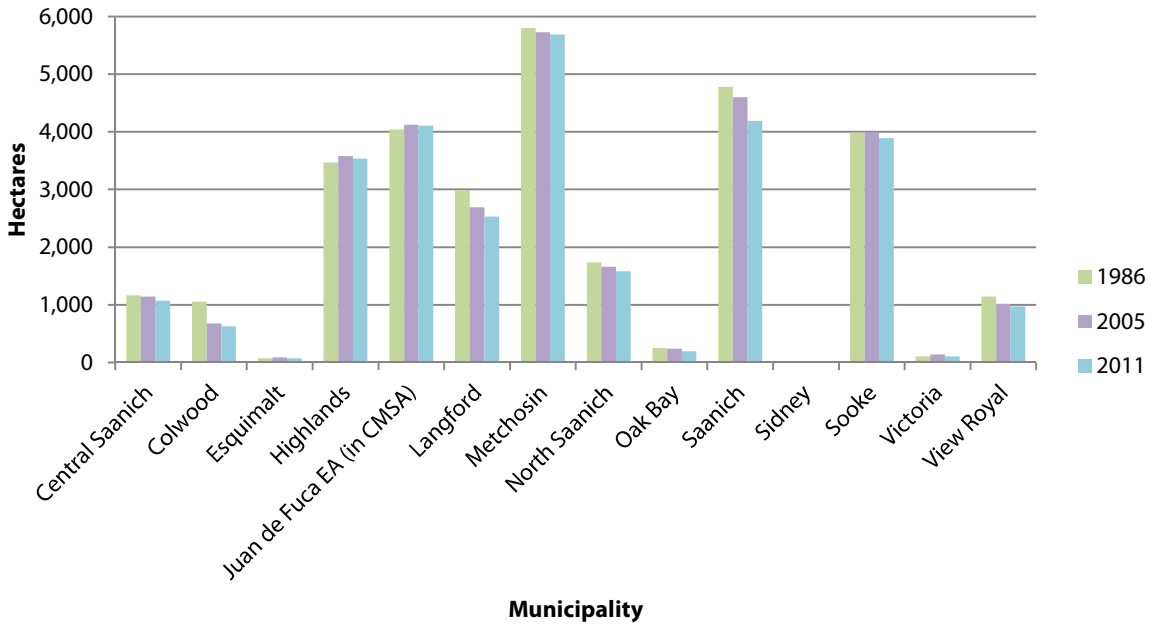


Figure E3 maps the locations with the highest change in tree cover density (a reduction in density of two classes or more) between the two time periods.

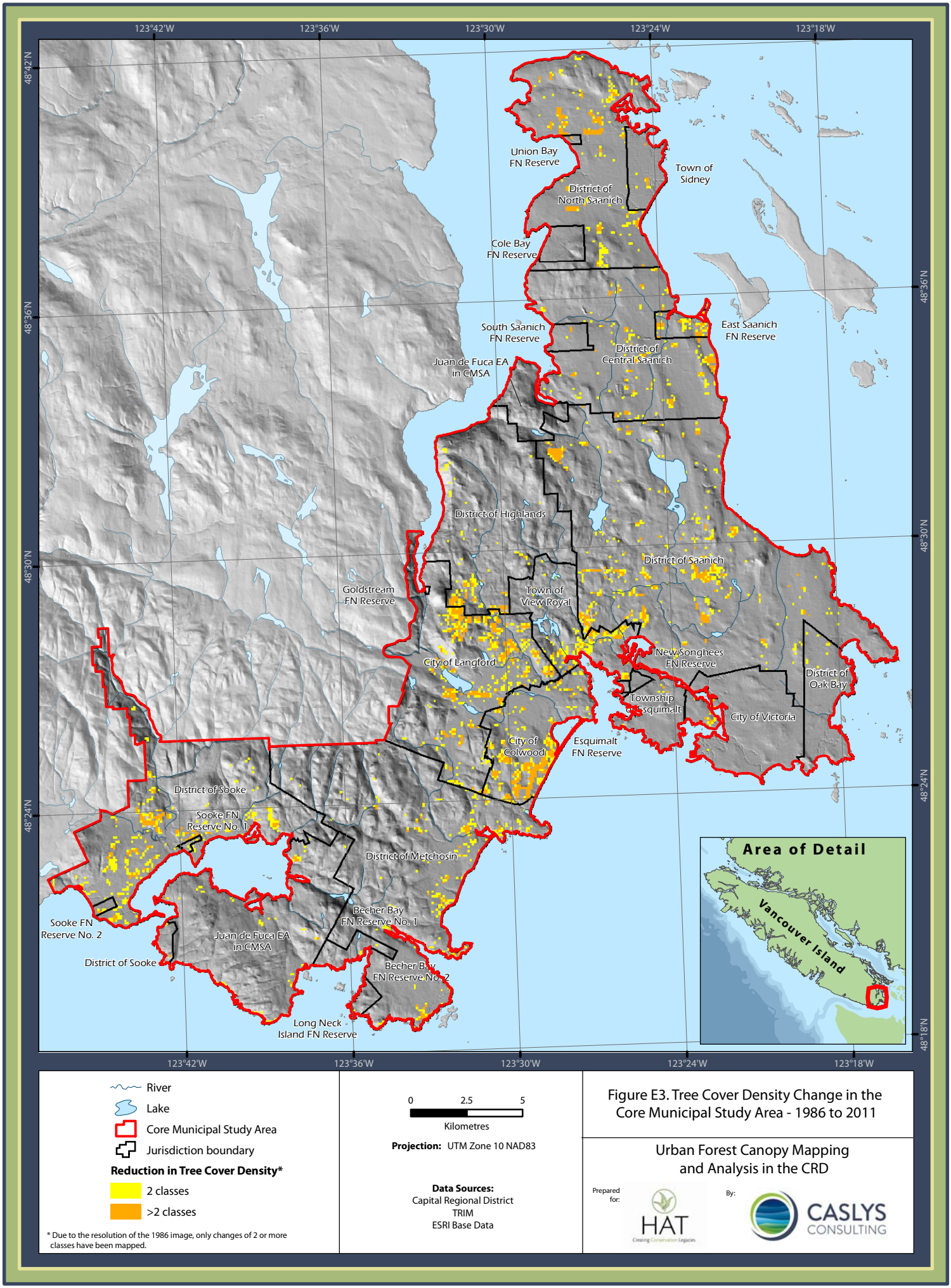


Figure E3. Tree Cover Density Change in the Core Municipal Study Area - 1986 to 2011

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT

By: CASLYS CONSULTING

Impervious Surface Density

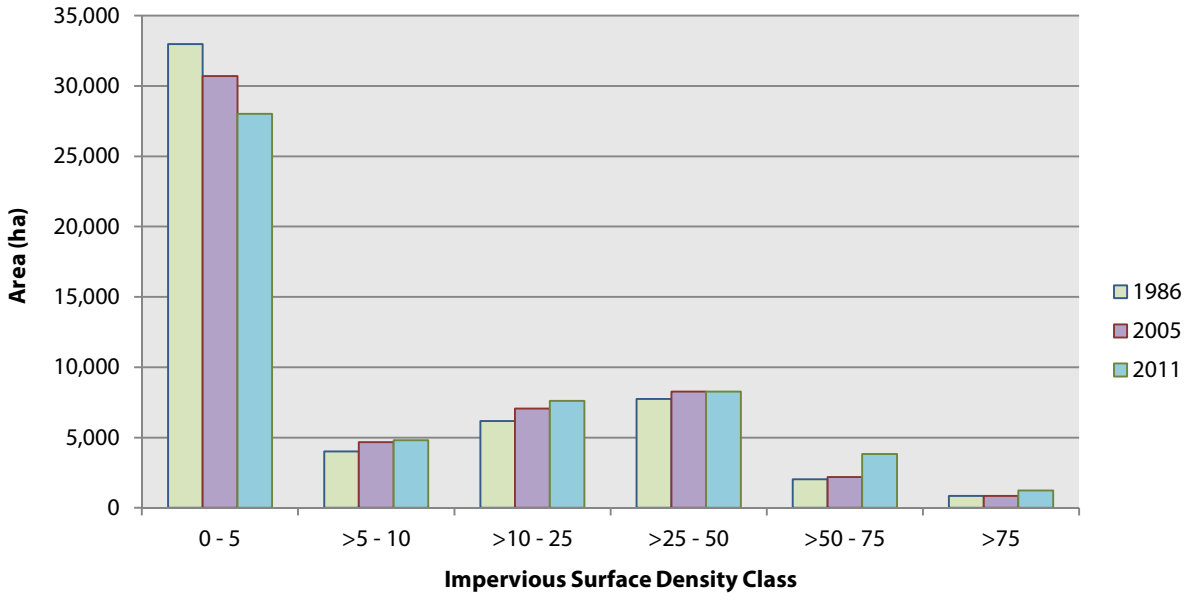
Impervious surface density values for the three time periods for the study area are presented in Table E5 and illustrated in Figure E4. The results indicate a consistent increase in impervious surface throughout the CMSA between 1986 and 2011. The number of cells with minimal impervious surface (the 0-5 % class) decreased by 8.7%. In other words, there are 2,678 hectares where pervious surfaces, present in 1986, have been replaced with enough impervious surface to move these cells into a higher density class in the 2011 time period. All of the other classes indicate an increase in density with 376 hectares moving to the very highly developed (>75%) class.

Table E5. Impervious Surface Density in the Core Municipal Study Area – 1986, 2005 and 2011

	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
Impervious Surface Density Class (%)	Hectares	Percent of CMSA	Hectares	Percent of CMSA			Hectares	Percent of CMSA		
0 - 5	32,976	61.3%	30,700	57.1%	-2,276	-6.9%	28,022	52.1%	-2,678	-8.7%
>5 - 10	4,020	7.5%	4,679	8.7%	659	16.4%	4,812	8.9%	133	2.8%
>10 - 25	6,180	11.5%	7,069	13.1%	889	14.4%	7,604	14.1%	535	7.6%
>25 - 50	7,739	14.4%	8,276	15.4%	537	6.9%	8,262	15.4%	-14	-0.2%
>50 - 75	2,042	3.8%	2,184	4.1%	142	7.0%	3,832	7.1%	1,648	75.5%
>75	839	1.6%	858	1.6%	19	2.3%	1,234	2.3%	376	43.8%
Total	**53,796**	**100.0%**	**53,766**	**100.0%**			**53,766**	**100.0%**		

*Negative numbers indicate a decrease and positive an increase in the number of hectares within each class over the six year time period. Percent change quantifies change in the class (i.e., the difference between two time periods divided by the area of that class in the earlier time period), whereas percent difference compares the class to the overall composition in the area of interest (i.e., a 2011 % of CMSA value is subtracted from the 2005 value).

Figure E4. Impervious Surface Density Class Frequency in the CMSA – 1986, 2005 and 2011



The two most densely impervious classes (>50–75% and >75%) were grouped to examine the change in impervious surface density between the two time periods within each of the municipalities. As indicated in Table E6 and Figure E5, the municipalities with the largest absolute change in these two classes were: Saanich (an increase of 1,148 ha); Langford (an increase of 282 ha); and Victoria (an increase of 188 ha). The municipalities with the highest percentage change in impervious surface density are Sooke (a 220.5% increase), Metchosin (a 200.0% increase) and Saanich (a 169.6% increase). The results indicate a total increase of 2,223 ha in the two highest impervious surface density classes within the municipalities in the study area.

Table E6. Change in Impervious Surface Densities Greater than 50% by Municipality – 1986 to 2011

Municipality	Area of the Municipality (ha)	1986 Impervious density >50% (ha)	2005 Impervious density >50% (ha)	2011 Impervious density >50% (ha)	Difference 1986 to 2011	% Change from 1986 to 2011
Central Saanich	4,167	151	169	246	95	62.9%
Colwood	1,770	106	102	193	87	82.1%
Esquimalt	705	201	202	247	46	22.9%
Highlands	3,814	13	18	27	14	107.7%
Juan de Fuca EA (in CMSA)	4,315	0	0	0	0	0.0%
Langford	4,099	268	335	550	282	105.2%
Metchosin	6,978	5	5	15	10	200.0%
North Saanich	3,721	117	148	202	85	72.6%
Oak Bay	1,045	66	65	100	34	51.5%
Saanich	10,708	677	734	1,825	1,148	169.6%
Sidney	514	195	195	250	55	28.2%
Sooke	5,075	39	52	125	86	220.5%
Victoria	1,946	868	868	1,056	188	21.7%
View Royal	1,503	72	105	165	93	129.2%
TOTAL	**50,360**	**2,778**	**2,998**	**5,001**	**2,223**	

*Negative numbers indicate a decrease and positive an increase in the number of hectares within each class over the six year time period. Percent change quantifies change in the class (i.e., the difference between two time periods divided by the area of that class in the earlier time period).

Figure E5. Area of Impervious Surface Density Greater than 50% within each Municipality – 1986, 2005 and 2011

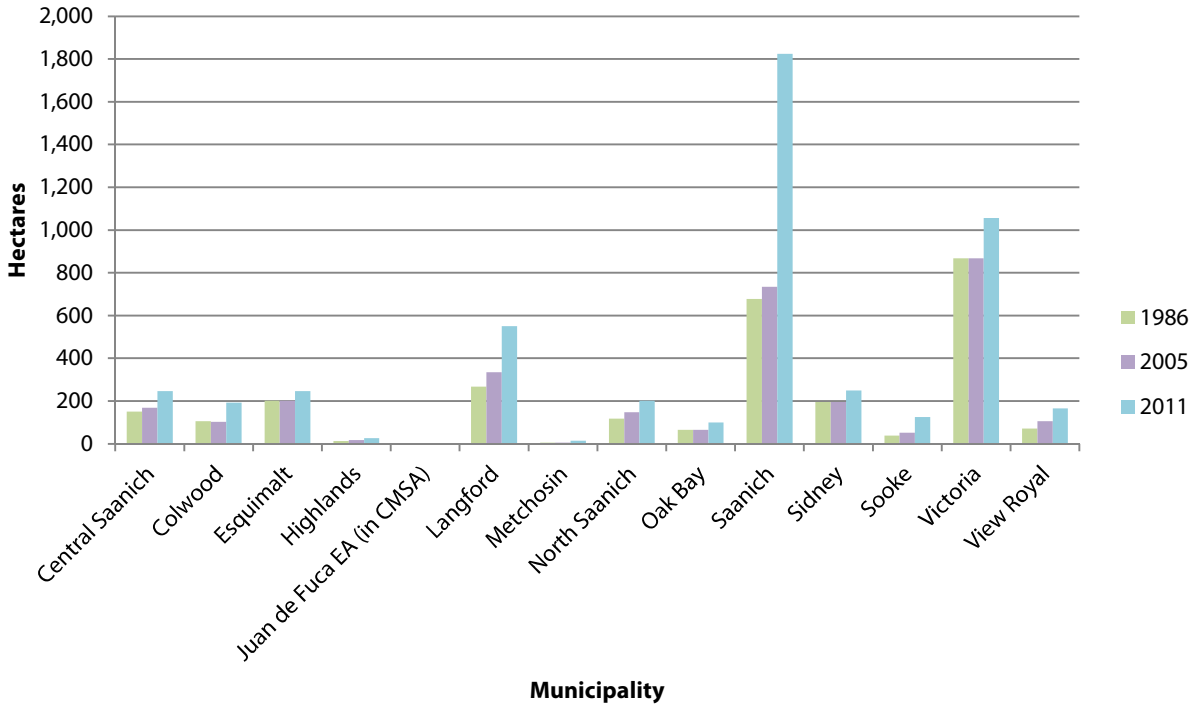


Figure E6 maps the locations with the highest increase in impervious surface density (an increase in density of two classes or more) between the two time periods.

Summary

When interpreting the data, it is important to remember that a decrease in tree cover density does not always represent a corresponding increase in impervious surface density - trees may be replaced by impervious surfaces (e.g., buildings or roads) or by pervious surface (e.g., grass or agricultural fields). When we examine the change in both tree cover and impervious surface density any assumptions should be interpreted with caution[1]. More detailed mapping should be conducted in key areas to confirm what things are changing from and to. The results do allow us to identify the following trends:

- Both tree cover and tree cover densities are decreasing; and
- The amount of impervious surface and impervious surface densities are increasing.

[1] Section 1.3 details the limitations of the data used in the study.

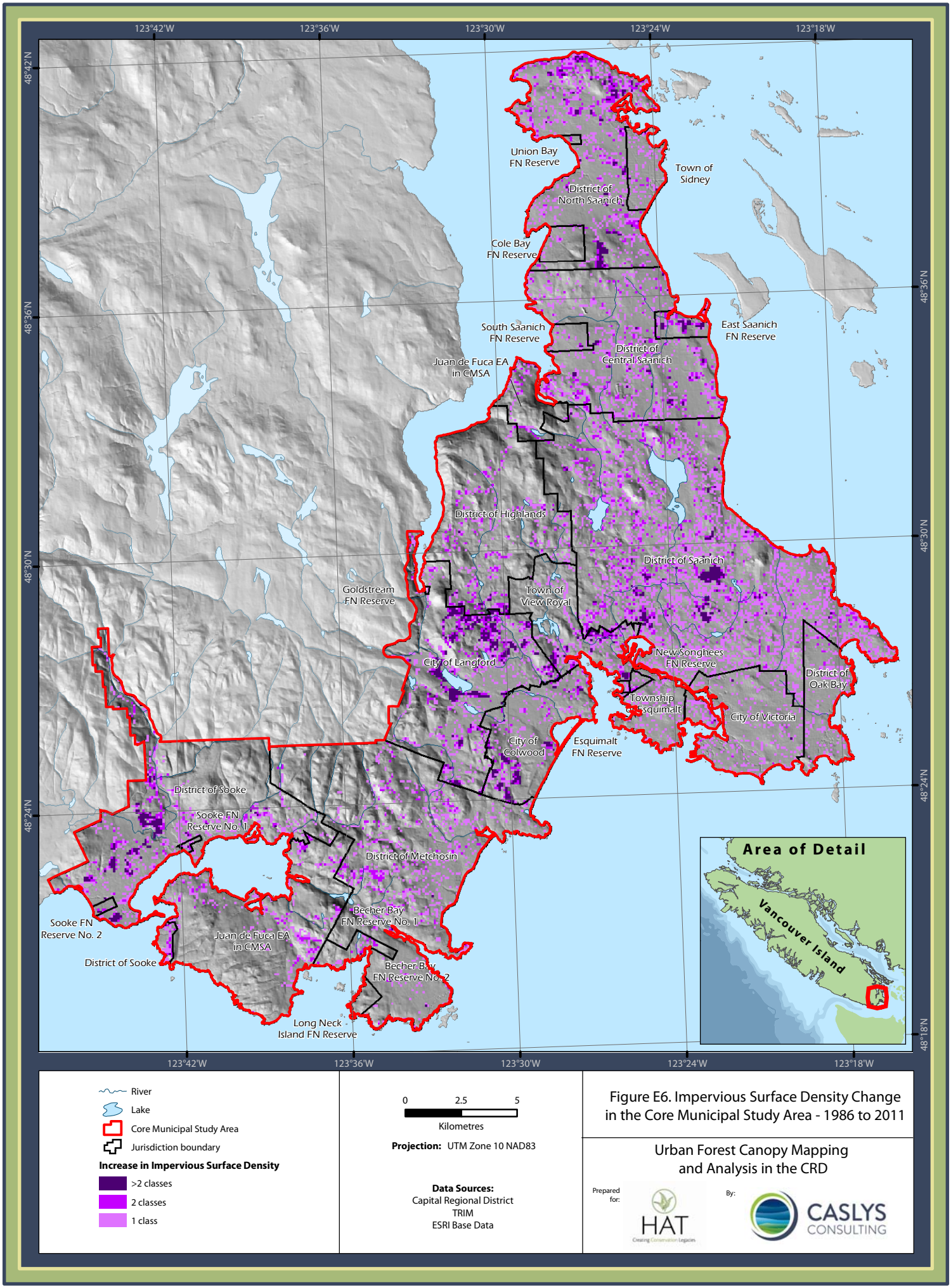


Figure E6. Impervious Surface Density Change in the Core Municipal Study Area - 1986 to 2011

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT Creating Conservation Legacies

By: CASLYS CONSULTING

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1.0 INTRODUCTION

1.1 Background

In 2007 Habitat Acquisition Trust (HAT) sponsored a project to map the density of the Capital Regional District's (CRD) urban forest and impervious surfaces[2]. Urban forests are treed landscapes found within a community. They include old-growth remnants, backyard fruit trees, urban parks and trail systems, Garry oak meadows, and treed boulevards. Impervious surfaces include paved areas (e.g., roads, parking lots, and driveways) and buildings. The density statistics were summarized using a one-hectare grid – the percentage of tree cover or impervious surface in each one-hectare grid cell. To examine trends over an approximate twenty year span, the mapping was conducted for two time periods: 1986 and 2005.

The approach used to quantify the density values was to classify a digital air photo for each of the time periods. For the 1986 time period impervious surfaces and tree covers were identified and the density values summarized to the one-hectare grid. The 2005 image was of a higher quality so a complete land cover dataset could be generated. The 2005 land cover product provided a baseline for the land cover of the region as it allows specific features (or groups of similar features) to be identified.

As part of an ongoing effort to manage the region's tree cover, HAT identified the need to update the land cover dataset based on more recent 2011 imagery to quantify the impacts of recent development activities. This involved a comparison of the 2005[3] and 2011 land cover datasets and the examination of tree cover and impervious surface density statistics for the resultant three time periods: 1986, 2005 and 2011[4]. This report summarizes the methods used to conduct the mapping and presents some of the key findings.

1.2 Study Area

The study area for the project includes the following municipalities within the Capital Regional District:

- Town of Sidney;
- District of North Saanich;
- District of Central Saanich;
- District of Highlands;
- District of Saanich;
- District of Oak Bay;
- City of Victoria;
- Township of Esquimalt;
- Town of View Royal;
- City of Colwood;
- City of Langford;
- District of Metchosin;

[2] Details on the CRD-wide project may be found in the report *Urban Forest Canopy Mapping and Analysis in the CRD 1986-2005 - Summary Report.*

[3] The original 2005 classification was updated to remove as many inaccuracies (e.g., shadow) as possible .

[4] The original 1986 and 2005 time periods were selected to examine change over an approximate 20-year time span however, as with 2011 time period, the selection of each year was also a function of the vintages of air photo imagery available for the study area.

- District of Sooke;
- the portions of the Juan de Fuca Electoral Area covered by the Willis Point and East Sooke areas; and
- a number of First Nations reserves.

Land cover for this area has been mapped for two different time periods: 2005 and 2011. Tree cover and impervious surface density values have been determined for these two points in time and 1986. For the purposes of this report, this portion of the study area will subsequently be referred to as the Core Municipal Study Area (CMSA) (Figure 1).

As part of the 2011 update, the extent of the mapping was expanded to cover the entire Juan de Fuca Electoral Area. This mapping was conducted using a combination of air photo imagery taken in both 2005 and 2011 because the 2011 coverage was not complete for the entire Electoral Area (i.e., the 2011 imagery was used where available and gaps were filled with the 2005 imagery). A portion of the electoral area overlaps the core municipalities. This area of overlap has been excluded from any statistical summaries generated for the electoral area and therefore, to minimize any potential confusion arising from this division, the expansion is subsequently referred to as Juan de Fuca West (JDFW) (Figure 2).

1.3 Data Limitations

The following limitations are associated with the various source and derivative data layers:

- All classification-based datasets derived from remotely sensed imagery (e.g., air photos) have an inherent level of error. Typically, the accuracy threshold for land use or land cover datasets is 80%. In this study, we were able to achieve accuracies significantly above this threshold – ranging from 94.0% to 97.8% (see Section 2.4) however, it should be understood that a level of error is present in the data and therefore the resultant summary statistics.
- Shadow, present in the source air photos, meant that portions of the image could not be classified. These areas have been identified as a shadow in both the 2005 and 2011 land cover datasets. Where possible, areas of shadow present in one time period have been classified using values from the other time period. This allowed the accuracy of the original 2005 classification to be improved significantly however, it means the results of this study are not directly comparable with those of the previous one (Caslys, 2007). While the overall trends are similar, there is variation in both the land cover and density statistics. It is important to note that this variation results in movement between the classes (i.e., a one-hectare cell might be in the >10-25% class in one time period and in the >25-50% class in another). Often this is a result of the values in one of the studies being on the cusp between classes (e.g., 24% in one and 26% in the other would result in movement from one class to the other). The values are not lost – there are just small movements between the classes.
- The method used to summarize the area of each jurisdiction falling into each density class was improved. In the previous study, the statistics included all one-hectare cells both falling within and intersecting the jurisdiction boundary. As a result, the one-hectare cells overlapping multiple jurisdictions (i.e., those along the jurisdiction boundaries) were counted more than once. In this study – the majority of each one-hectare cell had to fall within the jurisdiction. The application of this approach resolved the

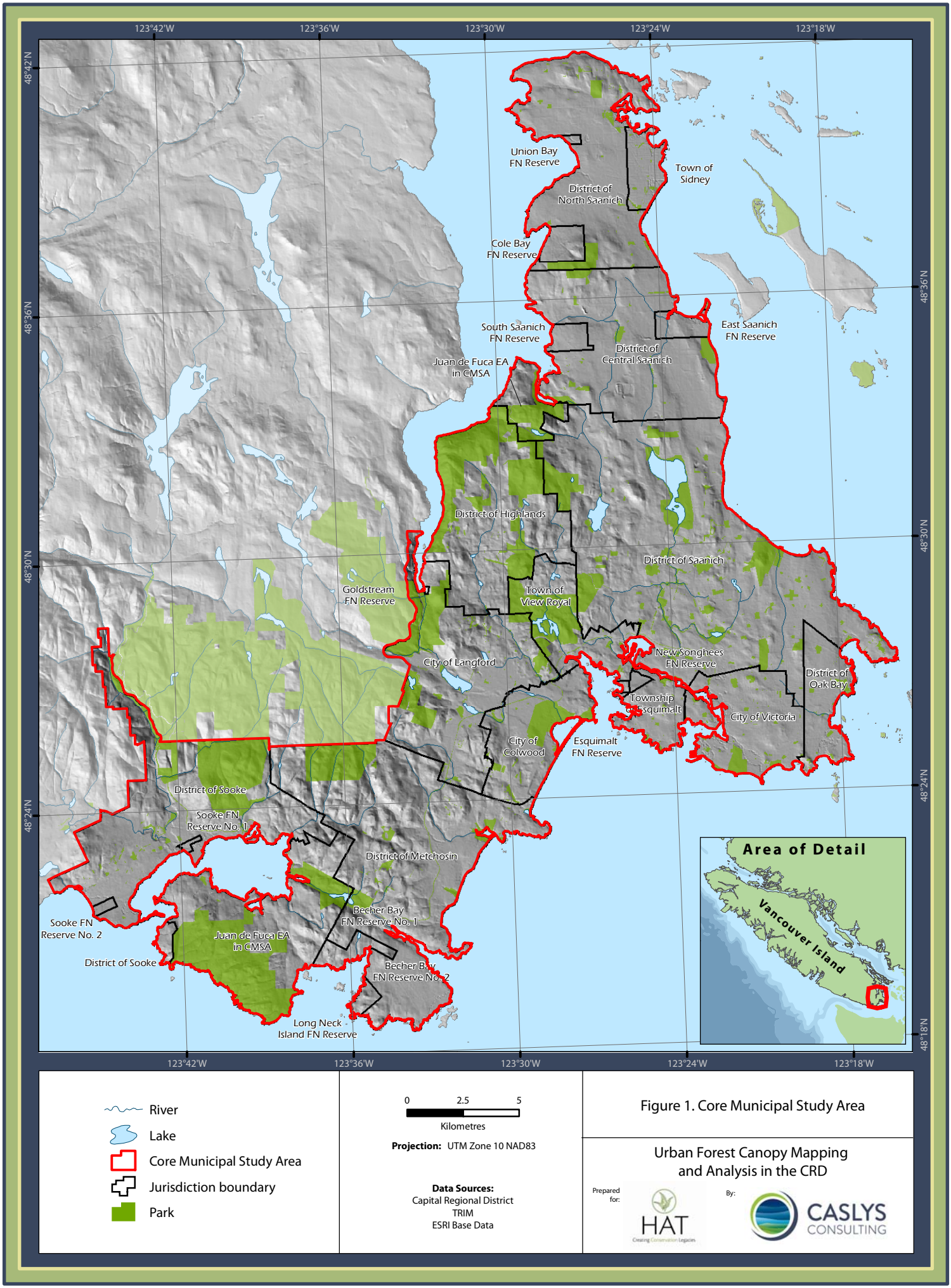

Figure 1. Core Municipal Study Area

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT

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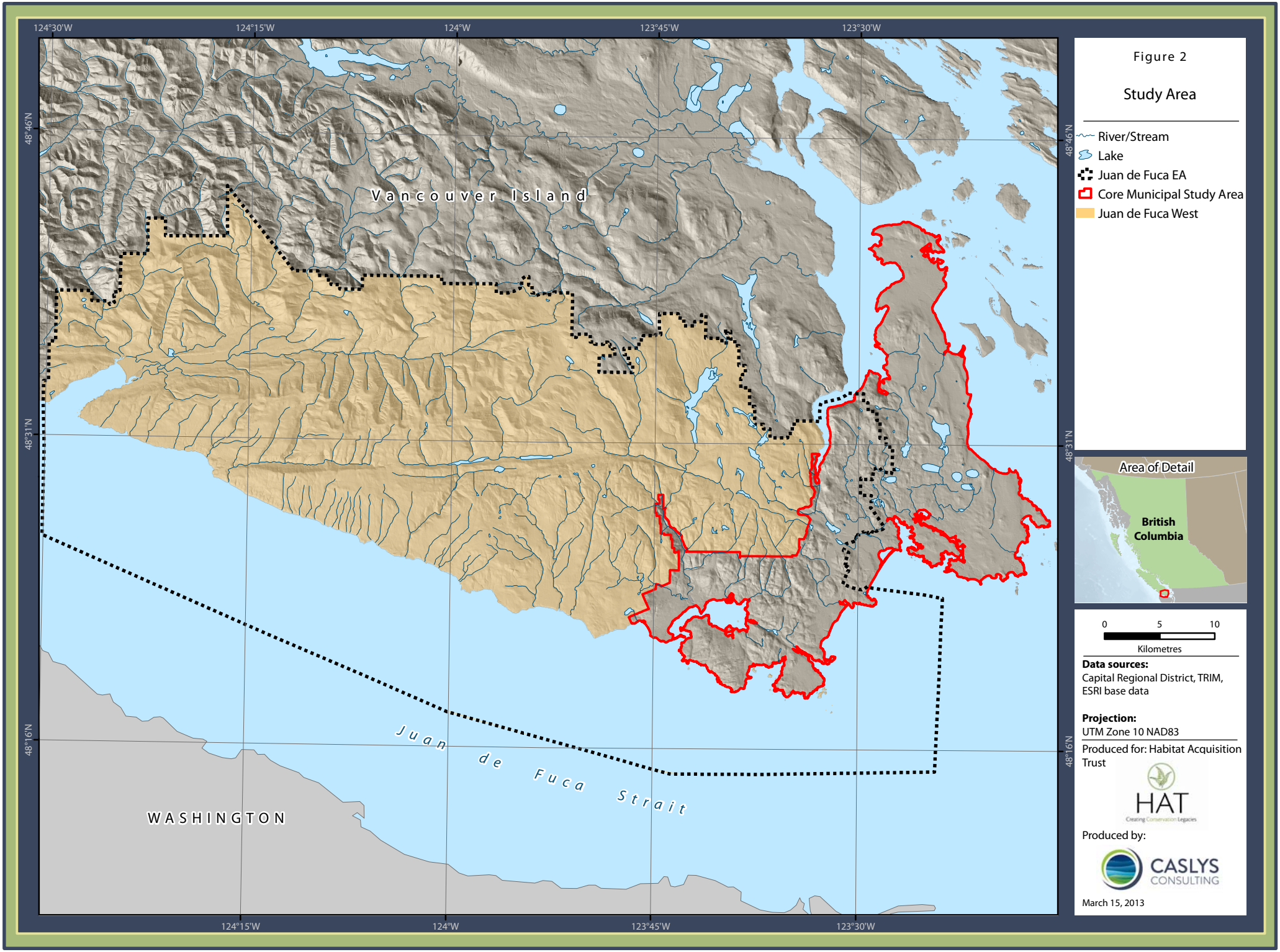

124°30'W
124°15'W
124°W
123°45'W
123°30'W
48°46'N
48°31'N
48°16'N
Vancouver Island
Juan de Fuca Strait
WASHINGTON
Figure 2
Study Area
River/Stream
Lake
Juan de Fuca EA
Core Municipal Study Area
Juan de Fuca West
Area of Detail
British Columbia
0
5
10
Kilometres
Data sources:
Capital Regional District, TRIM, ESRI base data
Projection:
UTM Zone 10 NAD83
Produced for: Habitat Acquisition Trust
HAT
Creating Conservation Legacies
Produced by:
CASLYS CONSULTING
March 15, 2013

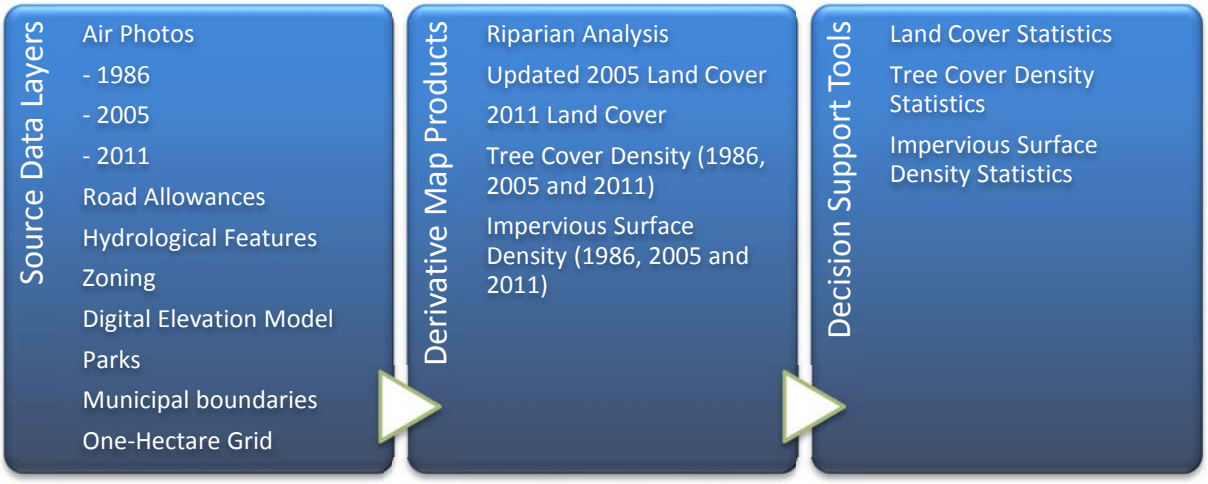
- double-counting issue but it should be noted that the density summaries are not directly comparable between the two reports due to this change.
- As detailed in Caslys 2007, the 1986 source imagery had some significant limitations:
    - The digital image was derived from multiple sources and time periods (the colour portion of the image was based on 1986 imagery whereas the portion of the study area derived from black and white hard copy images was from photos taken in 1987).
    - The resolution of the imagery did not facilitate the identification of smaller patches of trees and impervious surface. This issue has the greatest impact on the 0-5% class for both tree density and impervious surface density because this class represents areas where cells with just a few small features would fall within. To help mitigate this issue it was assumed that established urban areas with a increase in tree cover between 1986 and 2005 were small patches of treed land cover assumed to be present (but not visible due to resolution issues) in the 1986 land cover and, therefore, the 2005 tree cover density attribute was assigned to the 1986 value for the cell. This assumption means that some areas of regrowth between the two time periods may be overlooked. The second assumption applied to one-hectare cells having higher levels of impervious surface in 1986 than in 2005. In these instances, the 2005 density values were applied to the 1986 value for the cell because it was assumed that impervious surface was not decreasing over time[5].
    - The 1986 image was not orthorectified and, as a result, small spatial inaccuracies are present throughout the image.
- The 2011 land cover data is derived from 2011 imagery and does not reflect land use changes over the last two years (i.e., 2011 to 2013). Areas that have been cleared for development or those recently developed may represent significant changes to the land base.
- There are slight area differences between some of the statistical summaries presented in the tables. These differences are a function of scale and rounding errors.
- The maps in the report portraying the results for the entire study area generalize the data being displayed to fit the map on an 8.5" x 11" page size. The true detail of the land cover data is discussed in Section 2.2.2.
- The 2011 image was taken in the spring and therefore not all trees were in full leaf. As a result, tree cover values in areas where deciduous species are dominant may be underestimated.
- The 2005 image was taken later in the summer during a drier year that 2011. As a result, there are variations between the two classifications. For example, some areas of herbaceous vegetation classified correctly in 2005 are classified as young trees in the 2011 time period because of moisture differences. This variation can also cause confusion between similar classes within a single time period, for example, in dry years drier grasses can be confused with exposed soil.
- Snow was present at higher elevations in portions of the 2011 imagery (in the JDFW portion of the study area) and therefore the underlying land cover could not be classified (it has been classified as snow).
- The JDFW dataset was derived from both 2005 and 2011 imagery because only portions of the study area were flown in 2011. As a result, portions of the land cover mapping are eight years out of date.
- A land cover classification was developed for the District of Saanich using 2009 imagery. The tree cover and tree cover density statistics in this report are not directly comparable with the results of the 2009 mapping because the results of the classification vary slightly due to differences in the source imagery.

[5] The changes were implemented using the 2005 classification generated in the previous project.

2.0 METHODS

The following task descriptions detail the technical approach taken to develop the various derivative datasets for the study area. The analysis work was conducted in PCI Geomatica and ESRI's ArcMap. The raster-based components of the analysis were conducted using ArcMap's Spatial Analyst extension. Figure 3 summarizes the various source data layers, derivative map products and the resultant decision support tools.

Figure 3. Land Cover Mapping Overview



2.1 Source Data Layers

The following datasets, each clipped to a polygon defining the extent of the study area, represent the source data layers used in the analysis:

2.1.1 Air Photos

1986 Imagery

A low resolution colour image for the 1986 time period was available in digital format for approximately 2/3 of the study area – covering the Saanich Peninsula, Victoria and Esquimalt. The image was provided at a resolution of 1 metre, however the effective resolution of the imagery was approximately 10-20 metres as the source image was a manually constructed mosaic of colour imagery based on 1986 photography. The supplied image was not georeferenced. To ensure comparisons between the two time periods were as accurate as possible the 1986 imagery was georeferenced to the 2005 imagery – to increase the internal consistency of the source data. This image was used to identify impervious surface and tree cover for this portion of the study area for the 1986 time period[6].

2005 Imagery

Digital colour orthophoto imagery for the 2005 time period was provided by the Capital Regional District. The air photo was taken in the summer of 2005 and was supplied at a resolution of 10 cm (i.e., each pixel in the image was 10 cm by 10 cm). The imagery was provided as a series of tiles covering the study area. To develop the original land cover classification the imagery was generalized to a resolution of 1 metre (i.e., each pixel in the

[6] The processing of the 1986 imagery was a component of the 2007 project.

image was 1 metre by 1 metre) and the tiled images merged into a single image covering the extent of the CMSA. This allowed a seamless land cover product to be developed for the entire area. The resolution of the imagery was reduced to decrease file size and to facilitate the development of the land cover product as the original 10 cm resolution was too detailed for classification purposes. As part of this project, the land cover classes derived in the previous project (Caslys, 2007) were updated and re-classified to refine the 2005 land cover classification.

2011 Imagery

The CRD supplied a digital colour orthophoto taken in the spring[7] of 2011 (Figure 4). These images were supplied at three different resolutions (10, 30 and 50 centimetres) and were resampled to a resolution of one metre to provide a seamless dataset. The resampled image was used as the basis of the 2011 land cover classification. The extent of the 2011 imagery included the CMSA, however, only partial coverage was available for JDFW. The 2005 imagery was used to fill in these gaps in coverage (Figure 4).

2.1.2 Road Allowances

A dataset identifying road allowances within the Region was supplied by the CRD's GIS department. This data was used to assist in the identification of paved surfaces.

2.1.3 Hydrological Features

The CRD supplied a dataset mapping hydrological features. These included polygonal features such as lakes, ponds and wetlands; and linear features delineating streams. The data were used to refine the land cover datasets for both time periods and were also used to model the riparian habitat.

2.1.4 Zoning

The CRD supplied a zoning layer that was used to refine the land cover information. For example, a pixel identified as soil in a rural zone was labelled as agriculture (i.e., a fallow field), whereas that same pixel value in an residential or commercial zone was labelled as exposed soil because it typically represents a construction site.

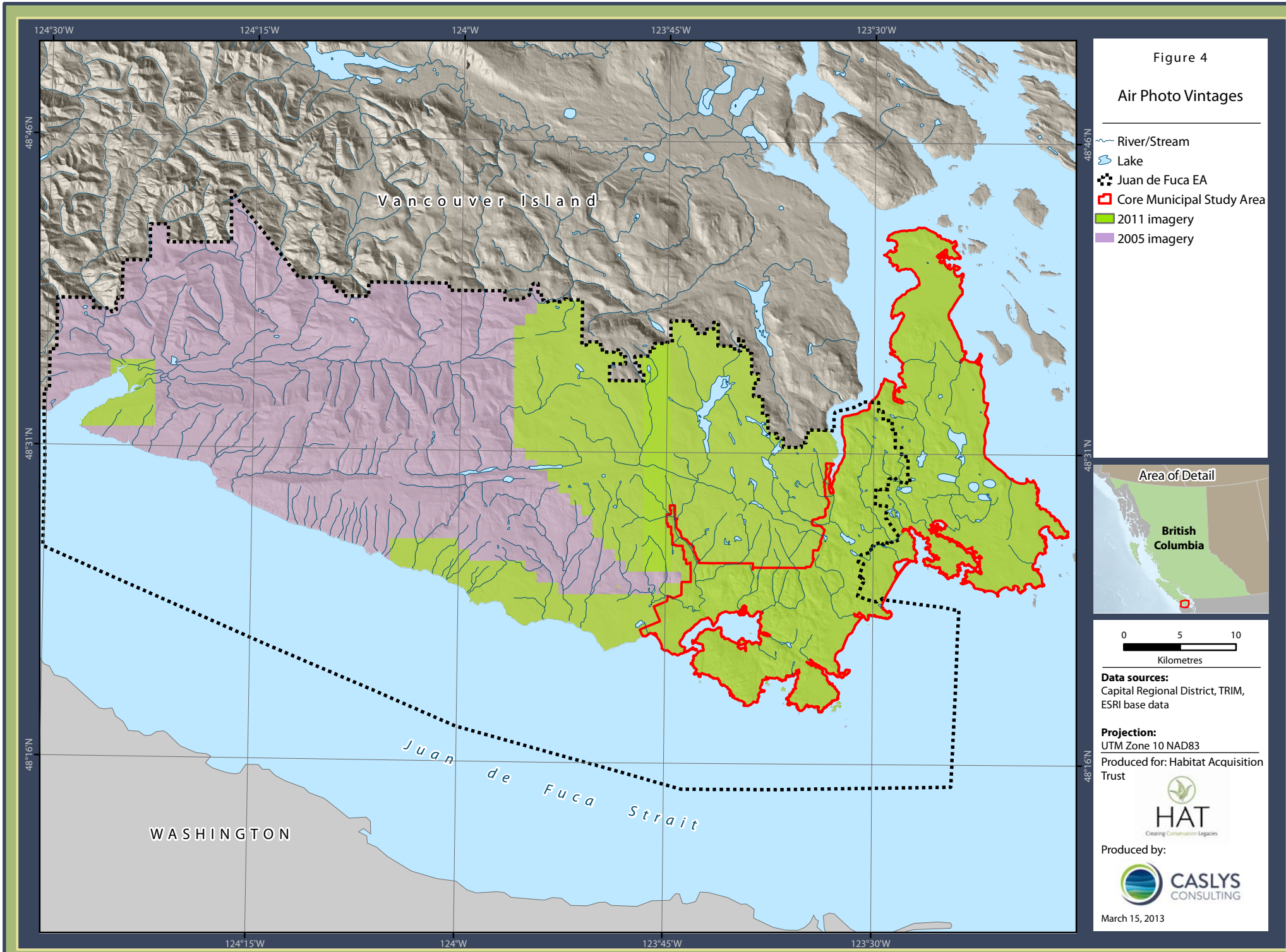
2.1.5 Digital Elevation Model

A digital elevation model (DEM) was generated from a Triangular Irregular Network (TIN) dataset supplied by the CRD. The DEM was used to derive a hillshade which was used in the final cartographic map products and a slope classification which helped refine the land cover attributes. In addition, these terrain data served as an input to the riparian habitat model. This dataset was available for the full extent of the CMSA, but not for the full extent of JDFW. The 1:20,000 scale TRIM dataset was used to fill in this data gap.

2.1.6 Parks and Open Space

A dataset specifying the locations of parks and open space was supplied by the CRD (Figure 1). The land cover and density values were summarized by park type.

[7] It appears the image was taken in the spring based on leaf cover and the presence of snow in higher elevation areas.


124°30'W
124°15'W
124°W
123°45'W
123°30'W
48°46'N
48°31'N
48°16'N
Vancouver Island
Juan de Fuca Strait
WASHINGTON
Figure 4
Air Photo Vintages
River/Stream
Lake
Juan de Fuca EA
Core Municipal Study Area
2011 imagery
2005 imagery
Area of Detail
British Columbia
0
5
10
Kilometres
Data sources:
Capital Regional District, TRIM, ESRI base data
Projection:
UTM Zone 10 NAD83
Produced for: Habitat Acquisition Trust
HAT
Creating Conservation Legacies
Produced by:
CASLYS CONSULTING
March 15, 2013

2.1.7 Jurisdictions

The CRD is comprised of 26 jurisdictions (13 municipalities, 12 First Nations Reserves and the Juan de Fuca Electoral Area) (Figure 1). This dataset, supplied by the CRD, was used to summarize the land cover and density values.

2.1.8 One-Hectare Grid

The provincial government has developed a mapping product entitled Hectares B.C. Hectares B.C. is a grid-based dataset that summarises biodiversity and land use information using a one-hectare cell size for the entire province. The one-hectare grid cell dataset used to generate the tree cover and impervious surface density statistics was identical to the one used for the previous project (Caslys 2007). It uses the same origin points as those used by Hectares B.C. to allow data to be exchanged seamlessly between the two datasets. The origin points (in B.C. Albers NAD 83) are as follows: Easting: 159 587.5; Northing:173 787.5.

2.2 Derivative Map Products

2.2.1 Riparian/Wetland Analysis

Riparian zones are moist and densely vegetated areas adjacent to streams, rivers, lakes and wetlands. They provide transitional green belts that separate areas that are perennially covered by surface water from drier upland regions. A terrain-based model was developed using the CRD's DEM (and TRIM data for JDFW) to identify riparian and wetland areas. The results of this model were used to refine the land cover classification.

The locations of riparian and wetland habitat were based on the development of a cost-weighted distance surface that determined the cost water would pay to flow or permeate through the surrounding terrain. The source data layers were the CRD's hydrological data layers and the DEM. A cost-weighted distance analysis calculates a value for each raster cell based on the least accumulated cost of travelling from each cell to the source (in this case the streams or lakes). Distances are not in geographic units but rather determined in cost units. The surface was developed by calculating a cost-weighted distance to determine the difficulty (the cost) of the streams to move through the surrounding terrain. A slope map was used as the terrain component of the model – flatter terrain (lower slopes) offer less resistance and therefore have a lower associated cost, whereas steeper slopes have a higher cost. Riparian and wetland habitats surrounding a stream will, therefore, be more extensive in flatter areas and narrower in steeper terrain. The resulting raster dataset is based on the slope coverage, derived from the one metre cell size DEM, and therefore, its spatial accuracy is one metre in the CMSA. In JDFW the resolution of the dataset decreases to 25 metres as this is the resolution of the TRIM DEM. Figure 5 illustrates the results of the analysis.

The output of the analysis is a raster dataset in which each cell is assigned a cumulative cost to the closest source cell. This approach generates a more accurate representation of real-world conditions than the use of static corridor widths because:

- The inclusion of terrain data allows streams having otherwise identical characteristics to be differentiated from one another.
- It captures the headwaters of streams in flatter terrain more realistically.
- In areas of steep terrain, it yields narrow riparian corridors because the cost of travelling through steep terrain is higher.

Stream

Riparian/Wetland habitat

0 100 200

Metres

Projection: UTM Zone 10 NAD83

Data Sources:
Capital Regional District
TRIM
ESRI Base Data

Figure 5. Riparian/Wetland Habitat Model Results Example

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT

By: CASLYS CONSULTING

2.2.2 2005 and 2011 Land Cover Classifications

An unsupervised classification was conducted on both the 2005 and 2011 air photos supplied by the CRD. This type of classification is performed when there is no prior knowledge of the classes in a scene. In this project, it was used to detect and extract unique land cover features. Unsupervised classification algorithms compare the spectral signatures of individual pixels to the signatures of computer-determined classes and assign each pixel to one of these classes. The classifications yielded ~175 unique classes, each of which was assigned a preliminary land cover attribute. This classification was subsequently refined through the integration of various ancillary datasets available for the study area: the zoning data; building footprints; the results of the riparian analysis and hydrological features. The integration of these datasets allowed the classes to be refined based on land use. The land use refined attributes were then overlaid on the air photo image and further refined and verified based on the imagery. In some instances confusion existed within a given class; for example, darker portions of agricultural fields could sometimes be assigned a treed land cover class. As there are legitimate treed areas in agricultural land uses, this value could not be changed globally and therefore masks were developed to alter the values in specific areas as required. The results of the classification yielded the classes detailed in Table 1.

Table 1. Land Cover Classes

Value	Class	Description
1	Shadow	Areas in the land cover classification unresolved due to shadows in the source imagery that were unable to be classified.
2	Ocean	Ocean water features
3	Lake	Water falling within polygons identified in the hydrological features GIS dataset as being lakes.
4	Pond	Water falling within polygons identified in the hydrological features GIS dataset as being ponds.
5	River	Water falling within polygons identified in the hydrological features GIS dataset as being rivers.
6	Sand and gravel shoreline	Sand and gravel beaches. The extent of this land cover will vary between time periods as a function of the height of the tide at the time the image was taken.
7	Bedrock shoreline	Bedrock shoreline. The extent of this land cover will vary between time periods as a function of the height of the tide at the time the image was taken.
8	Exposed soil	Areas of exposed soil and bare land (e.g., construction sites, cleared areas) falling outside agricultural land uses.
9	Grass	Grass land cover falling within residential and urban land uses, including lawns, gardens, playing fields and institutional grounds. These areas represent lands subject to regular maintenance.
10	Herb	Areas of natural herbaceous vegetation (i.e., not manicured). Typically, these are areas of shrub or low-lying vegetation.
11	Riparian herb	Areas of natural herbaceous vegetation (i.e., not manicured) falling in riparian habitats. Typically these are areas of wetland and shrub vegetation.
12	Tree	Treed land covers.
13	Docks	Dock structures present along lake (e.g., Prospect Lake) and marine shorelines.
14	Pavement/Building	Paved areas (e.g., roads, sidewalks, driveways and parking lots) and buildings.
15	Agriculture	Grass, crop and shrub land covers falling within agriculture and rural residential land uses. The agriculture class includes areas of exposed soil as these are assumed to be fallow fields.
16	Exposed bedrock	Areas of exposed bedrock. Exposed bedrock is found in areas of rugged terrain (e.g., Mt Douglas).
17	Riparian tree	Treed land covers falling in riparian habitats.
18	Snow	Areas covered by snow.

The classification provides a baseline for the land cover of the study area and can be used to identify specific features towards the goal of highlighting priority areas. The dataset provides a more complete picture of the region and can be used for multiple purposes (e.g., the identification of habitat reservoirs and refuges and connectivity corridors). Figure 6 illustrates the resolution of the land cover dataset at a scale of 1:2,000.

2.2.3 Tree Cover and Impervious Surface Density Statistics

Zonal statistics were calculated for the one-hectare summary dataset using the refined 1986 tree cover and impervious surface datasets, and the 2005 and 2011 land cover datasets to determine the percentage of tree cover for each one-hectare cell. The percentage values were then divided by the percentage of land within each cell to determine the percentage of the land base within each cell that is treed. The cells were then grouped into the following classes based on the land-based percentage value. Figure 7 illustrates the resolution of the tree cover density classification using these classes:

- 0 - 5 % (primarily unforested [e.g., an urban area or agricultural field with little to no trees]);
- >5 – 10% (very low density urban forest [e.g., an agricultural area with hedgerow trees or a high density residential area with a few street trees]);
- >10 – 25% (low density urban forest [e.g., a moderate density residential area or a golf course with some treed areas]);
- >25 – 50% (medium density urban forest [e.g., a low to moderate density or well established residential area, parks with playing fields and trees]);
- >50- 75% (high density urban forest [e.g., rural residential areas or cells fringing on very high density forest areas]); or
- >75% (very high density urban forest [e.g., undeveloped areas or heavily treed parks]).

The density of impervious surface present in each time period was determined using steps similar to those used to quantify and classify tree cover. Based on the percentage values the impervious surface class attribute fields were assigned to one of the following classes (Figure 8):

- 0 - 5 % (primarily undeveloped or highly pervious [e.g., treed areas or grass areas, agricultural fields, golf courses]);
- >5 – 10% (very lightly developed [e.g., rural residential areas, agricultural areas with a few associated buildings and paved surfaces]);
- >10 – 25% (lightly developed [e.g., low density residential areas, or areas on the fringe of green space]);
- >25 – 50% (moderately developed [e.g., suburban residential areas]);
- >50 – 75% (heavily developed [e.g., highways with grass covered boulevards, apartment complexes with limited grass/treed areas]); or
- > 75% (very heavily developed [e.g., parking lots, large buildings, downtown core]).

Figure 6. 2011 Land Cover Detail (1:2,000)

Urban Forest Canopy Mapping
and Analysis in the CRD

Prepared for: HAT

By: CASLYS CONSULTING

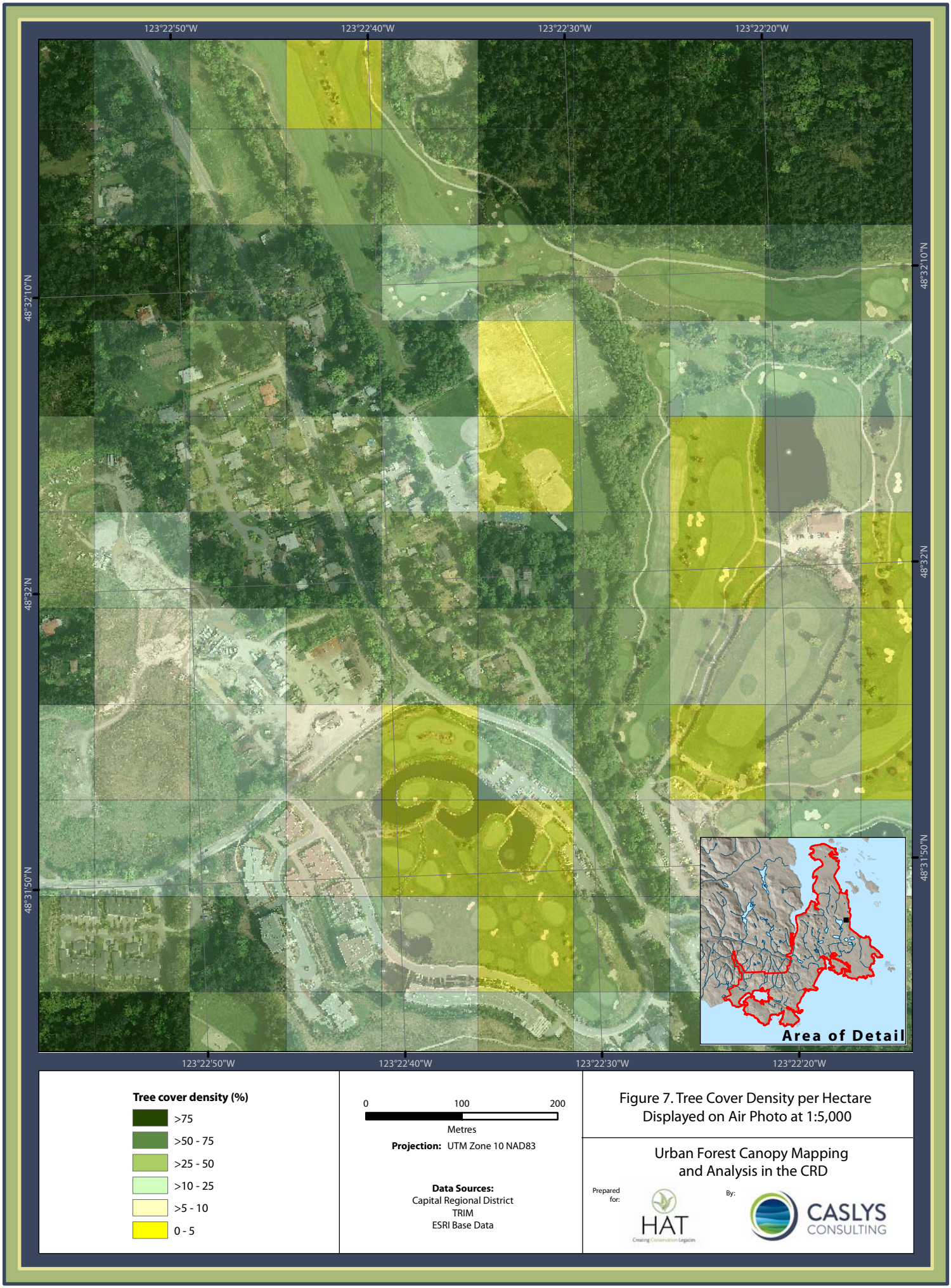
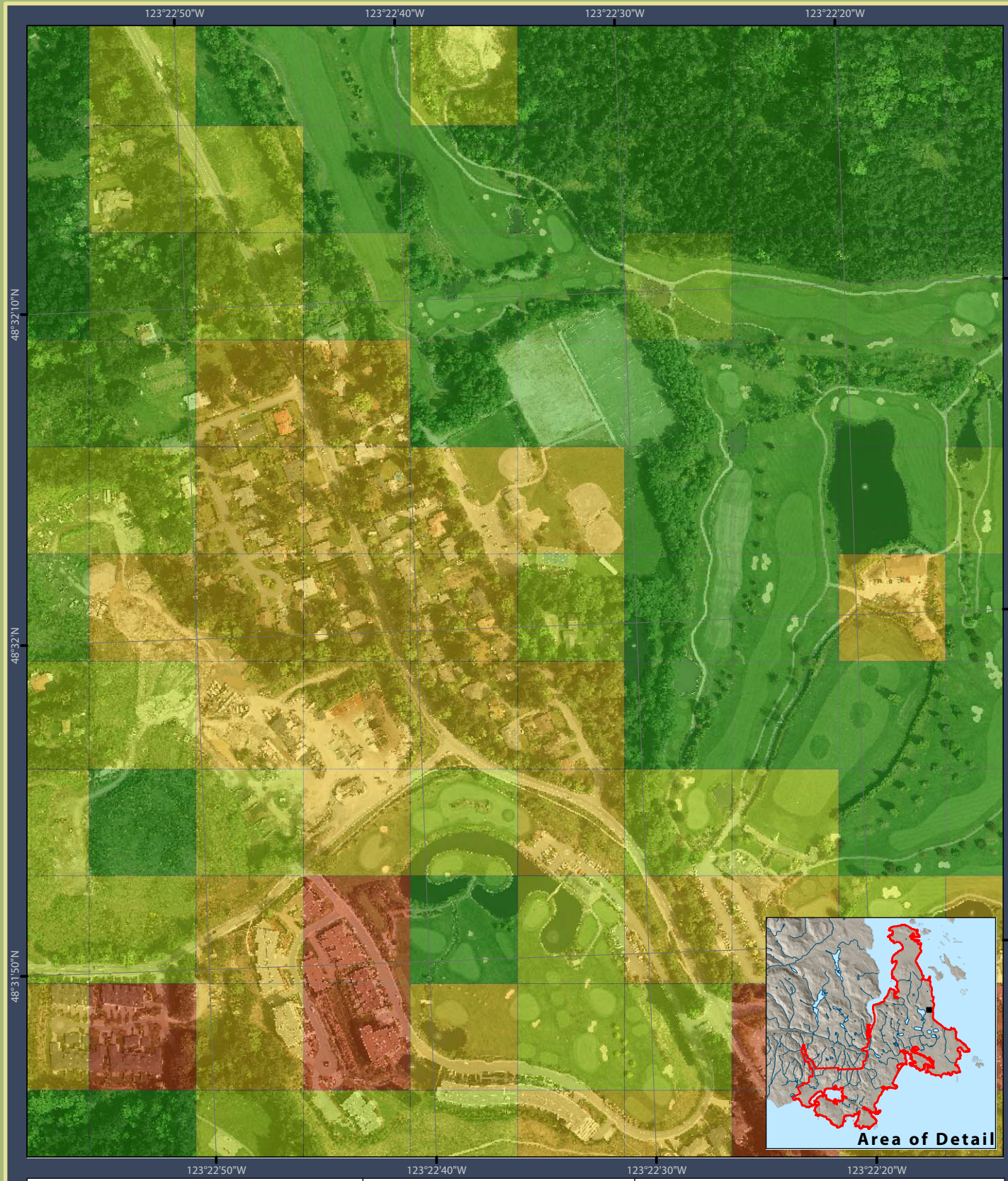


Figure 7. Tree Cover Density per Hectare Displayed on Air Photo at 1:5,000

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT

By: CASLYS CONSULTING



Impervious surface density (%)

- 0 - 5
- >5 - 10
- >10 - 25
- >25 - 50
- >50 - 75
- >75 - 100

0 100 200

Metres

Projection: UTM Zone 10 NAD83

Data Sources:
Capital Regional District
TRIM
ESRI Base Data

Figure 8. Impervious Surface Density per Hectare Displayed on Air Photo at 1:5,000

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT Creating Conservation Legacies

By: CASLYS CONSULTING

As detailed in the 2007 report, the resolution of the 1986 imagery did not facilitate the identification of smaller patches of trees and impervious surface. To help mitigate this issue, thereby increasing the accuracy of the comparisons between the time periods, two assumptions were incorporated into the density summaries. One-hectare cells located in established urban areas that indicated an increase in tree cover between the 1986 and 2005 time periods were attributed to small patches of treed land cover assumed to be present (but not visible due to resolution issues) in the 1986 land cover. In these instances, the 2005 tree cover density attribute was assigned to the 1986 value for the cell as it was assumed that if the trees were present in 2005 they were probably present in 1986. This assumption means that some areas of regrowth or planting between the two time periods may be overlooked. The second assumption applied to one-hectare cells having higher levels of impervious surface in 1986 than in 2005. Again, in these instances, the 2005 density values were applied to the 1986 value for the cell because it was assumed that, for the most part, impervious surface was not decreasing over time.

Table 2 provides a list of attributes and a data structure for the file. It should be noted that as additional mapping is conducted in the future the data can easily be stored within the file by simply adding new year-specific attributes.

Table 2. Data Structure for the One-hectare Grid Coverage

Field Name	Description	Field Type	Attributes
Feature ID	A unique identifier allowing the polygon to be linked to other datasets (e.g., land cover, zoning, Hectares B.C.) as required	Numeric	Numeric ID
Bin_Tree_86	Cells are assigned to one of six classes (bins) to indicate the percentage of tree cover present in the 1986 time period.	Character	0 – 5 >5 – 10 >10 – 25 >25 – 50 >50 – 75 >75 - 100
Bin_Imp_86	Cells are assigned to one of six classes (bins) to indicate the percentage of impervious surface present in the 1986 time period.	Character	0 – 5 >5 – 10 >10 – 25 >25 – 50 >50 – 75 >75 - 100
Pct_Tree_05	The percent tree cover present on the land base in the cell in the 2005 time period. Revised from the original 2005 values.	Numeric	0 - 100
Pct_Imp_05	The percent of impervious surface present on the land base in the cell in the 2005 time period. Revised from the original 2005 values.	Numeric	0 - 100
Bin_Tree_05	Cells are assigned to one of six classes (bins) to indicate the percentage of tree cover present in the 2005 time period. Revised from the original 2005 values.	Character	0 – 5 >5 – 10 >10 – 25 >25 – 50 >50 – 75 >75 - 100
Bin_Imp_05	Cells are assigned to one of six classes (bins) to indicate the percentage of impervious surface present in the 2005 time period. Revised from the original 2005 values.	Character	0 – 5 >5 – 10 >10 – 25 >25 – 50 >50 – 75

Field Name	Description	Field Type	Attributes
			>75 - 100
Percent_Tree_11	The percent tree cover present on the land base in the cell in the 2011 time period.	Numeric	0 - 100
Percent_Imp_11	The percent of impervious surface present on the land base in the cell in the 2011 time period.	Numeric	0 - 100
Bin_Tree_11	Cells are assigned to one of six classes (bins) to indicate the percentage of tree cover present in the 2011 time period.	Numeric	0 - 100
Bin_Imp_11	Cells are assigned to one of six classes (bins) to indicate the percentage of impervious surface present in the 2011 time period.	Numeric	0 - 100

2.3 Decision Support Tools

2.3.1 Land Cover Statistics

Summary statistics were generated (provided in Excel format) to quantify the following land cover changes:

- A summary of the 2011 land cover classes for the CMSA.
- A summary of the 2011 land cover classes for JDFW.
- A comparison of land cover changes between 2005 and 2011 for the CMSA.
- Percent tree cover and impervious surface in 2011 for the CMSA.
- Percent tree cover and impervious surface in 2011 for JDFW.
- Percent tree cover and impervious surface changes between 2005 and 2011 by jurisdiction for the CMSA.

2.3.2 Tree Cover and Impervious Surface Density Statistics

Summary statistics were generated (provided in Excel format) to quantify the following tree cover and impervious surface density changes:

- Tree cover and impervious surface density in 2011 (summarized on a one-hectare grid) for the CMSA.
- Tree cover and impervious surface density in 2011 (summarized on a one-hectare grid) for JDFW.
- A comparison of tree cover and impervious surface density (summarized on a one-hectare grid) change between 1986, 2005 and 2011 for the CMSA.
- A summary of tree cover and impervious surface density changes by jurisdiction between 1986, 2005 and 2011.
- A summary of tree cover and impervious surface density within parks between 1986, 2005 and 2011 for the CMSA.

2.4 Quality Control

2.4.1 2005 Land Cover Accuracy Assessment – Core Municipal Study Area

An independent operator reviewed the accuracy of the data by comparing the land cover classification to a set of 500 randomly selected sample points. The sample points were overlaid on the digital air photo and assigned a land cover attribute by the reviewer based on visual interpretation. These points were then overlaid on the land cover dataset and the attribute assignments compared. Table 3 summarizes the composition of the sample points used in the assessment and Table 4 presents the results of the accuracy assessment for the 2005 classification in the form of a confusion matrix. The matrix compares information from reference sites that are assumed to be correct (i.e., based on a manual review of the air photo) to information on the map for a number of sample areas (i.e., the land cover mapping). The results are summarized in the form of a matrix presented as a square array of numbers set out in rows and columns. The labels depicted on one axis (typically the columns) represent the class assignments from the reference sites and the other (i.e., the rows) the classes found in the mapped information. The number of occurrences when the values in the reference site dataset match those of the sample dataset are recorded along the major diagonal in the matrix. Errors (i.e., where the classes do not match) are recorded in the other cells.

The overall accuracy of the dataset is the sum of the major diagonal (i.e., the correctly classified sample units) divided by the total number of sample units. However, this number does not tell you how accurate the individual classes are. This information is reflected in the user's and producer's accuracies. The producer's accuracy quantifies errors of commission – mapped areas that have been erroneously included in a class. The user's accuracy quantifies errors of omission – mapped areas that have been erroneously excluded from a class. In Table 4, the user's accuracy for the pavement/building class is 94.0% - 67 areas were mapped as being pavement/building, 63 were mapped correctly, three should have been exposed soil and one trees. The producer's accuracy for the same class is 98.4% - 63 of the reference sites fell on locations mapped as pavement/building while one of the reference sites fell in the exposed soil class.

Typically, the accuracy threshold for a land use or land cover dataset is 80%. The assessment indicates that the overall accuracy of the 2005 land cover data is 94.0% - the sample point and the land cover data were an exact match 94.0% of the time – which exceeds the standard accuracy threshold by 14.0%.

Table 3. 2005 Accuracy Assessment Sample Composition – Core Municipal Study Area

Land Cover	Ha in CMSA	% of CMSA	Number of Points in Sample	% of Sample	Difference
shadow/no data	460.8	0.9%	4	0.8%	0.1%
ocean	6.2	0.0%	0	0.0%	0.0%
lake	503.3	1.0%	7	1.4%	-0.4%
pond	233.8	0.5%	2	0.4%	0.1%
river	27.4	0.1%	0	0.0%	0.1%
sand/gravel shoreline	75.2	0.1%	0	0.0%	0.1%
bedrock shoreline	76.1	0.1%	1	0.2%	-0.1%
exposed soil	1,405.0	2.7%	17	3.4%	-0.7%
grass	4,903.8	9.5%	48	9.6%	-0.1%
herb	2,123.3	4.1%	25	5.0%	-0.9%
riparian herb	284.5	0.6%	1	0.2%	0.4%
tree	29,476.8	57.1%	282	56.4%	0.7%
docks	0.5	0.0%	0	0.0%	0.0%
pavement/building	6,751.8	13.1%	64	12.8%	0.3%
agricultural fields	4,053.8	7.9%	36	7.2%	0.7%
exposed bedrock	64.8	0.1%	0	0.0%	0.1%
riparian tree	1,182.5	2.3%	13	2.6%	-0.3%
TOTAL	**51,629.6**		**500**		

Table 4. 2005 Accuracy Assessment Confusion Matrix – Core Municipal Study Area

	Reference Sites																		
Land cover mapping	shadow	ocean	lake	pond	river	sand/ gravel shore-line	bed-rock shore-line	exposed soil	grass	herb	riparian herb	tree	docks	pave-ment/ building	agric-ultural fields	expo-sed bed-rock	riparian tree	**Row Total**	**User Accuracy**
shadow	**3**											2						5	60.0%
ocean																		0	-
lake			**7**															7	100.0%
pond				**2**														2	100.0%
river																		0	-
sand/gravel shoreline							1											1	0.0%
bedrock shoreline																		0	-
exposed soil								**13**		1		2		1				17	76.5%
grass								1	**43**			6						50	86.0%
herb									1	**22**		3						26	84.6%
riparian herb											**1**							1	100.0%
tree	1								4	2		**268**			1			276	97.1%
docks																		0	-
pavement/ building								3				1		**63**				67	94.0%
agricultural fields															**35**			35	100.0%
exposed bedrock																		0	-
riparian tree																	**13**	13	100.0%
Column Total	4	0	7	2	0	0	1	17	48	25	1	282	0	64	36	0	13	**470**	
Producer Accuracy	75.0%	-	100.0%	100.0%	-	-	0.0%	76.5%	89.6%	88.0%	100.0%	95.0%	-	98.4%	97.2%	-	100.0%		**94.0%**

The classes that caused the most confusion were exposed soil versus pavement/building; grass versus trees; and herb versus trees. These issues are common in land cover mapping as exposed soil and grass are often confused because roof tops can look very similar to exposed soil. Trees, herb and grass are easily confused because they have similar spectral properties.

2.4.2 2011 Land Cover Accuracy Assessment – Core Municipal Study Area

An identical approach was used to assess the accuracy of the 2011 land cover classification – 500 randomly selected sample points were overlaid on the digital air photo and assigned a land cover attribute by the reviewer based on visual interpretation. These points were then overlaid on the land cover dataset and the attribute assignments compared. Table 5 summarizes the composition of the sample points used in the assessment and Table 6 presents the results of the accuracy assessment for the 2011 classification in the form of a confusion matrix. The assessment indicates that the overall accuracy of the 2011 land cover data is 94.4% - the sample point and the land cover data were an exact match 94.4% of the time – which exceeds the standard accuracy threshold of 80% by 14.4%.

In the 2011 classification, exposed soil was confused with pavement and grass. Exposed soil and grass are often confused because dry grass classes can look very similar to exposed soil, particularly in the summer months, when most imagery is obtained. Exposed soil is also commonly confused with other highly reflective surfaces (e.g., pavement and roof tops). The herb and grass classes were also confused with trees. This is because shrubs and trees can have similar properties in the source image and small patches of tree pixels in large grassy areas can be grouped into the grass class.

Table 5. 2011 Accuracy Assessment Sample Composition – Core Municipal Study Area

Land Cover	Ha in CMSA	% of CMSA	Number of Points in Sample	% of Sample	Difference
shadow/no data	159.4	0.3%	1	0.2%	-0.1%
ocean	8.4	0.0%	0	0.0%	0.0%
lake	496.3	1.0%	5	1.0%	0.0%
pond	214.9	0.4%	1	0.2%	-0.2%
river	29.3	0.1%	1	0.2%	0.1%
sand/gravel shoreline	103.4	0.2%	0	0.0%	-0.2%
bedrock shoreline	55.1	0.1%	0	0.0%	-0.1%
exposed soil	630.9	1.2%	10	2.0%	0.8%
grass	5,209.9	10.1%	49	9.8%	-0.3%
herb	2,385.8	4.6%	22	4.4%	-0.2%
riparian herb	287.5	0.6%	5	1.0%	0.4%
tree	28,424.8	55.1%	292	58.4%	3.3%
docks	0.6	0.0%	0	0.0%	0.0%
pavement/building	8,253.9	16.0%	59	11.8%	-4.2%
agricultural fields	4,112.2	8.0%	35	7.0%	-1.0%
exposed bedrock	60.8	0.1%	1	0.2%	0.1%
riparian tree	1,196.6	2.3%	19	3.8%	1.5%
TOTAL	**51,629.6**		**500**		

Table 6. 2011 Accuracy Assessment Confusion Matrix – Core Municipal Study Area

	Reference Sites																		
Land cover mapping	shadow	ocean	lake	pond	river	sand/ gravel shore-line	bed-rock shore-line	exposed soil	grass	herb	riparian herb	tree	docks	pave-ment/ building	agric-ultural fields	expo-sed bed-rock	riparian tree	**Row Total**	**User Accuracy**
shadow	**1**											1						2	50.0%
ocean																		0	-
lake			**5**															5	100.0%
pond				**1**														1	100.0%
river					**1**													1	100.0%
sand/gravel shoreline																		0	-
bedrock shoreline																		0	-
exposed soil								**9**						3				12	75.0%
grass								1	**38**			2		1				42	90.5%
herb									1	**21**		3			1		1	27	77.8%
riparian herb											**5**							5	100.0%
tree									7	1		**286**			1	1		296	96.6%
docks																		0	-
pavement/ building									3					**54**				57	94.7%
agricultural fields														1	**33**			34	97.1%
exposed bedrock																		0	-
riparian tree																	**18**	18	100.0%
Column Total	1	0	5	1	1	0	0	10	49	22	5	292	0	59	35	1	19	**472**	
Producer Accuracy	100.0%	-	100.0%	100.0%	100.0%	-	-	90.0%	77.6%	95.5%	100.0%	97.9%	-	91.5%	94.3%	0.0%	94.7%		**94.4%**

2.4.3 Land Cover Accuracy Assessment – Juan de Fuca West

As with the accuracy assessments conducted for the CMSA, in JDFW 500 randomly selected sample points were again overlaid on the digital air photo and assigned a land cover attribute by the reviewer based on visual interpretation. These points were then overlaid on the land cover dataset and the attribute assignments compared. Table 7 summarizes the composition of the sample points used in the assessment and Table 8 presents the results of the accuracy assessment for JDFW classification in the form of a confusion matrix. The assessment indicates that the overall accuracy of JDFW land cover data is 97.8% - the sample point and the land cover data were an exact match 97.8% of the time – which exceeds the standard accuracy threshold of 80% by 17.8%.

In JDFW classification herb was confused with exposed soil and trees. These errors typically occurred in cutblocks – in recently harvested areas, herb was confused with exposed soil and in areas where regrowth is occurring, herb was confused with young trees.

Table 7. Accuracy Assessment Sample Composition – Juan de Fuca West

Land Cover	Ha in JDFW	% of JDFW	Number of Points in Sample	% of Sample	Difference
shadow/no data	3,758.9	2.6%	9	1.8%	-0.8%
ocean	1.6	0.0%	64	12.8%	12.8%
lake	1,569.4	1.1%	7	1.4%	0.3%
pond	108.2	0.1%	0	0.0%	-0.1%
river	212.4	0.1%	1	0.2%	0.1%
sand/gravel shoreline	31.0	0.0%	2	0.4%	0.4%
bedrock shoreline	15.2	0.0%	3	0.6%	0.6%
exposed soil	5,486.6	3.7%	11	2.2%	-1.5%
grass	148.8	0.1%	0	0.0%	-0.1%
herb	9,758.1	6.6%	31	6.2%	-0.4%
riparian herb	390.4	0.3%	0	0.0%	-0.3%
tree	119,434.5	81.1%	352	70.4%	-10.7%
docks	0.1	0.0%	0	0.0%	0.0%
pavement/building	812.6	0.6%	2	0.4%	-0.2%
agricultural fields	18.5	0.0%	0	0.0%	0.0%
exposed bedrock	417.6	0.3%	0	0.0%	-0.3%
riparian tree	5,011.6	3.4%	18	3.6%	0.2%
snow	142.0	0.1%	0	0.0%	-0.1%
TOTAL	**147,317.7**		**500**		

Table 8. Accuracy Assessment Confusion Matrix – Juan de Fuca West

	Reference Sites																		
Land cover mapping	shadow	ocean	lake	pond	river	sand/ gravel shore-line	bedrock shore-line	expo-sed soil	grass	herb	riparian herb	tree	docks	pave-ment/ building	agricul-tural fields	expo-sed bed-rock	riparian tree	snow	**Row Total**	**User Accuracy**
shadow	9																		9	100.0%
ocean		64																	64	100.0%
lake			7																7	100.0%
pond																			0	-
river					1														1	100.0%
sand/gravel shoreline						2													2	100.0%
bedrock shoreline							3												3	100.0%
exposed soil								7											7	100.0%
grass																			0	-
herb								4		30		6							40	75.0%
riparian herb																			0	-
tree										1		346							347	99.7%
docks																			0	-
pavement/ building														2					2	100.0%
agricultural fields																			0	-
exposed bedrock																			0	-
riparian tree																	18		18	100.0%
snow																			0	-
Column Total	9	64	7	0	1	2	3	11	0	31	0	352	0	2	0	0	18	0	489	
Producer Accuracy	100.0%	100.0%	100.0%	-	100.0%	100.0%	100.0%	63.6%	-	96.8%	-	98.3%	-	100.0%	-	-	100.0%	-		97.8%

3.0 RESULTS

The following sections present an overview of some of the key statistics. The statistics presented include absolute areas and both percent change and percent difference values. Percent change quantifies change in the class (i.e., the area difference divided by the 2005 area for that class), whereas percent difference compares the class to the overall composition in the area of interest (i.e., the 2011 percentage of the CMSA minus the 2005 percentage). The examples below, using value for the pavement/building land cover class found in Table 9, illustrate how the two different percentages are calculated:

Percent Change

In 2005 the pavement/building class represented 6,751.8 ha of the CMSA. This number rose to 8,253.9 ha in 2011 representing an increase (or difference) of 1,502.1 ha. To calculate the percent change between 2005 and 2011, the difference between the two time periods is divided by the 2005 value and then multiplied by 100 to yield a percentage:

Difference/2005 Area * 100 = Percent Change
1,502.1/6,751.8 * 100 = 22.2%

Percent Difference

In 2005, the pavement/building class represented 13.1% of the CMSA. The 1,502.1 ha increase in this class between 2005 and 2011 increased this percentage to 16.0% of the CMSA. The percent difference value quantifies this change by subtracting one value from the other:

2011 % of the CMSA – 2005 % of the CMSA = % Difference
16.0% – 13.1% = 2.9%

When interpreting the statistics it is important to consider the percent change in the context of the change in area – classes with small areas can have a large percentage changes.

3.1 Land Cover

3.1.1 Core Municipal Study Area

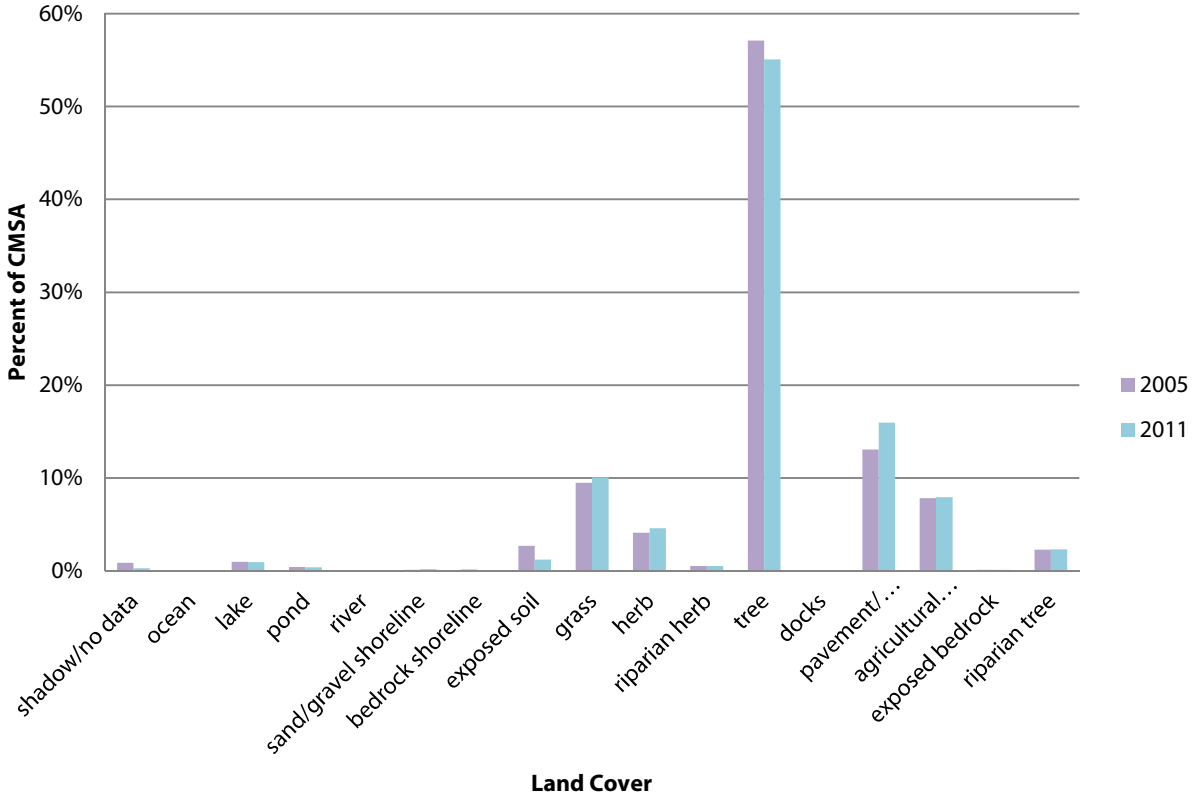
The land cover for the two time periods (2005 and 2011) allows us to examine change over time. Note that if a third time period was available we could also examine the rate of change in more detail. Table 9 and Figure 9 provide a comparison of the percentage of each class in each time period. While these data do not allow us to examine what classes are moving from and to, over the six years we can see that the agricultural fields (an increase of 58.4 ha), herb (an increase of 262.4 ha), grass (an increase of 306.1 ha), and pavement/building (an increase of 1,502.1 ha) classes are increasing, while the tree (a decrease of 1,052.0 ha) and exposed soil (a decrease of 774.1 ha) classes are decreasing.

Table 9. Comparison of 2005 and 2011 Land Cover Classes in the Core Municipal Study Area

Land Cover	Major Land Cover Class	2005 Area (ha)	2005 % of CMSA	2011 Area (ha)	2011 % of CMSA	Difference Area (ha)	% Change 2005 to 2011	% Difference 2005 to 2011
shadow/no data	Shadow	460.8	0.9%	159.4	0.3%	-301.4	-65.4%	-0.6%
ocean	Water	6.2	0.0%	8.4	0.0%	2.1	34.0%	0.0%
lake		503.3	1.0%	496.3	1.0%	-7.1	-1.4%	0.0%
pond		233.8	0.5%	214.9	0.4%	-18.9	-8.1%	0.0%
river		27.4	0.1%	29.3	0.1%	1.9	6.9%	0.0%
sand/gravel shoreline	Exposed soil/rock	75.2	0.1%	103.4	0.2%	28.2	37.5%	0.1%
bedrock shoreline		76.1	0.1%	55.1	0.1%	-20.9	-27.5%	0.0%
exposed soil		1,405.0	2.7%	630.9	1.2%	-774.1	-55.1%	-1.5%
exposed bedrock		64.8	0.1%	60.8	0.1%	-4.0	-6.2%	0.0%
agricultural fields	Non-treed (disturbed)	4,053.8	7.9%	4,112.2	8.0%	58.4	1.4%	0.1%
grass		4,903.8	9.5%	5,209.9	10.1%	306.1	6.2%	0.6%
herb	Non-treed (natural	2,123.3	4.1%	2,385.8	4.6%	262.4	12.4%	0.5%
riparian herb		284.5	0.6%	287.5	0.6%	3.0	1.0%	0.0%
tree	Treed	29,476.8	57.1%	28,424.8	55.1%	-1,052.0	-3.6%	-2.0%
riparian tree		1,182.5	2.3%	1,196.6	2.3%	14.2	1.2%	0.0%
docks	Impervious	0.5	0.0%	0.6	0.0%	0.1	28.2%	0.0%
pavement/building		6,751.8	13.1%	8,253.9	16.0%	1,502.1	22.2%	2.9%
TOTAL		**51,629.6**		**51,629.6**				

*Negative numbers indicate a decrease and positive an increase in the number of hectares within each class over the six year time period. Percent change quantifies change in the class (i.e., the difference between two time periods divided by the area of that class in the earlier time period), whereas percent difference compares the class to the overall composition in the area of interest (i.e., a 2011 % of CMSA value is subtracted from 2005 value).

Figure 9. Percentage of Land Cover Type in the Core Municipal Study Area – 2005 and 2011



For ease of interpretation, the land cover types were grouped into major classes as per Table 10. The colours behind the land cover type in both tables 9 and 10 indicate how the classes were grouped. For example, the major land cover class treed consists of the classes tree and riparian tree. The results detailed in Table 10 indicate that in the CMSA as a whole:

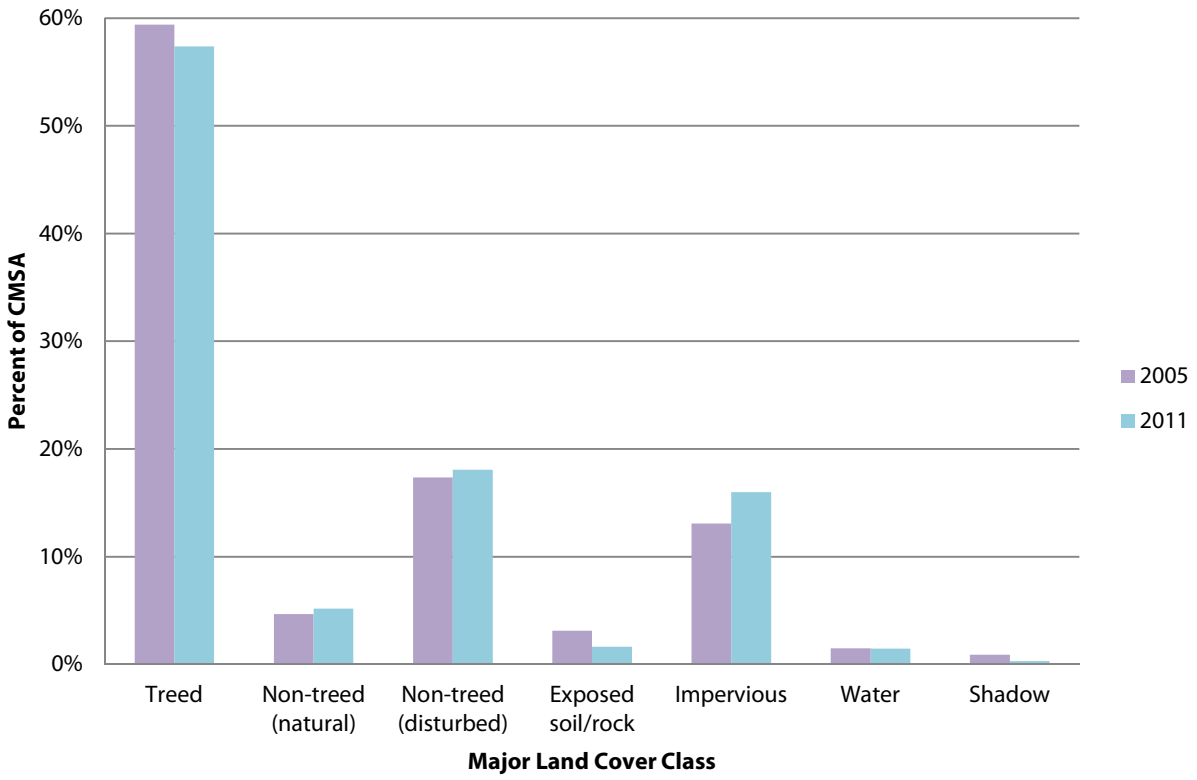
- The amount of impervious surface (the pavement/buildings and docks classes) increased by a total of 1,502.2 ha (a percent change increase of 22.2% within the class or an overall increase of 2.9% throughout the CMSA). This represents an annual increase of 250.4 ha per year over the six year time period, assuming a constant rate of change.
- Treed land covers (tree and riparian tree) decreased by 1,037.8 ha (a percent change decrease of 3.4% or an overall difference of -2.0%). This represents a loss of 173.0 ha per year over the six year time period, assuming a constant rate of change.
- Non-treed vegetated areas, both natural (e.g., herb) and disturbed (manicured grass and agriculture) increased by a total of 265.4 ha (a percent change of 11.0%) and 364.5 ha (a percent change of 4.1%) respectively.
- Exposed soil and rock decreased by a total of 770.9 ha, representing a percent change of 47.6%.

Table 10. Comparison of 2005 and 2011 Major Land Cover Classes in the Core Municipal Study Area

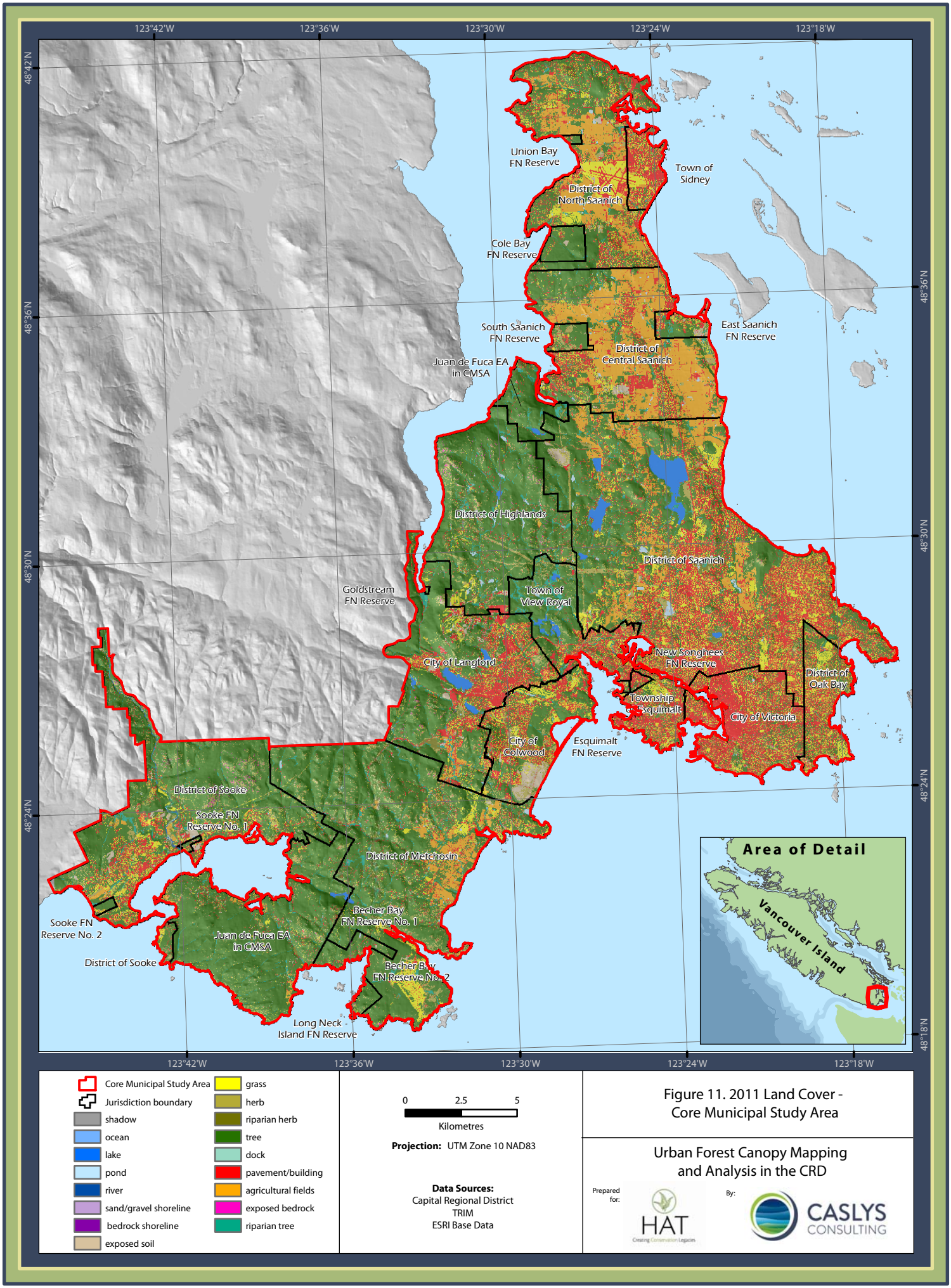
Major Land Cover Class	2005 Area (ha)	2005 % of CMSA	2011 Area (ha)	2011 % of CMSA	Difference Area (ha)	% Change 2005 to 2011	% Difference 2005 to 2011
Treed	30,659.2	59.4%	29,621.4	57.4%	-1,037.8	-3.4%	-2.0%
Non-treed (natural)	2,407.8	4.7%	2,673.2	5.2%	265.4	11.0%	0.5%
Non-treed (disturbed)	8,957.6	17.3%	9,322.1	18.1%	364.5	4.1%	0.7%
Exposed soil/rock	1,621.1	3.1%	850.2	1.6%	-770.9	-47.6%	-1.5%
Impervious	6,752.3	13.1%	8,254.5	16.0%	1,502.2	22.2%	2.9%
Water	770.7	1.5%	748.8	1.5%	-22.0	-2.8%	0.0%
Shadow	460.8	0.9%	159.4	0.3%	-301.4	-65.4%	-0.6%
	51,629.6		51,629.6				

*Negative numbers indicate a decrease and positive an increase in the number of hectares within each class over the six year time period. Percent change quantifies change in the class (i.e., the difference between two time periods divided by the area of that class in the earlier time period), whereas percent difference compares the class to the overall composition in the area of interest (i.e., a 2011 % of CMSA value is subtracted from the CMSA value).

Figure 10. Percentage of Major Land Cover Classes in the Core Municipal Study Area – 2005 and 2011



The results of the land cover classification for the CMSA for the 2011 time period are presented in Figure 11 while Figure 12 illustrates the results grouped into the major classes.


123°42'W
123°36'W
123°30'W
123°24'W
123°18'W
48°42'N
48°36'N
48°30'N
48°24'N
48°18'N
Union Bay FN Reserve
Town of Sidney
District of North Saanich
Cole Bay FN Reserve
South Saanich FN Reserve
East Saanich FN Reserve
District of Central Saanich
Juan de Fuca EA in CMSA
District of Highlands
District of Saanich
Goldstream FN Reserve
Town of View Royal
City of Langford
New Songhees FN Reserve
District of Oak Bay
Township of Esquimalt
City of Victoria
City of Colwood
Esquimalt FN Reserve
District of Sooke
Sooke FN Reserve No. 1
District of Metchosin
Becher Bay FN Reserve No. 1
Sooke FN Reserve No. 2
Juan de Fuca EA in CMSA
District of Sooke
Becher Bay FN Reserve No. 2
Long Neck Island FN Reserve
Area of Detail
Vancouver Island
Core Municipal Study Area
Jurisdiction boundary
shadow
ocean
lake
pond
river
sand/gravel shoreline
bedrock shoreline
exposed soil
grass
herb
riparian herb
tree
dock
pavement/building
agricultural fields
exposed bedrock
riparian tree
0
2.5
5
Kilometres
Projection: UTM Zone 10 NAD83
Data Sources:
Capital Regional District
TRIM
ESRI Base Data
Figure 11. 2011 Land Cover - Core Municipal Study Area
Urban Forest Canopy Mapping and Analysis in the CRD
Prepared for:
HAT
By:
CASLYS CONSULTING

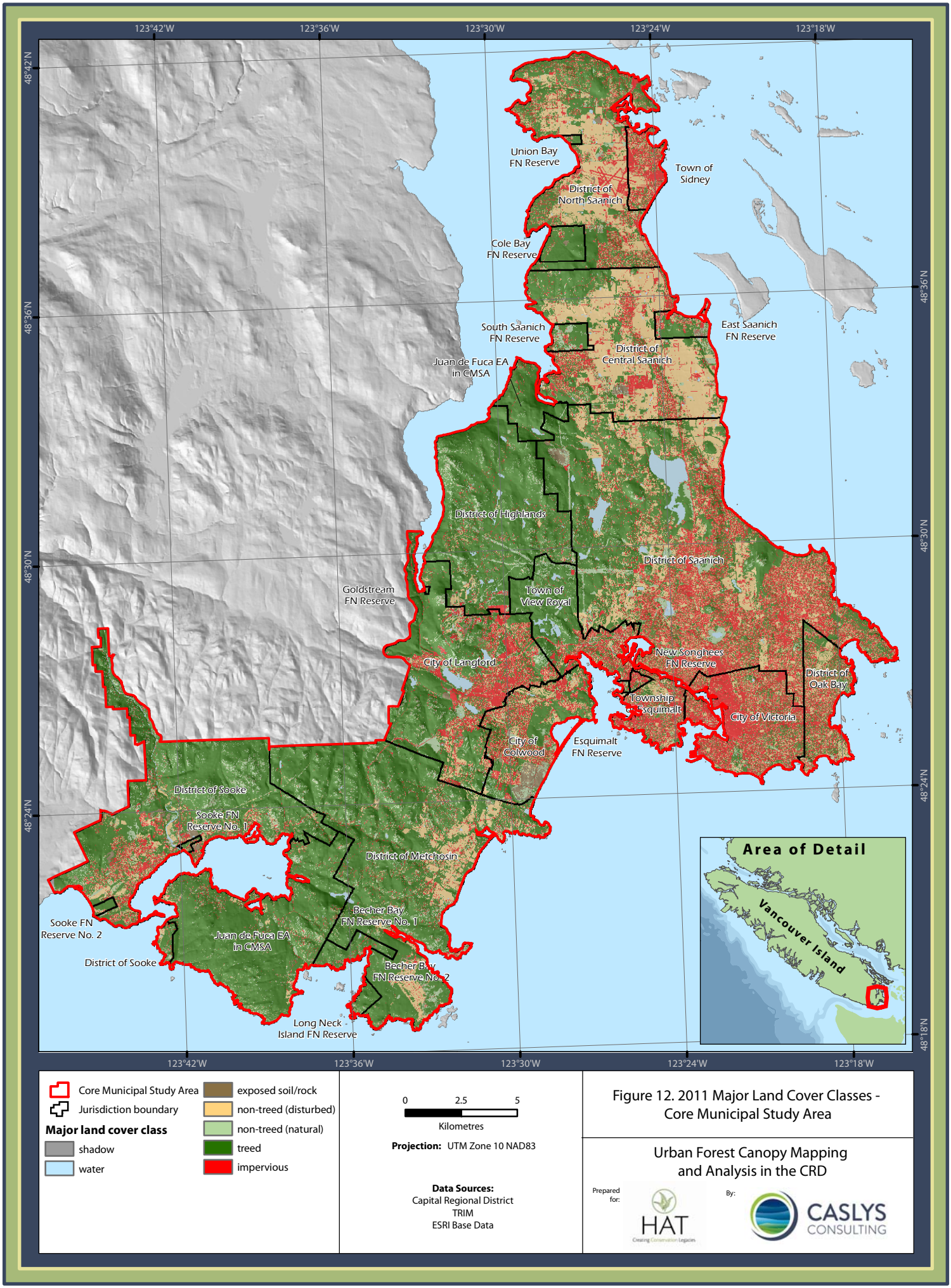


Figure 12. 2011 Major Land Cover Classes - Core Municipal Study Area

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT

By: CASLYS CONSULTING

3.1.2 Juan de Fuca West

Table 11 summarizes the land cover for JDFW[8]. This portion of the study area is heavily forested and therefore treed land covers predominate – 81.1% of JDFW is mapped as trees with an additional 3.4% falling into the riparian tree land cover. The relatively mountainous terrain of the area has resulted in a high proportion of shadow in the source imagery, a large amount of which is probably treed. The results are illustrated in Figure 13 and Figure 14 provides a land cover map.

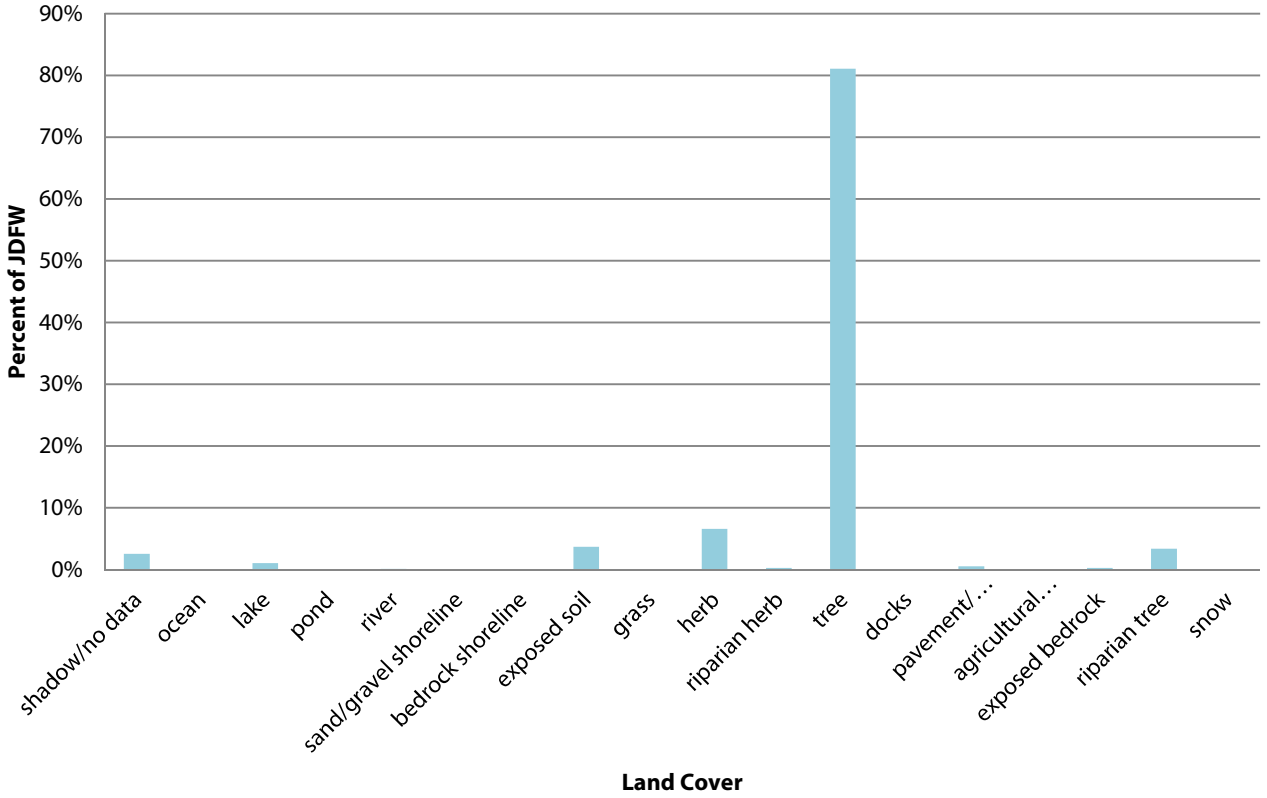
Timber harvest activities occur throughout JDFW and therefore the amount of herb (6.6%) and exposed soil (3.7%) are relatively high - these two land covers are typically associated with areas of timber harvest. Over time these areas will regrow and it is anticipated that new areas will be harvested.

Table 11. Land Cover Classes in Juan de Fuca West (2005/2011 composite)

Land Cover	Major Land Cover Class	2011 Area (ha)	2011 % of JDFW
shadow/no data	Shadow	3,758.9	2.6%
ocean	Water	1.6	0.0%
lake		1,569.4	1.1%
pond		108.2	0.1%
river		212.4	0.1%
sand/gravel shoreline	Exposed soil/rock	31.0	0.0%
bedrock shoreline		15.2	0.0%
exposed soil		5,486.6	3.7%
exposed bedrock		417.6	0.3%
agricultural fields	Non-treed (disturbed)	18.5	0.0%
grass		148.8	0.1%
herb	Non-treed (natural	9,758.1	6.6%
riparian herb		390.4	0.3%
tree	Treed	119,434.5	81.1%
riparian tree		5,011.6	3.4%
docks	Impervious	0.1	0.0%
pavement/building		812.6	0.6%
snow	Shadow/no data	142.0	0.1%
TOTAL		**147,317.7**	

[8] JDFW land cover is derived from a composite of 2005 and 2011 imagery.

Figure 13. Percentage of Land Cover Type in Juan de Fuca West



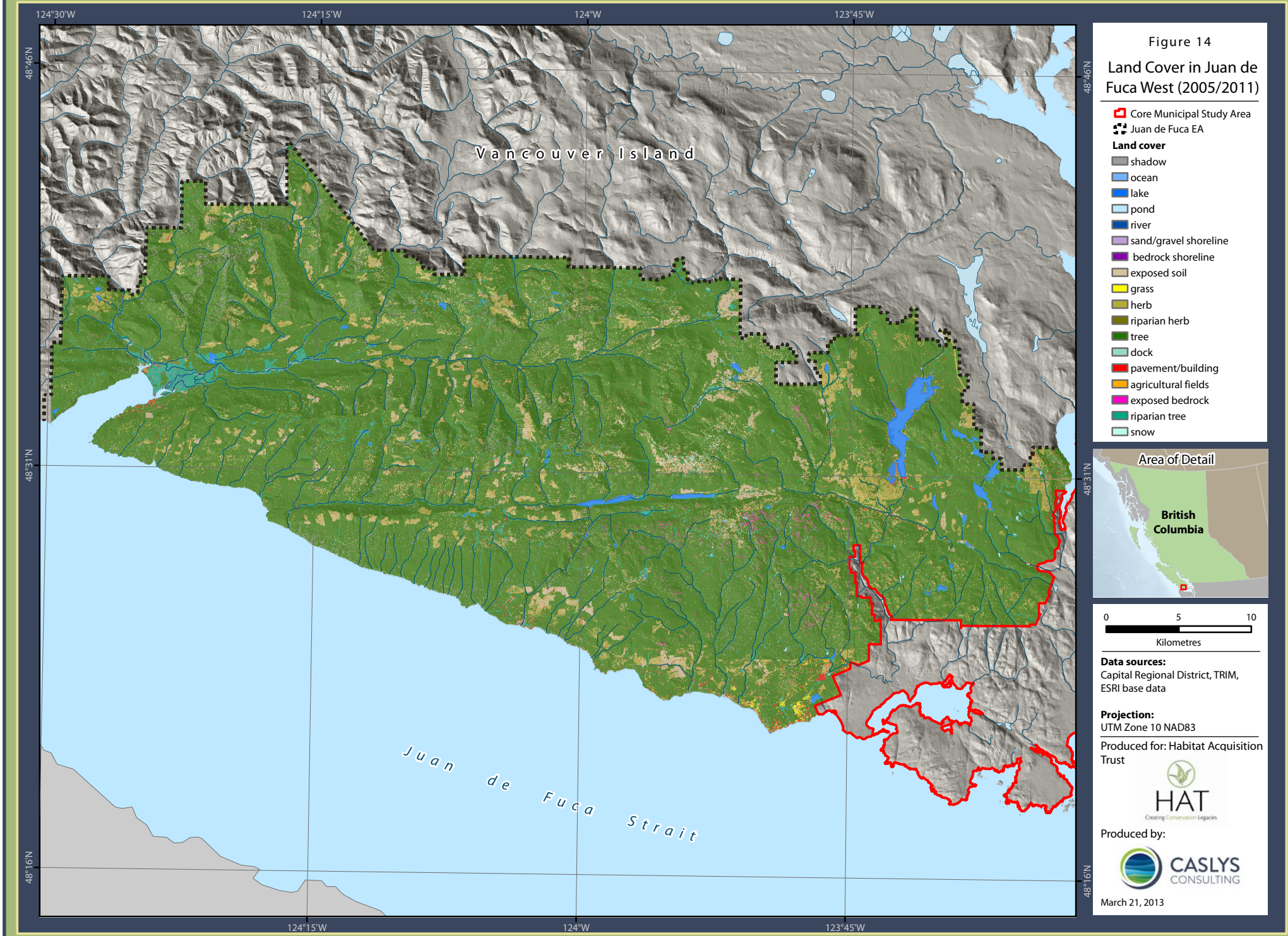
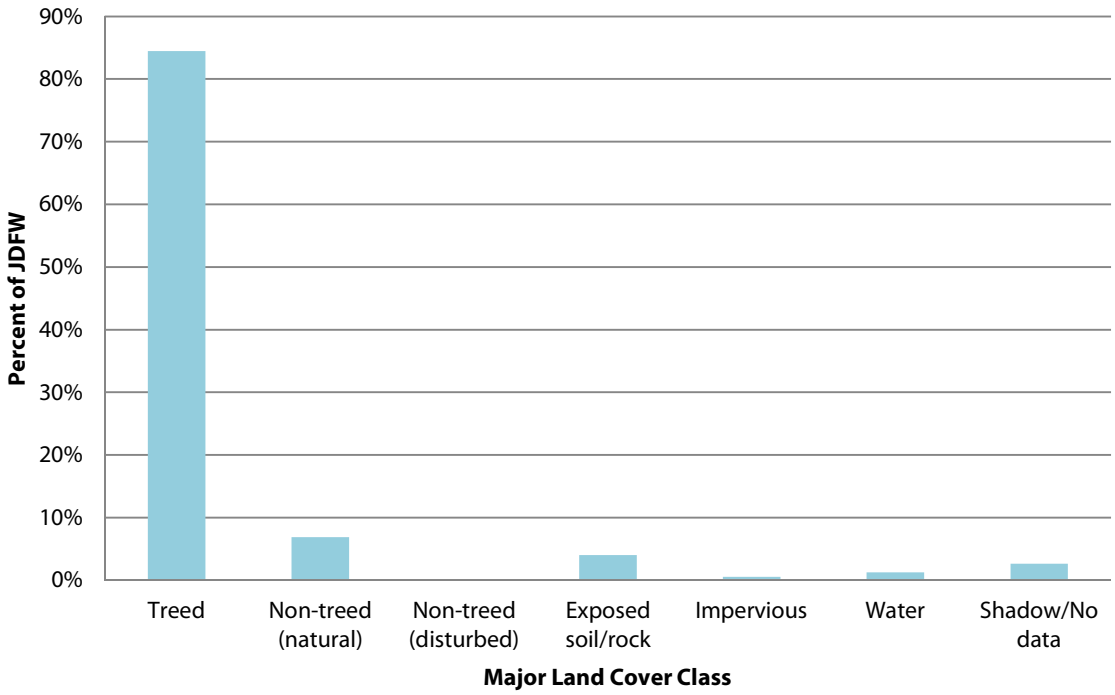

124°30'W
124°15'W
124°W
123°45'W
48°46'N
48°31'N
48°16'N
Vancouver Island
Juan de Fuca Strait
Figure 14
Land Cover in Juan de Fuca West (2005/2011)
Core Municipal Study Area
Juan de Fuca EA
Land cover
shadow
ocean
lake
pond
river
sand/gravel shoreline
bedrock shoreline
exposed soil
grass
herb
riparian herb
tree
dock
pavement/building
agricultural fields
exposed bedrock
riparian tree
snow
Area of Detail
British Columbia
0
5
10
Kilometres
Data sources:
Capital Regional District, TRIM, ESRI base data
Projection:
UTM Zone 10 NAD83
Produced for: Habitat Acquisition Trust
HAT
Creating Conservation Legacies
Produced by:
CASLYS CONSULTING
March 21, 2013

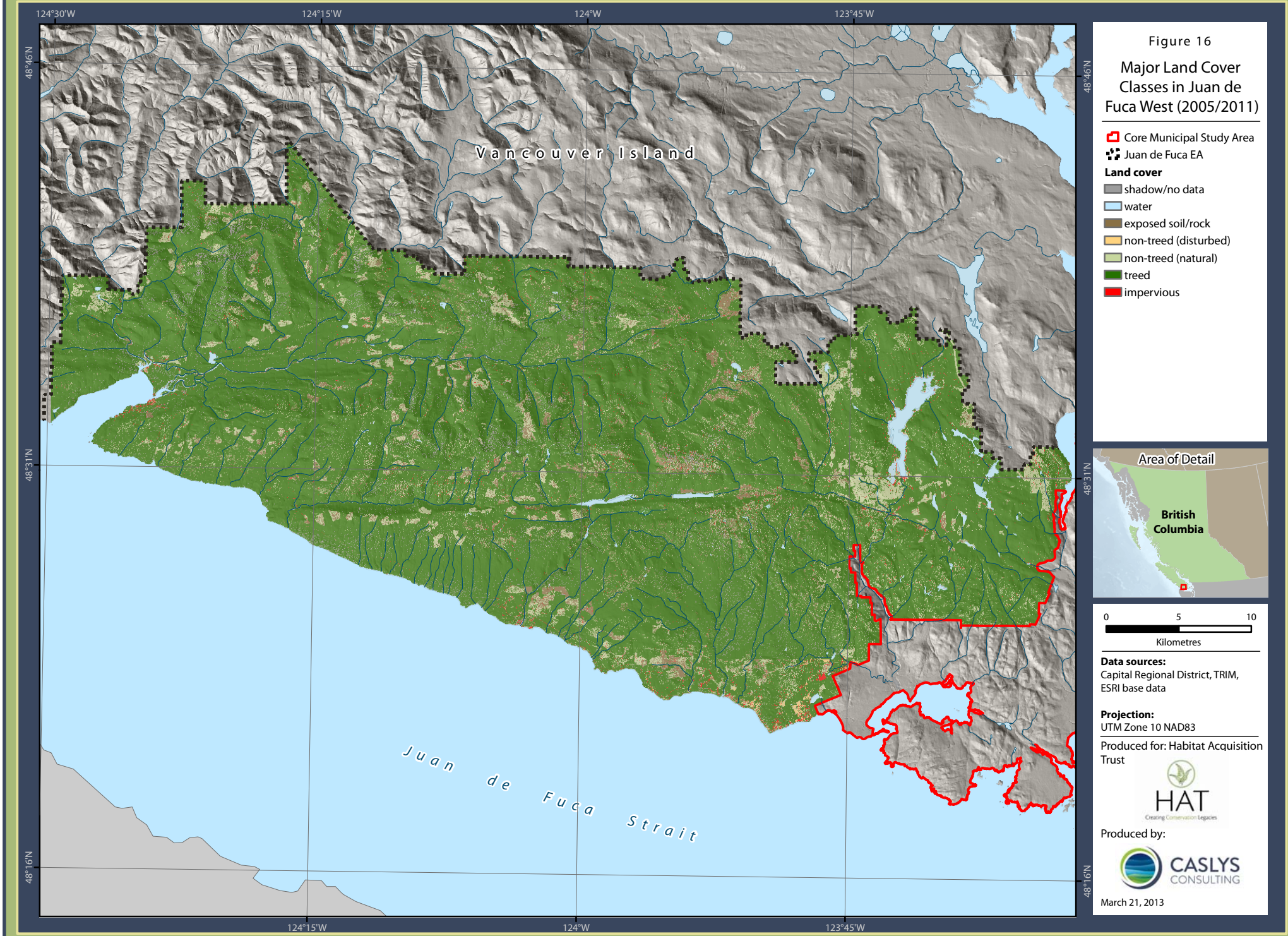
Table 12 groups the land cover classes into major classes for JDFW and the results are illustrated in Figure 13. As mentioned above, treed land covers dominate the area – 84.5% of JDFW is treed. Figure 16 maps the major land cover classes within JDFW.

Table 12. Major Land Cover Classes in Juan de Fuca West

Major Land Cover Class	2011 Area (ha)	2011 % of JDFW
Treed	124,446.1	84.5%
Non-treed (natural)	10,148.5	6.9%
Non-treed (disturbed)	167.3	0.1%
Exposed soil/rock	5,950.4	4.0%
Impervious	812.7	0.6%
Water	1,891.6	1.3%
Shadow	3,900.9	2.6%
	147,317.7	

Figure 15. Percentage of Major Land Cover Classes in Juan de Fuca West




124°30'W
124°15'W
124°W
123°45'W
48°46'N
48°31'N
48°16'N
Vancouver Island
Juan de Fuca Strait
Figure 16
Major Land Cover Classes in Juan de Fuca West (2005/2011)
Core Municipal Study Area
Juan de Fuca EA
Land cover
shadow/no data
water
exposed soil/rock
non-treed (disturbed)
non-treed (natural)
treed
impervious
Area of Detail
British Columbia
0
5
10
Kilometres
Data sources:
Capital Regional District, TRIM, ESRI base data
Projection:
UTM Zone 10 NAD83
Produced for: Habitat Acquisition Trust
HAT
Creating Conservation Legacies
Produced by:
CASLYS CONSULTING
March 21, 2013

3.1.3 Impervious and Treed Land Covers by Jurisdiction

3.1.3.1 Tree Cover

Detailed land cover statistics were generated for each of the 26 jurisdictions (comprised of 13 municipalities, 12 First Nation reserves[9] and the Juan de Fuca Electoral Area) in the CMSA. Table 13 summarizes the changes related to treed land covers by jurisdiction. When interpreting the statistics it is important to consider the percentage change values in the context of the absolute area values and vice versa. In jurisdictions with minimal tree cover a small change in area may represent a large percentage change. Alternatively, jurisdictions with more trees can have significantly larger losses in terms of area that represent minimal percentage change values. The results indicate the following for the municipalities:

- The amount of treed land cover is decreasing in all 13 municipalities - ranging from a loss of 7.4 ha in Sidney to 378.3 ha in Saanich.
- The three municipalities with the highest percentage of tree cover in 2011 were Juan de Fuca Electoral Area (88.9%), Highlands (84.0%) and Metchosin (75.3%).
- The three municipalities with the lowest percentage of tree cover in 2011 were Esquimalt (27.9%), Victoria (22.6%) and Sidney (18.3%).
- Of the municipalities, Sidney, Esquimalt and Oak Bay have the least area of treed land covers in 2011 at 92.9, 197.4, and 362.4 ha respectively.
- Juan de Fuca EA (in the CMSA), Saanich and Metchosin have the greatest area of treed land covers at 3,825.5, 4,676.9 and 5,259.6 ha respectively.
- The three municipalities that lost the most tree cover in terms of absolute area were Saanich, Langford and Sooke (378.3, 118.6 and 82.1 ha respectively).
- The three municipalities with the highest percentage change in tree cover over the six years were Sidney (-7.4%), Saanich (-7.5%) and Victoria (-8.8%). This represents a loss of 7.4, 378.3 and 42.5 ha respectively.
- The three municipalities with the lowest percentage change over the six years were Juan de Fuca Electoral Area (-0.9%), Metchosin (-1.3%) and Highlands (-1.4%).

[9] Statistics for the First Nations reserves have been present in Appendix A.

Table 13. Summary of Treed Land Covers by Jurisdiction

Jurisdiction	2005 Area (ha)	2005 % of Juris-diction	2011 Area (ha)	2011 % of Juris-diction	Difference Area (ha)	% Change 2005 to 2011	% Difference 2005 to 2011
First Nations Reserves							
Becher Bay First Nation Reserve No. 1	239.8	87.6%	237.2	86.7%	-2.6	-1.1%	-0.9%
Becher Bay First Nation Reserve No. 2	98.7	85.3%	98.3	85.0%	-0.3	-0.3%	-0.3%
Cole Bay First Nation Reserve	258.1	93.0%	256.3	92.4%	-1.8	-0.7%	-0.6%
East Saanich First Nation Reserve	125.0	49.5%	121.7	48.2%	-3.3	-2.6%	-1.3%
Esquimalt First Nation Reserve	7.5	34.5%	7.1	32.6%	-0.4	-5.5%	-1.9%
Goldstream First Nation Reserve	5.4	94.5%	5.4	94.6%	0.0	0.1%	0.1%
Long Neck Island First Nation Reserve	1.5	47.3%	1.5	47.1%	0.0	-0.4%	-0.2%
New Songhees First Nation Reserve	20.0	30.0%	19.1	28.6%	-0.9	-4.5%	-1.3%
Sooke First Nation Reserve No. 1	18.1	62.2%	17.9	61.4%	-0.2	-1.2%	-0.8%
Sooke First Nation Reserve No. 2	38.1	81.2%	37.9	80.9%	-0.1	-0.4%	-0.3%
South Saanich First Nation Reserve	128.3	62.9%	127.1	62.3%	-1.2	-0.9%	-0.6%
Union Bay First Nation Reserve	20.5	69.9%	20.3	69.4%	-0.2	-0.8%	-0.6%
Municipality							
Central Saanich	1,314.9	31.6%	1,234.0	29.6%	-80.9	-6.2%	-1.9%
Colwood	778.2	44.0%	737.1	41.7%	-41.0	-5.3%	-2.3%
Esquimalt	209.5	29.6%	197.4	27.9%	-12.1	-5.8%	-1.7%
Highlands	3,254.1	85.2%	3,207.5	84.0%	-46.6	-1.4%	-1.2%
Juan de Fuca EA (in the CMSA)	3,859.6	89.7%	3,825.5	88.9%	-34.1	-0.9%	-0.8%
Langford	2,587.1	63.3%	2,468.5	60.4%	-118.6	-4.6%	-2.9%
Metchosin	5,326.3	76.3%	5,259.6	75.3%	-66.7	-1.3%	-1.0%
North Saanich	1,657.0	44.6%	1,587.2	42.7%	-69.8	-4.2%	-1.9%
Oak Bay	386.9	37.4%	362.4	35.0%	-24.5	-6.3%	-2.4%
Saanich	5,055.2	47.3%	4,676.9	43.7%	-378.3	-7.5%	-3.5%
Sidney	100.3	19.8%	92.9	18.3%	-7.4	-7.4%	-1.5%
Sooke	3,703.5	73.1%	3,621.4	71.5%	-82.1	-2.2%	-1.6%
Victoria	482.5	24.8%	440.0	22.6%	-42.5	-8.8%	-2.2%
View Royal	982.2	65.6%	960.4	64.1%	-21.8	-2.2%	-1.5%
TOTAL	**30,658.3**		**29,620.6**		**-1,037.7**		

*Negative numbers indicate a decrease and positive an increase in the number of hectares within each class over the six year time period. Percent change quantifies change in the class (i.e., the difference between two time periods divided by the area of that class in the earlier time period), whereas percent difference compares the class to the overall composition in the area of interest (i.e., a 2011 % of jurisdiction value is subtracted from the 2005 value).

Figure 17 illustrates the total area of treed land covers in both 2005 and 2011 for each of the municipalities and Figure 18 summarizes the total area lost for each municipality. Figure 19 compares the percentage of tree cover within each municipality for both time periods and Figure 20 summarizes the percent change between 2005 and 2011.

Figure 17. Tree Cover Area by Municipality 2005 and 2011

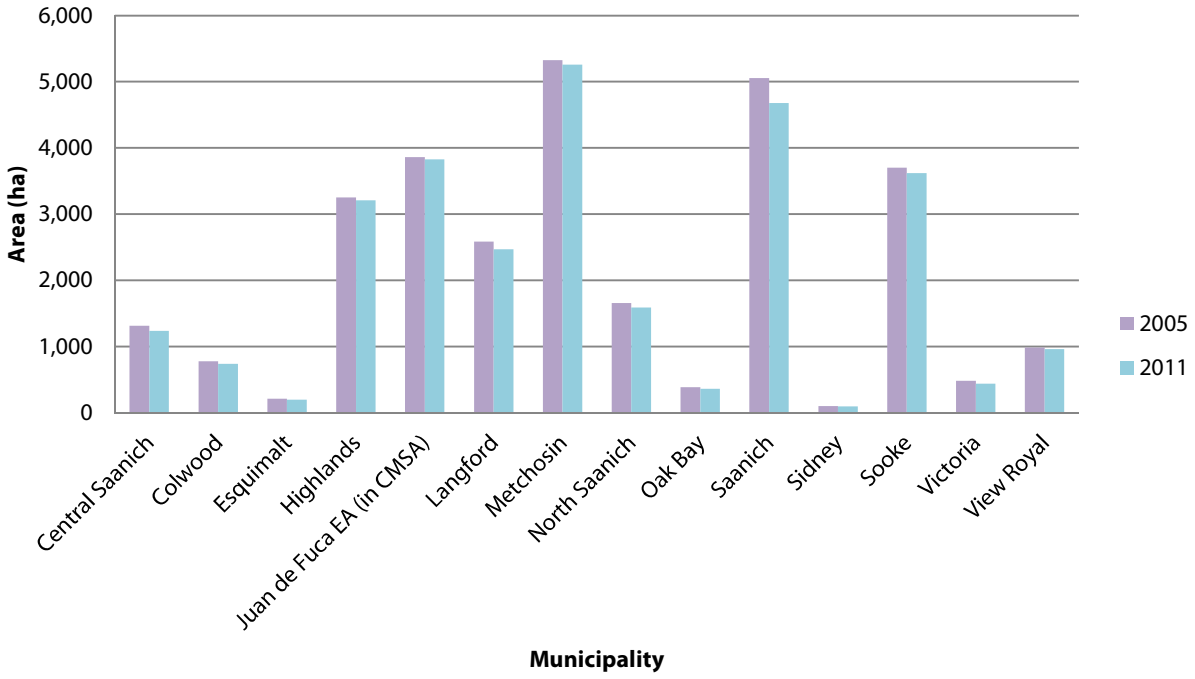


Figure 18. Loss in Tree Cover Area between 2005 and 2011 by Municipality

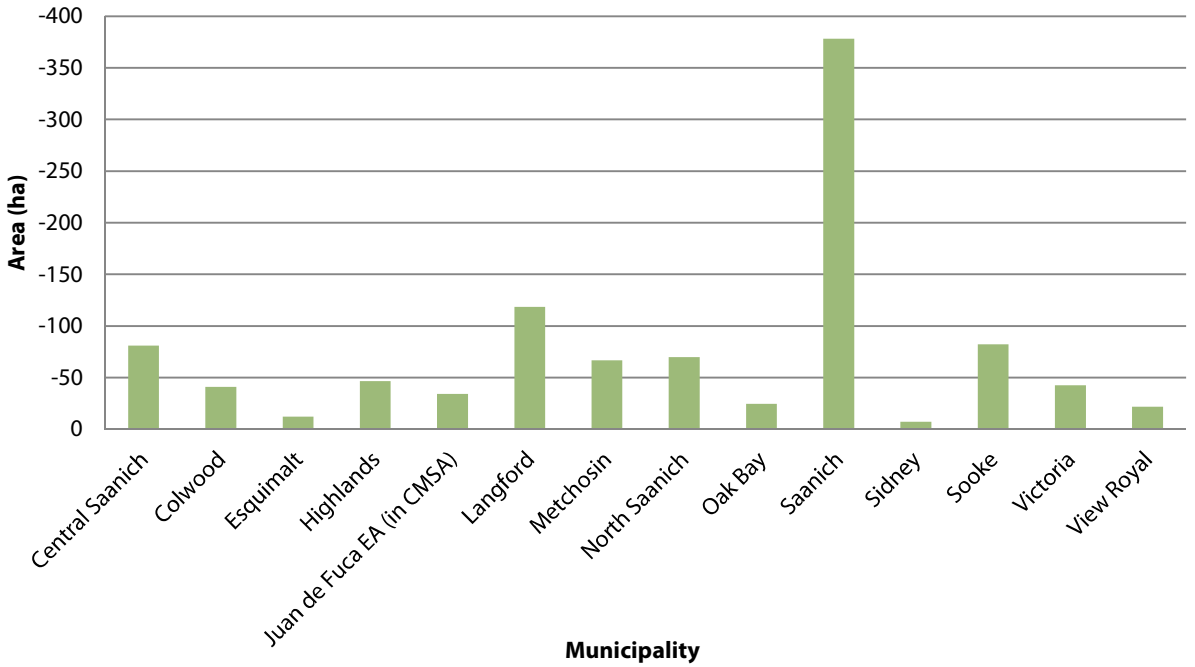


Figure 19. Tree Cover Percentage by Municipality 2005 to 2011

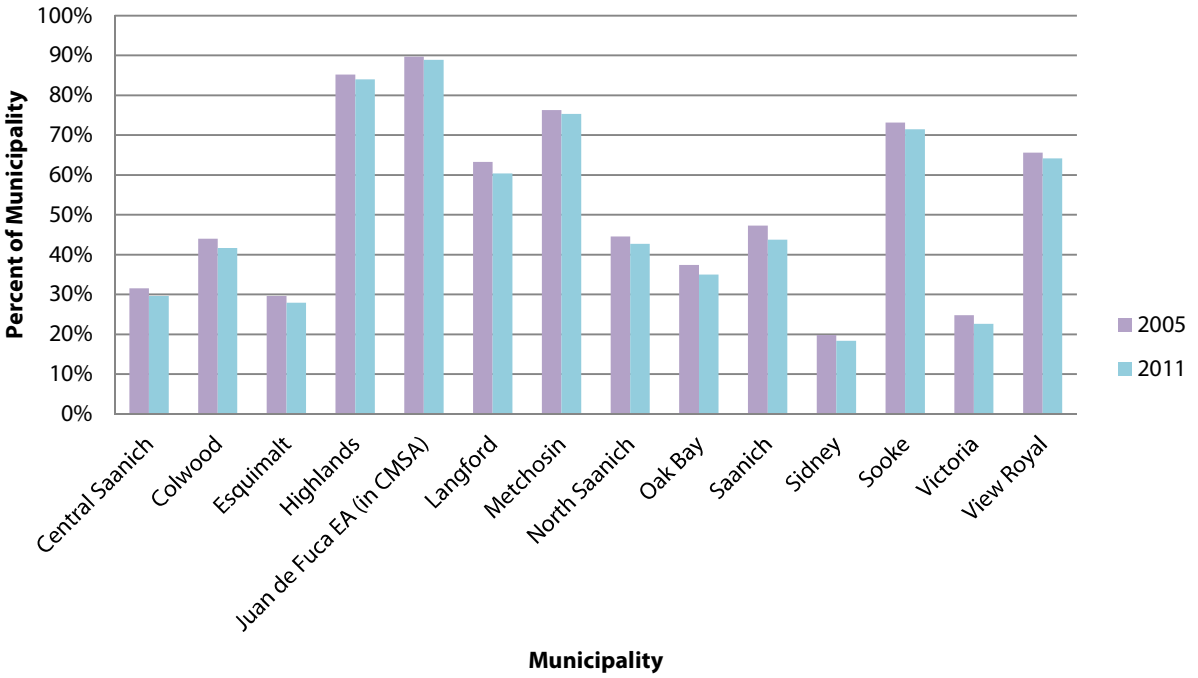
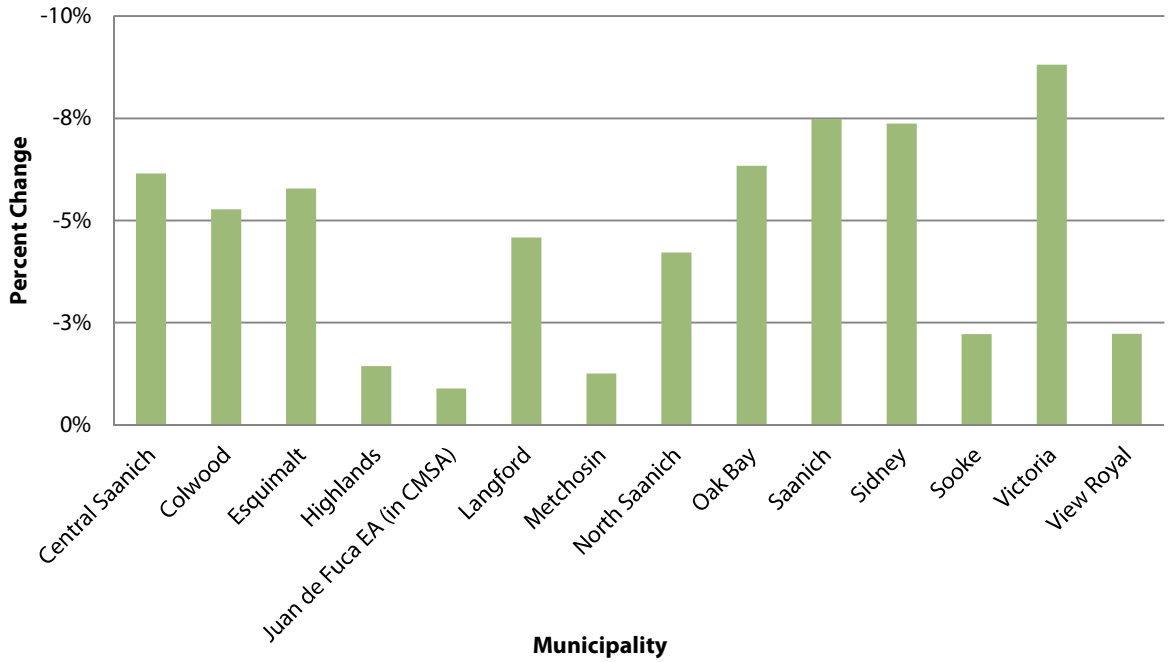


Figure 20. Percent Change (Loss) in Tree Cover between 2005 and 2011 by Municipality



3.1.3.2 Impervious Surface

Table 14 summarizes the changes related to impervious land covers by jurisdiction[10]. The results for the municipalities indicate that the following:

- The amount of impervious surface is increasing in all but two of the municipalities/reserves ranging from a gain of 19.2 ha in Sidney to 532.8 ha in Saanich.
- The three municipalities with the highest percentage of impervious surface in 2011 were Esquimalt (43.8%), Sidney (51.4%) and Victoria (55.7%).
- The three municipalities with the lowest percentage of impervious surface in 2011 were Juan de Fuca EA (2.4%), Highlands (3.1%) and Metchosin (4.3%).
- Juan de Fuca EA, Highlands and View Royal have the least area of impervious surface at 103.3, 116.5, and 245.3 ha respectively.
- Langford, Victoria and Saanich have the greatest area of impervious surface at 781.1, 1,082.3 and 2,559.1 ha respectively. Two of the three (Langford and Saanich) were among the municipalities that gained the most impervious surface in terms of absolute area (183.4 and 532.8 ha respectively). The third one being Sooke with an increase of 118.2 ha.
- The three municipalities with the highest percentage change in impervious surface over the six years were Sooke (40.4%), Highlands (42.1%) and Juan de Fuca EA (49.7%). These values represent a gain of 118.2, 34.5 and 34.3 ha respectively.
- The three municipalities with the lowest percentage change over the six years were Sidney (8.0%), Victoria (9.3%) and Esquimalt (9.7%).

Table 14. Summary of Impervious Land Covers by Jurisdiction

Jurisdiction	2005 Area (ha)	2005 % of Jurisdiction	2011 Area (ha)	2011 % of Jurisdiction	Difference Area (ha)	% Change 2005 to 2011	% Difference 2005 to 2011
First Nation Reserves							
Becher Bay First Nation Reserve No. 1	7.5	2.7%	10.2	3.7%	2.7	35.4%	1.0%
Becher Bay First Nation Reserve No. 2	0.1	0.1%	0.1	0.1%	0.1	101.5%	0.1%
Cole Bay First Nation Reserve	6.2	2.2%	7.8	2.8%	1.6	25.9%	0.6%
East Saanich First Nation Reserve	33.8	13.4%	44.6	17.7%	10.9	32.2%	4.3%
Esquimalt First Nation Reserve	4.2	19.3%	5.6	25.8%	1.4	33.7%	6.5%
Goldstream First Nation Reserve	0.3	4.7%	0.3	4.8%	0.0	2.3%	0.1%
Long Neck Island First Nation Reserve	0.1	2.2%	0.1	2.5%	0.0	14.1%	0.3%
New Songhees First Nation Reserve	28.3	42.4%	31.1	46.5%	2.8	9.9%	4.2%
Sooke First Nation Reserve No. 1	4.0	13.8%	4.6	15.7%	0.6	14.1%	1.9%
Sooke First Nation Reserve No. 2	2.2	4.7%	2.8	5.9%	0.6	26.6%	1.2%
South Saanich First Nation Reserve	15.4	7.6%	18.8	9.2%	3.4	22.2%	1.7%
Union Bay First Nation Reserve	2.9	9.7%	3.2	10.9%	0.3	11.5%	1.1%

[10] Statistics for the First Nations reserves have been presented in Appendix B.

Jurisdiction	2005 Area (ha)	2005 % of Jurisdiction	2011 Area (ha)	2011 % of Jurisdiction	Difference Area (ha)	% Change 2005 to 2011	% Difference 2005 to 2011
Municipality							
Central Saanich	474.6	11.4%	582.4	14.0%	107.7	22.7%	2.6%
Colwood	345.8	19.6%	410.7	23.2%	64.9	18.8%	3.7%
Esquimalt	281.8	39.9%	309.2	43.8%	27.4	9.7%	3.9%
Highlands	82.0	2.1%	116.5	3.1%	34.5	42.1%	0.9%
Juan de Fuca EA	69.0	1.6%	103.3	2.4%	34.3	49.7%	0.8%
Langford	597.7	14.6%	781.1	19.1%	183.4	30.7%	4.5%
Metchosin	221.0	3.2%	298.8	4.3%	77.8	35.2%	1.1%
North Saanich	529.3	14.2%	634.1	17.1%	104.7	19.8%	2.8%
Oak Bay	291.9	28.2%	330.6	32.0%	38.7	13.3%	3.7%
Saanich	2,026.3	18.9%	2,559.1	23.9%	532.8	26.3%	5.0%
Sidney	240.8	47.6%	260.0	51.4%	19.2	8.0%	3.8%
Sooke	292.7	5.8%	410.9	8.1%	118.2	40.4%	2.3%
Victoria	990.5	50.9%	1,082.3	55.7%	91.8	9.3%	4.7%
View Royal	203.2	13.6%	245.3	16.4%	42.1	20.7%	2.8%
TOTAL	**6,751.5**		**8,253.4**		**1,501.9**		

*Negative numbers indicate a decrease and positive an increase in the number of hectares within each class over the six year time period. Percent change quantifies change in the class (i.e., the difference between two time periods divided by the area of that class in the earlier time period), whereas percent difference compares the class to the overall composition in the area of interest (i.e., a 2011 % of jurisdiction value is subtracted from the 2005 value).

Figure 21 illustrates the total area of impervious surface by municipality for 2005 and 2011 and Figure 22 summarizes the total increase for each municipality. Figure 23 compares the percentage of impervious surface within each municipality for both time periods and Figure 24 summarizes the percent change between 2005 and 2011.

Figure 21. Impervious Surface Area by Municipality 2005 and 2011

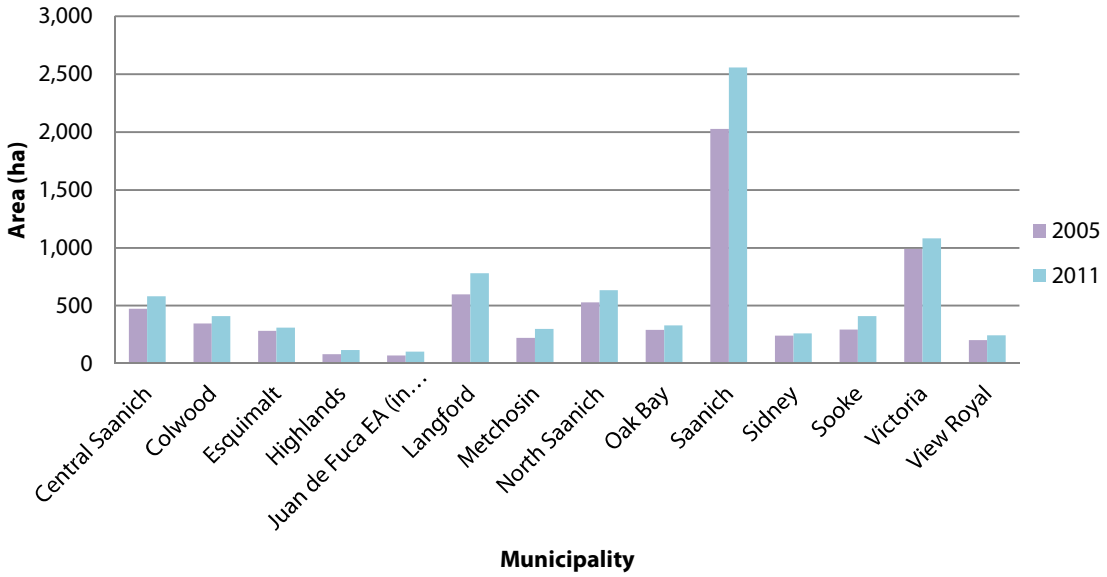


Figure 22. Increase in Impervious Surface Area between 2005 and 2011 by Municipality

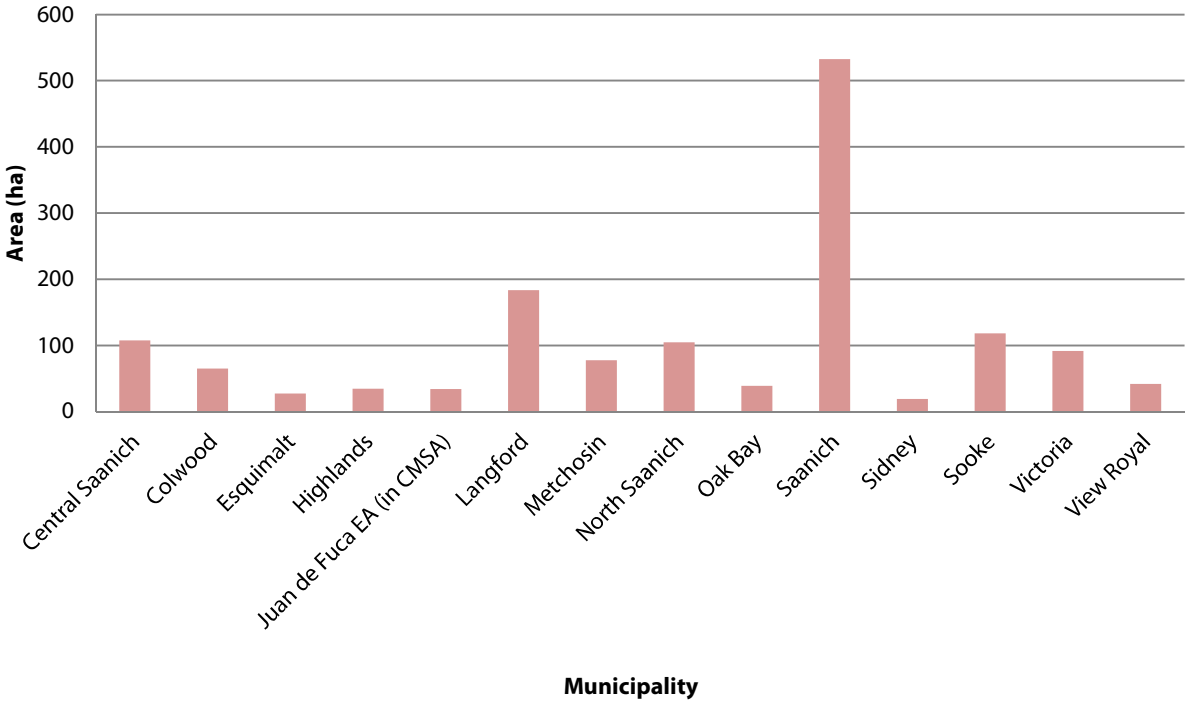


Figure 23. Impervious Surface Percentage by Municipality 2005 to 2011

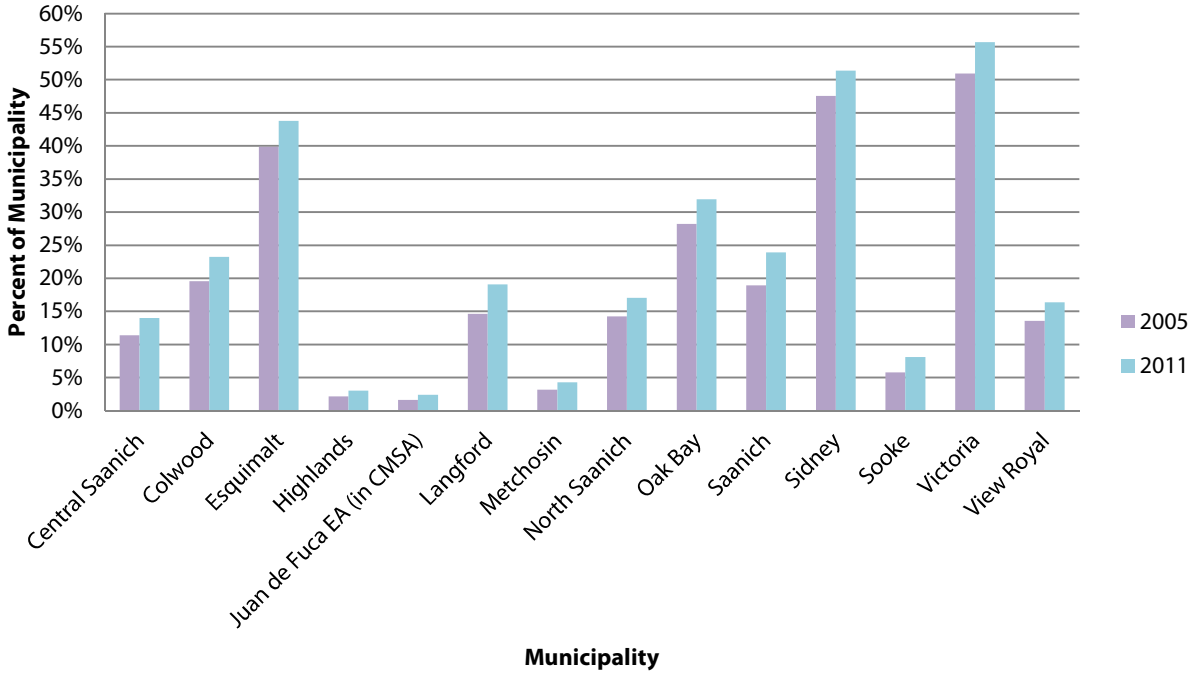
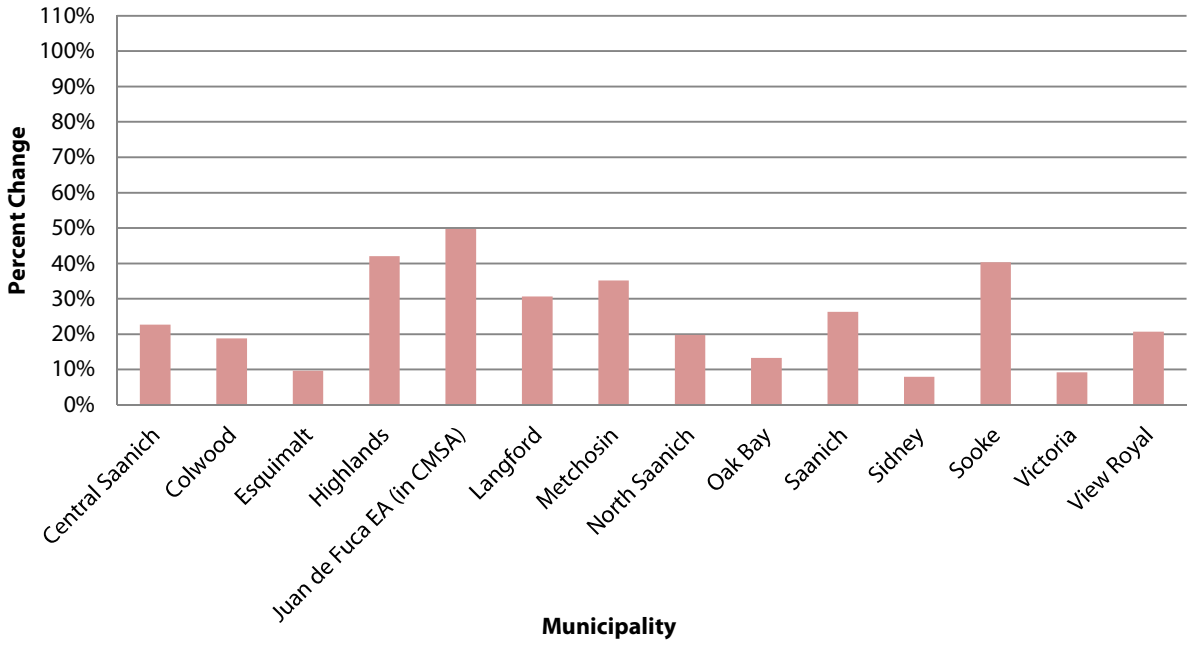


Figure 24. Percent Change (Increase) in Impervious Surface Area between 2005 and 2011 by Municipality



3.2 Tree Cover Density

The tree cover density statistics are based on the percentage of tree cover in each one-hectare grid cell. For interpretation purposes, the density values have been grouped into the following classes: 0-5, >5-10, >10-25, >25-50, >50-75, and >75. The values have been summarized for the CMSA; JDFW; each jurisdiction; and for the parks within the CMSA. These results are presented in the following sections. As with the land cover results, when interpreting the statistics it is important to consider the percent change in the context of the change in area – classes with small areas can have a large percentage changes.

3.2.1 Core Municipal Study Area

Tree cover density values for the CMSA for the three time periods are presented in Table 15 and illustrated in Figure 25. It should be noted that a much higher degree of confidence can be place in the 2005 versus 2011 comparison than between 1986 and 2005 due to quality issues associated with the 1986 air photo. It is also important to note that decreases in tree cover do not necessarily reflect increases in impervious surfaces because lost trees may have been replaced by another pervious surface (e.g., grass or agricultural fields). Between 1986 and 2005, the results indicate that:

- The number of cells that are primarily unforested (0-5% tree cover) are decreasing by 24.5% which could be a result of an increase in the number or trees planted or regrowth in urban or rural cleared areas, however, an inspection of the results indicates that this is primarily due to resolution issues associated with the 1986 imagery.
- The number of very high density forest cells (>75% tree cover) is decreasing during this time period by 4.6% (1,106 ha). These areas represent the removal of relatively intact forest from the landscape generally due to urban and agricultural expansion.

The changes between 2005 and 2011 indicate a trend toward lower density tree stands in the CMSA:

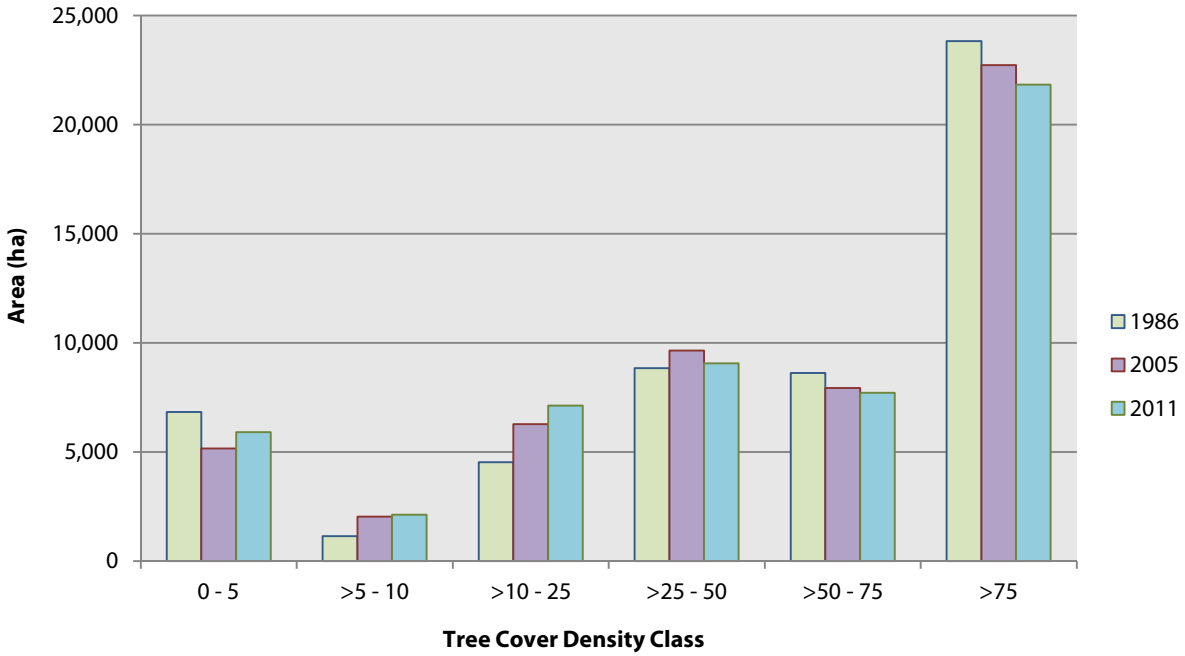
- The three higher density classes are all decreasing while the three lower density classes are all increasing.
- The rate of change in the highest density class (>75% tree cover) appears to be increasing – in the 19 years between 1986 and 2005 the loss was 58.2 ha per year, whereas in the six years between 2005 and 2011 the rate of loss was 148.0 ha per year

Table 15. Tree Cover Density in the Core Municipal Study Area – 1986, 2005 and 2011

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of CMSA	Hectares	Percent of CMSA			Hectares	Percent of CMSA		
0 - 5	6,833	12.7%	5,159	9.6%	-1,674	-24.5%	5,906	11.0%	747	14.5%
>5 - 10	1,147	2.1%	2,034	3.8%	887	77.3%	2,129	4.0%	95	4.7%
>10 - 25	4,523	8.4%	6,270	11.7%	1,747	38.6%	7,118	13.2%	848	13.5%
>25 - 50	8,835	16.4%	9,643	17.9%	808	9.1%	9,063	16.9%	-580	-6.0%
>50 - 75	8,623	16.0%	7,931	14.8%	-692	-8.0%	7,709	14.3%	-222	-2.8%
>75	23,835	44.3%	22,729	42.3%	-1,106	-4.6%	21,841	40.6%	-888	-3.9%
Total	**53,796**	**100.0%**	**53,766**	**100.0%**			**53,766**	**100.0%**		

*Negative numbers indicate a decrease and positive an increase in the number of hectares within each class over the six year time period. Percent change quantifies change in the class (i.e., the difference between two time periods divided by the area of that class in the earlier time period), whereas percent difference compares the class to the overall composition in the area of interest (i.e., a 2011 % of CMSA value is subtracted from the 2005 value).

Figure 25. Tree Cover Density Class Frequency in the Core Municipal Study Area – 1986, 2005 and 2011



Figures 26 to 28 map tree cover density in the CMSA for each of the three time periods and Figures 29 to 31 depict where changes in tree cover density are occurring between 1986 to 2005, 2005 to 2011 and 1986 to 2011 respectively.

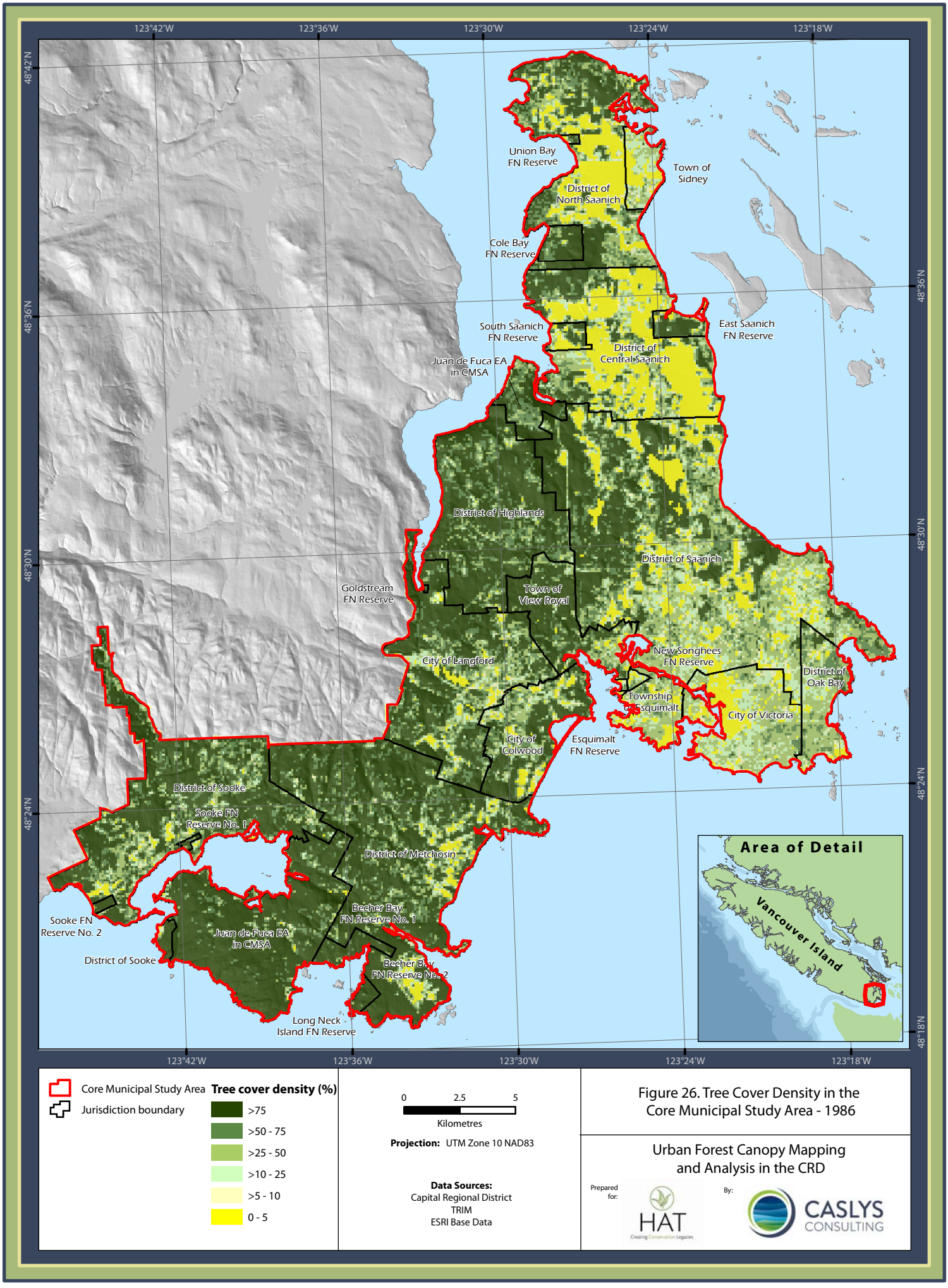


Figure 26. Tree Cover Density in the Core Municipal Study Area - 1986

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT

By: CASLYS CONSULTING

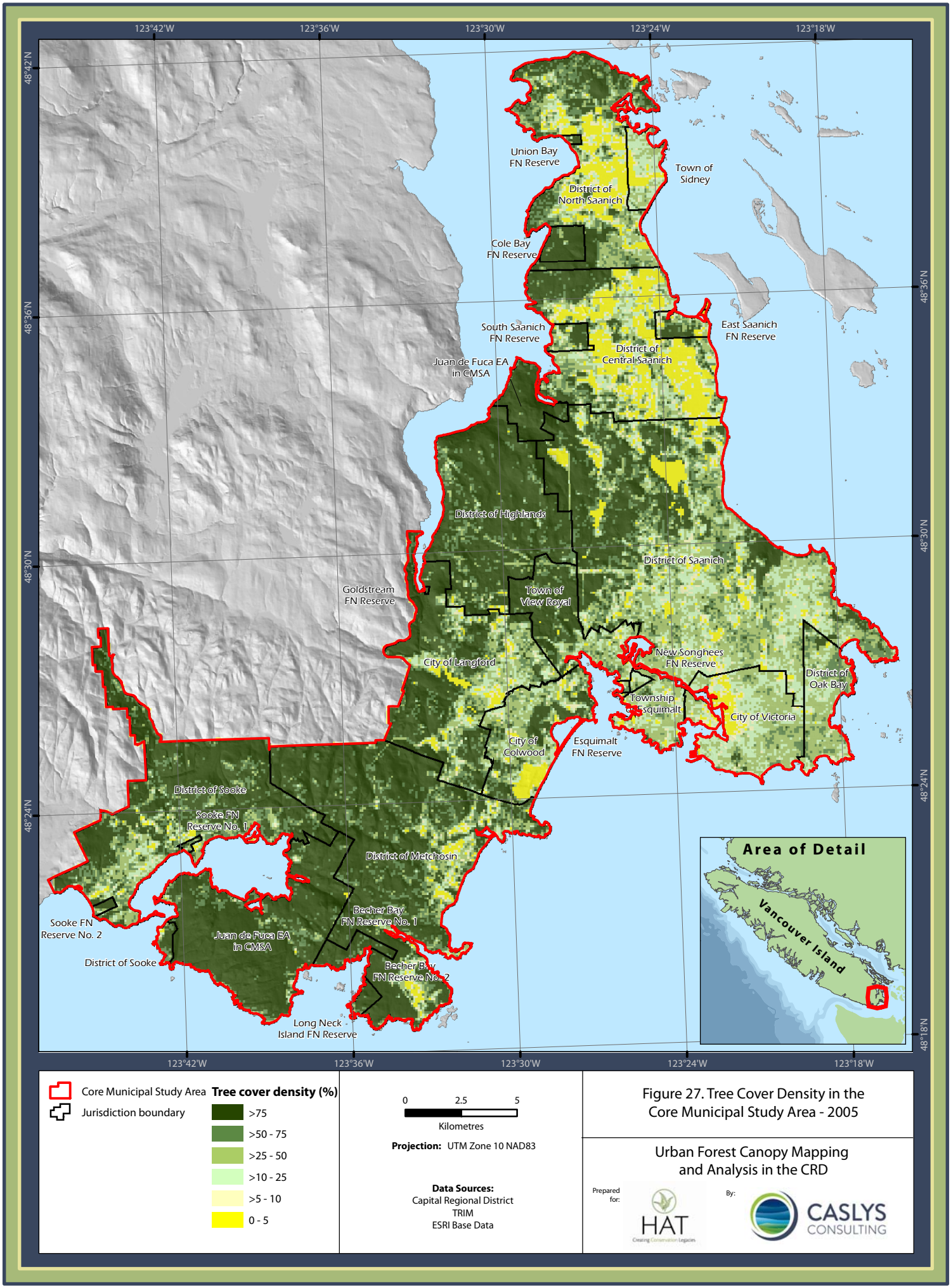


Figure 27. Tree Cover Density in the Core Municipal Study Area - 2005

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT

By: CASLYS CONSULTING

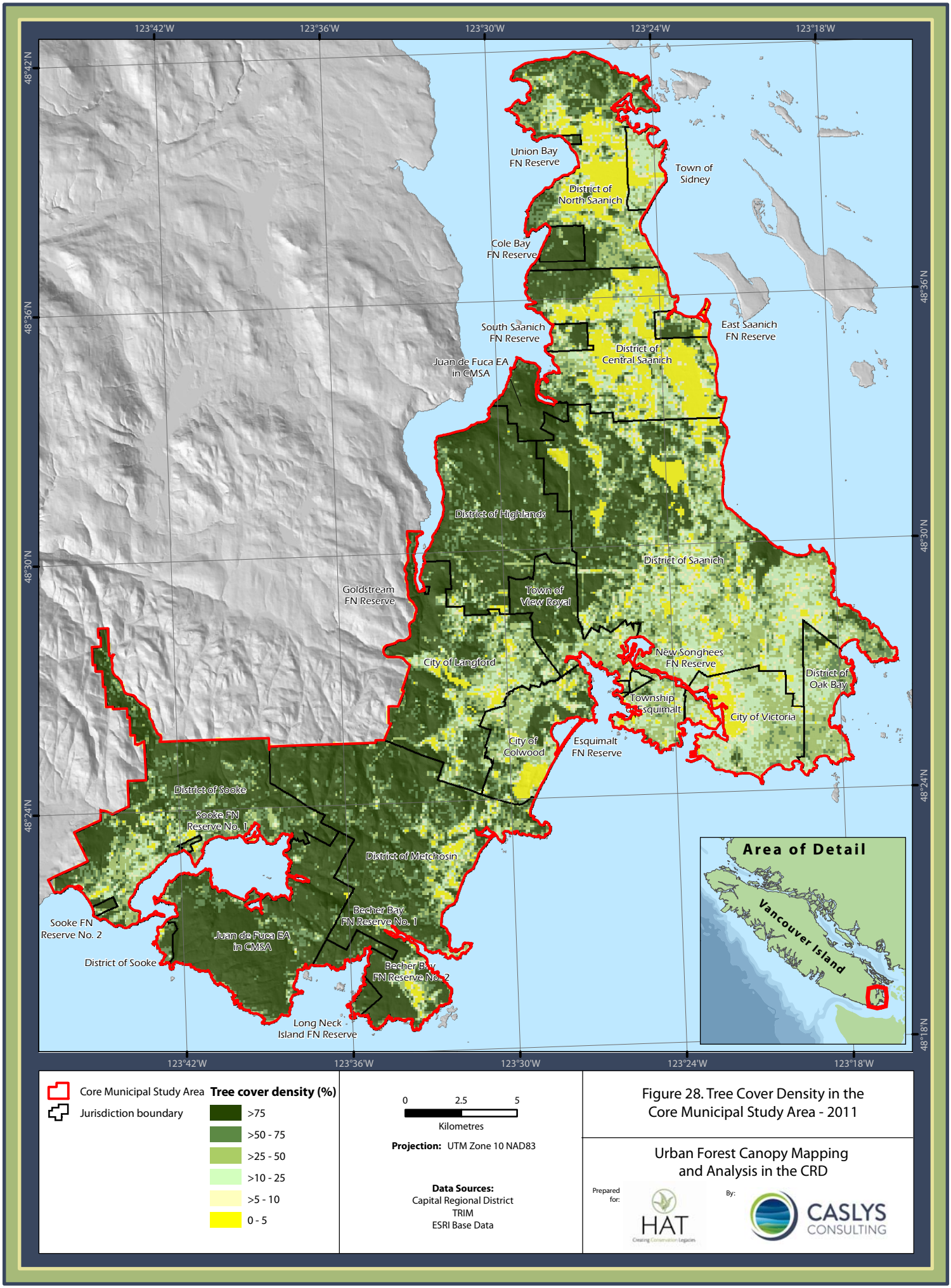


Figure 28. Tree Cover Density in the Core Municipal Study Area - 2011

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT

By: CASLYS CONSULTING

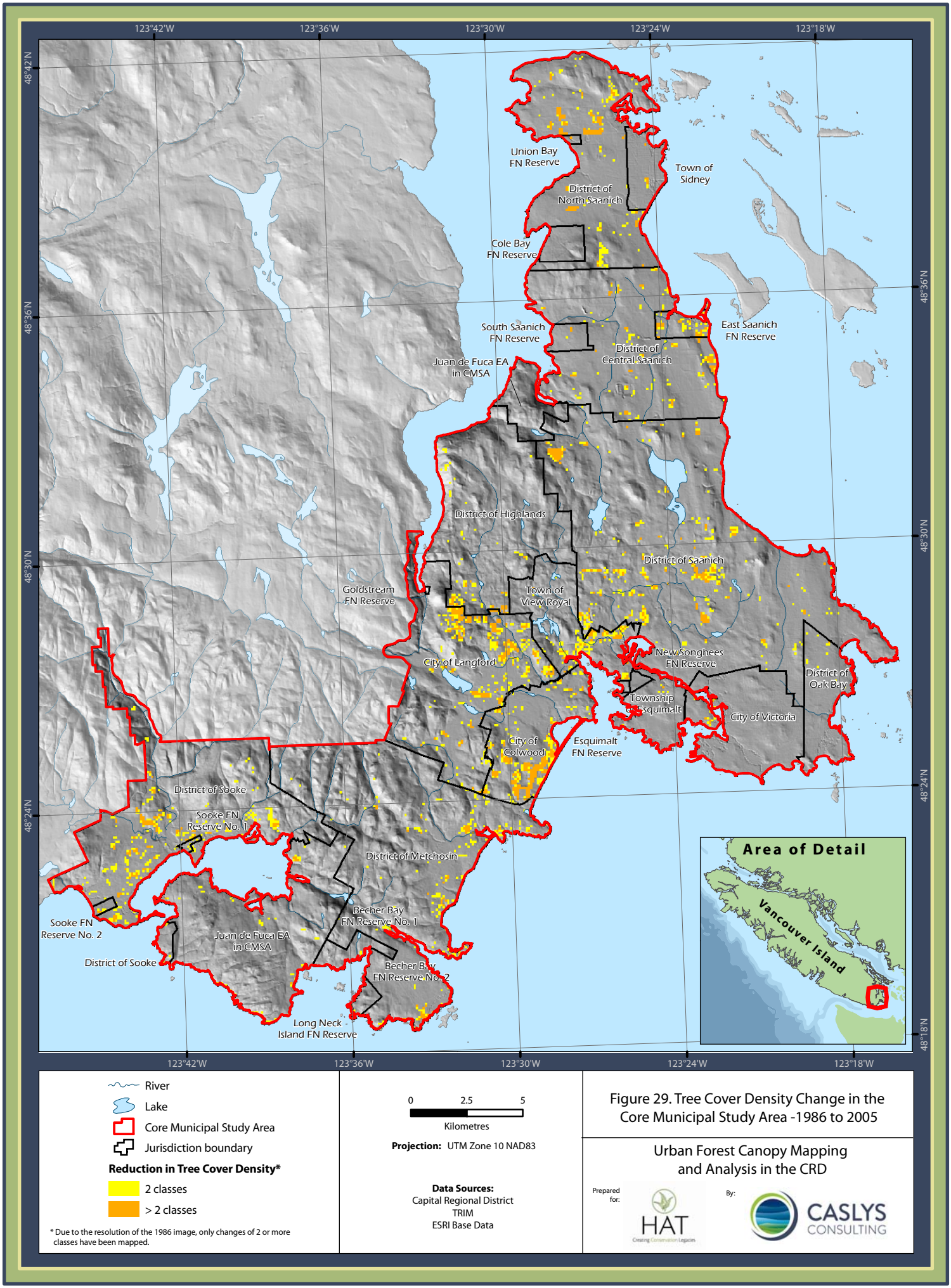


Figure 29. Tree Cover Density Change in the Core Municipal Study Area -1986 to 2005

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT

By: CASLYS CONSULTING

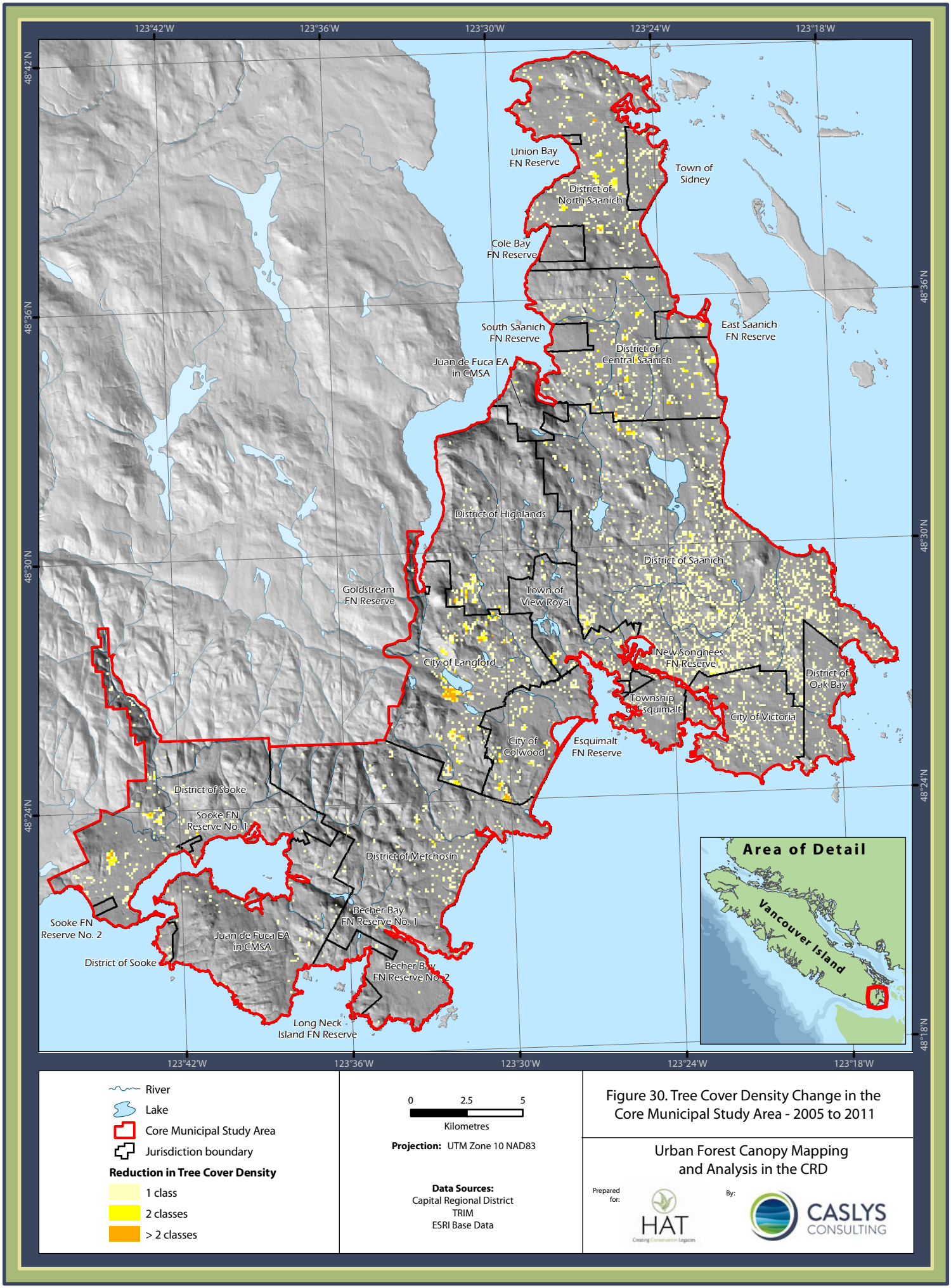


Figure 30. Tree Cover Density Change in the Core Municipal Study Area - 2005 to 2011

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT

By: CASLYS CONSULTING

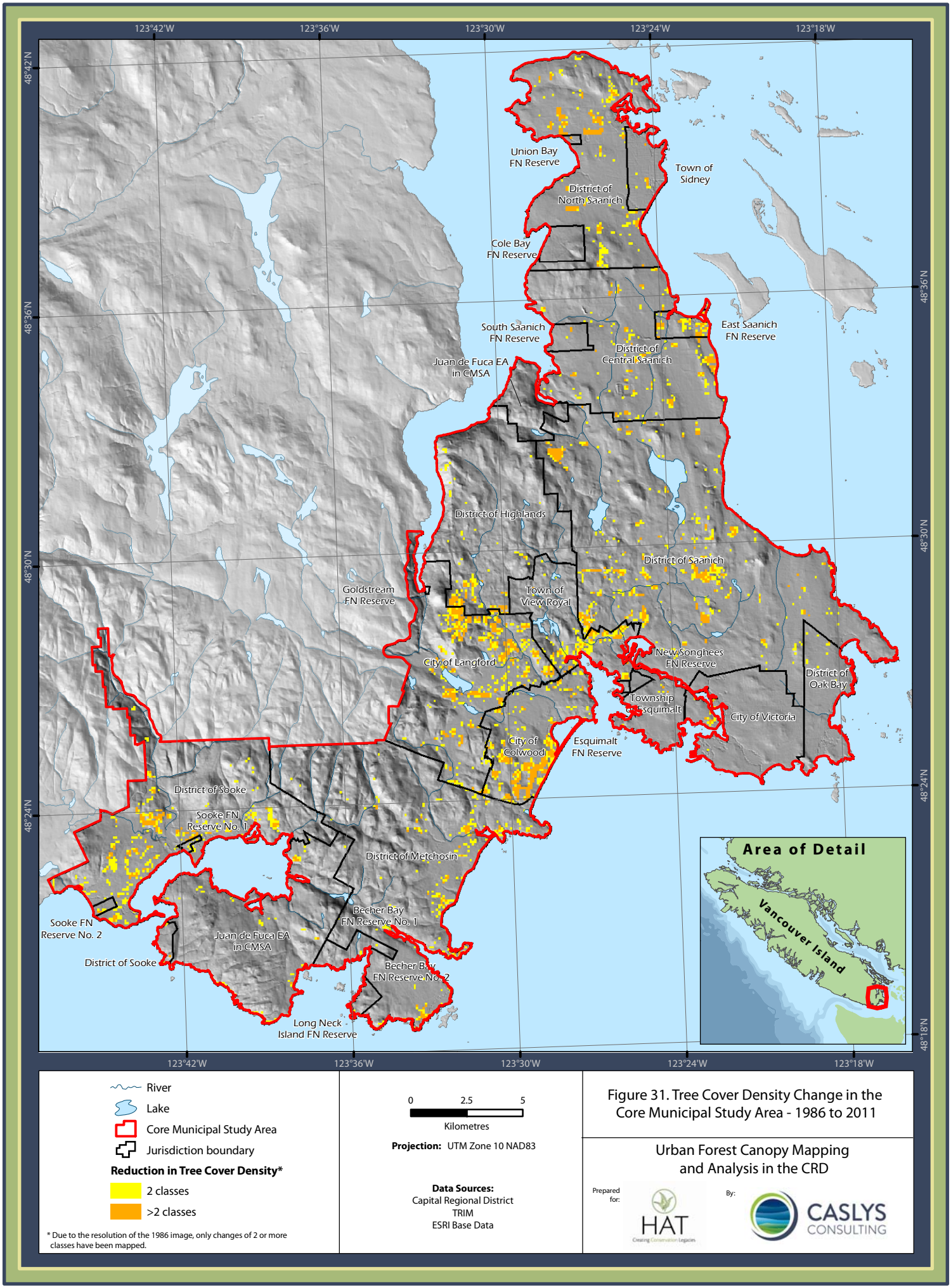


Figure 31. Tree Cover Density Change in the Core Municipal Study Area - 1986 to 2011

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT

By: CASLYS CONSULTING

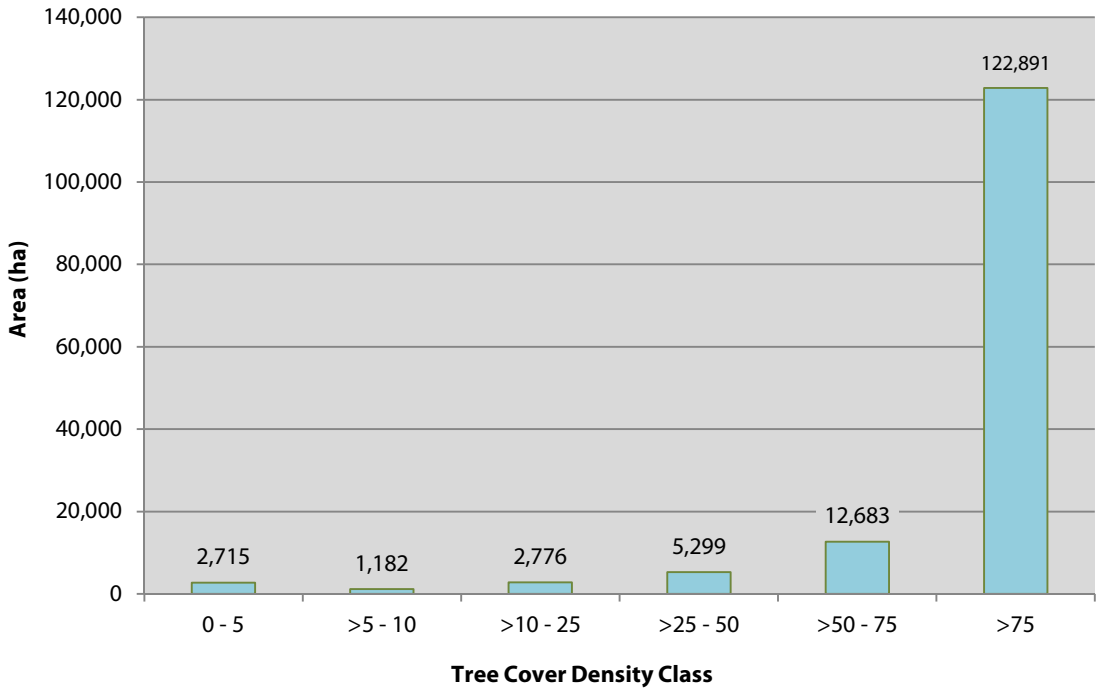
3.2.2 Juan de Fuca Electoral West

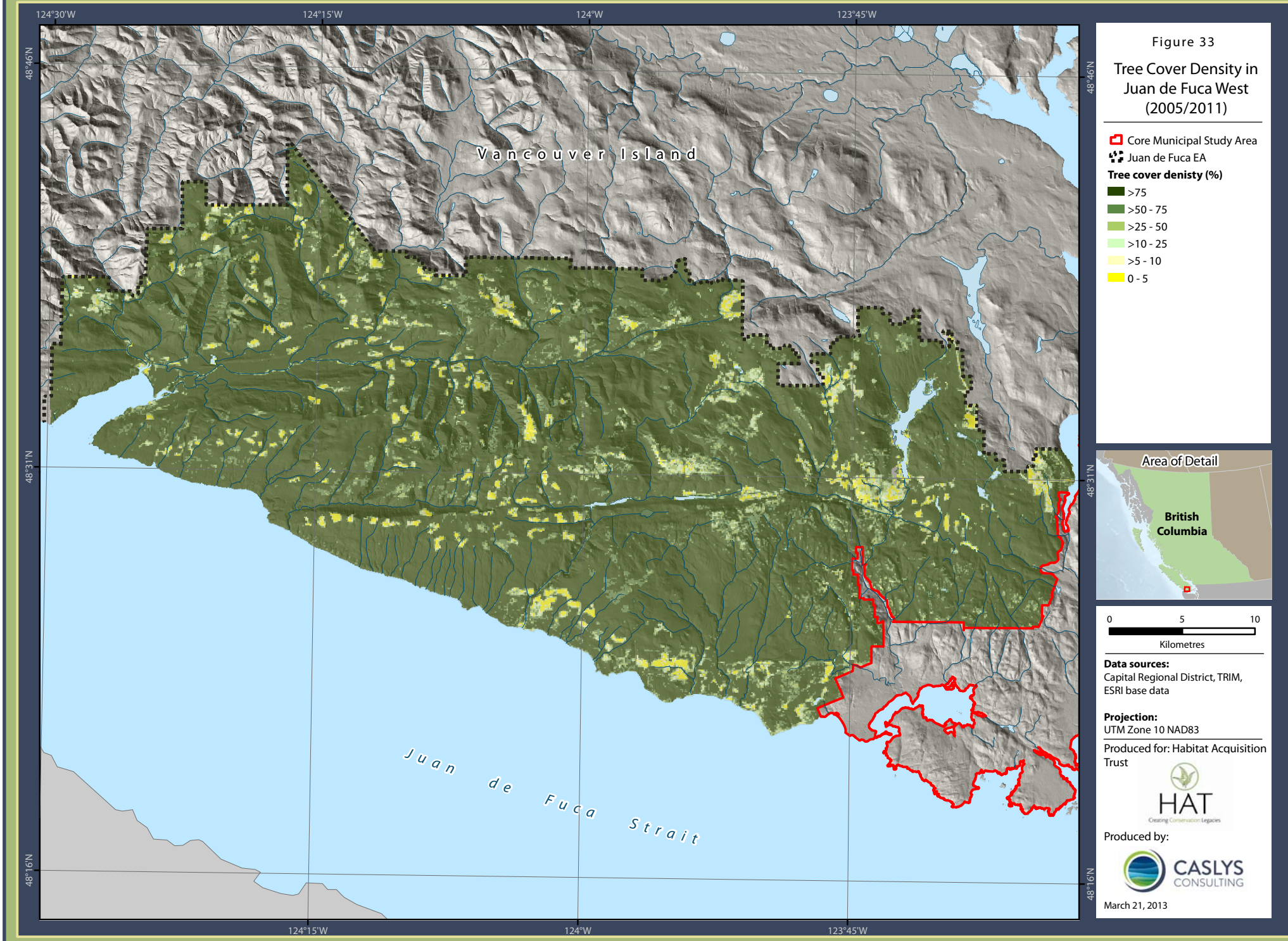
As indicated in Table 16 and Figure 32, the vast majority of JDFW falls within the top two tree cover density class – 83.3% of the land base has a tree cover greater than 75% and 8.6% of the land base falls in the >50-75% class. Figure 33 maps tree cover density in JDFW.

Table 16. Tree Cover Density in Juan de Fuca West

Tree Cover Density Class (%)	Hectares	Percent of JDFW
0 - 5	2,715	1.8%
>5 - 10	1,182	0.8%
>10 - 25	2,776	1.9%
>25 - 50	5,299	3.6%
>50 - 75	12,683	8.6%
>75	122,891	83.3%
Total	**147,546**	**100.0%**

Figure 32. Tree Cover Density Class Frequency in Juan de Fuca West




124°30'W
124°15'W
124°W
123°45'W
48°46'N
48°31'N
48°16'N
Vancouver Island
Juan de Fuca Strait
Figure 33
Tree Cover Density in Juan de Fuca West (2005/2011)
Core Municipal Study Area
Juan de Fuca EA
Tree cover denisty (%)
>75
>50 - 75
>25 - 50
>10 - 25
>5 - 10
0 - 5
Area of Detail
British Columbia
0
5
10
Kilometres
Data sources:
Capital Regional District, TRIM, ESRI base data
Projection:
UTM Zone 10 NAD83
Produced for: Habitat Acquisition Trust
HAT
Creating Conservation Legacies
Produced by:
CASLYS CONSULTING
March 21, 2013

3.2.3 Jurisdictions

Tree cover density values for each of the three time periods were summarized by jurisdiction and are presented in tables 17 to 19. Figure 34 illustrates the change in tree cover density between the time periods by grouping the two most densely treed classes (>50-75%and >75%) and plotting the level of change. The municipalities with the highest degree of change in these two classes were: Colwood (a loss of 429 ha); Langford (a loss of 452 ha); and Saanich (a loss of 585 ha).

Detailed summaries for each jurisdiction, comparing changes in tree cover density for each of the three time periods, have been provided in Appendix A.

Table 17. Tree Cover Density by Jurisdiction - 1986

Jurisdiction	0 - 5% (ha)	Percent of CMSA	>5 - 10% (ha)	Percent of CMSA	>10 - 25% (ha)	Percent of CMSA	>25 - 50% (ha)	Percent of CMSA	>50 - 75% (ha)	Percent of CMSA	>75% (ha)	Percent of CMSA	Total (ha)	Percent of CMSA
First Nations Reserves														
Becher Bay First Nation Reserve No. 1	0	0.00%	0	0.00%	2	0.05%	4	0.05%	26	0.31%	241	1.04%	**273**	**0.53%**
Becher Bay First Nation Reserve No. 2	0	0.00%	0	0.00%	2	0.05%	2	0.02%	8	0.10%	105	0.45%	**117**	**0.23%**
Cole Bay First Nation Reserve	2	0.03%	0	0.00%	5	0.12%	18	0.21%	53	0.63%	193	0.83%	**271**	**0.52%**
East Saanich First Nation Reserve	29	0.46%	10	0.96%	13	0.30%	28	0.33%	39	0.46%	132	0.57%	**251**	**0.49%**
Esquimalt First Nation Reserve	3	0.05%	2	0.19%	6	0.14%	5	0.06%	4	0.05%	0	0.00%	**20**	**0.04%**
Goldstream First Nation Reserve	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	6	0.03%	**6**	**0.01%**
Long Neck Island First Nation Reserve	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	2	0.01%	**2**	**0.00%**
New Songhees First Nation Reserve	19	0.30%	0	0.00%	22	0.51%	14	0.16%	10	0.12%	1	0.00%	**66**	**0.13%**
Sooke First Nation Reserve No. 1	0	0.00%	0	0.00%	0	0.00%	4	0.05%	7	0.08%	19	0.08%	**30**	**0.06%**
Sooke First Nation Reserve No. 2	1	0.02%	0	0.00%	1	0.02%	0	0.00%	2	0.02%	43	0.19%	**47**	**0.09%**
South Saanich First Nation Reserve	58	0.93%	7	0.67%	21	0.49%	21	0.25%	29	0.35%	73	0.31%	**209**	**0.40%**
Union Bay First Nation Reserve	4	0.06%	2	0.19%	5	0.12%	3	0.04%	8	0.10%	9	0.04%	**31**	**0.06%**
Municipality														
Central Saanich	1,861	29.76%	132	12.72%	405	9.48%	605	7.11%	482	5.74%	682	2.94%	**4,167**	**8.06%**
Colwood	146	2.33%	59	5.68%	168	3.93%	340	4.00%	349	4.16%	708	3.05%	**1,770**	**3.42%**
Esquimalt	186	2.97%	24	2.31%	131	3.07%	294	3.45%	59	0.70%	11	0.05%	**705**	**1.36%**
Highlands	13	0.21%	12	1.16%	52	1.22%	270	3.17%	764	9.11%	2,703	11.64%	**3,814**	**7.38%**
Juan de Fuca EA in the CMSA	13	0.21%	13	1.25%	48	1.12%	202	2.37%	537	6.40%	3,502	15.08%	**4,315**	**8.35%**
Langford	177	2.83%	66	6.36%	272	6.37%	600	7.05%	844	10.06%	2,140	9.22%	**4,099**	**7.93%**
Metchosin	256	4.09%	69	6.65%	267	6.25%	586	6.89%	1,187	14.15%	4,613	19.86%	**6,978**	**13.50%**
North Saanich	1,021	16.33%	99	9.54%	250	5.85%	612	7.19%	696	8.30%	1,043	4.49%	**3,721**	**7.20%**
Oak Bay	92	1.47%	25	2.41%	206	4.82%	472	5.55%	195	2.32%	55	0.24%	**1,045**	**2.02%**
Saanich	1,562	24.98%	325	31.31%	1,416	33.14%	2,630	30.90%	1,702	20.29%	3,073	13.23%	**10,708**	**20.72%**
Sidney	156	2.49%	28	2.70%	171	4.00%	139	1.63%	18	0.21%	2	0.01%	**514**	**0.99%**
Sooke	119	1.90%	61	5.88%	220	5.15%	691	8.12%	1,057	12.60%	2,931	12.62%	**5,079**	**9.83%**
Victoria	501	8.01%	95	9.15%	518	12.12%	725	8.52%	99	1.18%	8	0.03%	**1,946**	**3.76%**
View Royal	34	0.54%	9	0.87%	72	1.68%	245	2.88%	215	2.56%	928	4.00%	**1,503**	**2.91%**
Total	**6,253**		**1,038**		**4,273**		**8,510**		**8,390**		**23,223**		**51,687**	

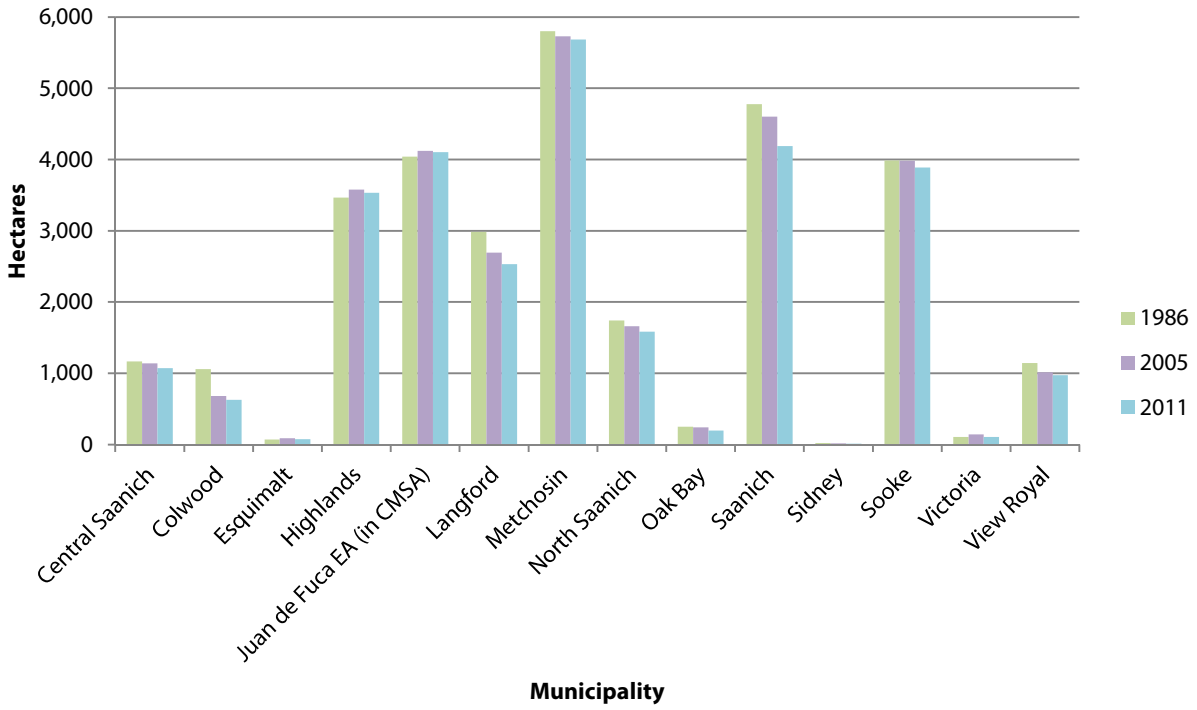
Table 18. Tree Cover Density by Jurisdiction - 2005

Jurisdiction	0 - 5% (ha)	Percent of CMSA	>5 - 10% (ha)	Percent of CMSA	>10 - 25% (ha)	Percent of CMSA	>25 - 50% (ha)	Percent of CMSA	>50 - 75% (ha)	Percent of CMSA	>75% (ha)	Percent of CMSA	Total (ha)	Percent of CMSA
First Nations Reserves														
Becher Bay First Nation Reserve No. 1	0	0.00%	0	0.00%	2	0.03%	8	0.09%	36	0.45%	227	1.00%	**273**	**0.53%**
Becher Bay First Nation Reserve No. 2	1	0.02%	2	0.11%	4	0.07%	6	0.06%	16	0.20%	88	0.39%	**117**	**0.23%**
Cole Bay First Nation Reserve		0.00%	0	0.00%	1	0.02%	10	0.11%	17	0.21%	243	1.07%	**271**	**0.52%**
East Saanich First Nation Reserve	34	0.84%	23	1.28%	28	0.48%	49	0.52%	34	0.43%	83	0.37%	**251**	**0.49%**
Esquimalt First Nation Reserve	4	0.10%	1	0.06%	3	0.05%	6	0.06%	6	0.08%	0	0.00%	**20**	**0.04%**
Goldstream First Nation Reserve	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	6	0.03%	**6**	**0.01%**
Long Neck Island First Nation Reserve	0	0.00%	0	0.00%	0	0.00%	1	0.01%	1	0.01%	0	0.00%	**2**	**0.00%**
New Songhees First Nation Reserve	3	0.07%	4	0.22%	29	0.50%	20	0.21%	9	0.11%	1	0.00%	**66**	**0.13%**
Sooke First Nation Reserve No. 1	0	0.00%	0	0.00%	1	0.02%	12	0.13%	9	0.11%	8	0.04%	**30**	**0.06%**
Sooke First Nation Reserve No. 2	0	0.00%	0	0.00%	3	0.05%	7	0.07%	7	0.09%	30	0.13%	**47**	**0.09%**
South Saanich First Nation Reserve	7	0.17%	10	0.56%	20	0.34%	44	0.47%	38	0.48%	90	0.40%	**209**	**0.40%**
Union Bay First Nation Reserve	0	0.00%	0	0.00%	2	0.03%	7	0.07%	7	0.09%	15	0.07%	**31**	**0.06%**
Municipality														
Central Saanich	1,356	33.55%	318	17.71%	666	11.44%	686	7.32%	447	5.64%	694	3.05%	**4,167**	**8.06%**
Colwood	213	5.27%	85	4.73%	264	4.54%	529	5.64%	305	3.85%	374	1.65%	**1,770**	**3.42%**
Esquimalt	60	1.48%	48	2.67%	197	3.38%	313	3.34%	70	0.88%	17	0.07%	**705**	**1.36%**
Highlands	21	0.52%	9	0.50%	36	0.62%	171	1.82%	526	6.64%	3,051	13.42%	**3,814**	**7.38%**
Juan de Fuca EA in the CMSA	6	0.15%	10	0.56%	33	0.57%	145	1.55%	433	5.47%	3,688	16.23%	**4,315**	**8.35%**
Langford	201	4.97%	124	6.90%	394	6.77%	686	7.32%	731	9.23%	1,963	8.64%	**4,099**	**7.93%**
Metchosin	205	5.07%	124	6.90%	294	5.05%	628	6.70%	1,100	13.89%	4,627	20.36%	**6,978**	**13.50%**
North Saanich	742	18.36%	209	11.64%	403	6.92%	708	7.55%	753	9.51%	906	3.99%	**3,721**	**7.20%**
Oak Bay	16	0.40%	38	2.12%	243	4.18%	509	5.43%	198	2.50%	41	0.18%	**1,045**	**2.02%**
Saanich	745	18.43%	480	26.73%	1,938	33.30%	2,943	31.39%	1,768	22.32%	2,834	12.47%	**10,708**	**20.72%**
Sidney	93	2.30%	45	2.51%	223	3.83%	138	1.47%	15	0.19%	0	0.00%	**514**	**0.99%**
Sooke	82	2.03%	64	3.56%	262	4.50%	684	7.30%	1,042	13.16%	2,941	12.94%	**5,075**	**9.82%**
Victoria	229	5.67%	176	9.80%	624	10.72%	777	8.29%	122	1.54%	18	0.08%	**1,946**	**3.77%**
View Royal	24	0.59%	26	1.45%	150	2.58%	289	3.08%	230	2.90%	784	3.45%	**1,503**	**2.91%**
Total	**4,042**		**1,796**		**5,820**		**9,376**		**7,920**		**22,729**		**51,683**	

Table 19. Tree Cover Density by Jurisdiction - 2011

Jurisdiction	0 - 5% (ha)	Percent of CMSA	>5 - 10% (ha)	Percent of CMSA	>10 - 25% (ha)	Percent of CMSA	>25 - 50% (ha)	Percent of CMSA	>50 - 75% (ha)	Percent of CMSA	>75% (ha)	Percent of CMSA	Total (ha)	Percent of CMSA
First Nations Reserves														
Becher Bay First Nation Reserve No. 1	0	0.00%	0	0.00%	2	0.03%	9	0.10%	39	0.51%	223	1.02%	**273**	**0.53%**
Becher Bay First Nation Reserve No. 2	1	0.02%	2	0.11%	4	0.06%	6	0.07%	16	0.21%	88	0.40%	**117**	**0.23%**
Cole Bay First Nation Reserve	0	0.00%	0	0.00%	3	0.04%	10	0.11%	18	0.23%	240	1.10%	**271**	**0.52%**
East Saanich First Nation Reserve	40	0.84%	24	1.27%	26	0.39%	48	0.54%	32	0.42%	81	0.37%	**251**	**0.49%**
Esquimalt First Nation Reserve	4	0.08%	1	0.05%	5	0.07%	4	0.05%	6	0.08%	0	0.00%	**20**	**0.04%**
Goldstream First Nation Reserve	0	0.00%	0	0.00%	0	0.00%	0	0.00%		0.00%	6	0.03%	**6**	**0.01%**
Long Neck Island First Nation Reserve	0	0.00%	0	0.00%	0	0.00%	1	0.01%	1	0.01%	0	0.00%	**2**	**0.00%**
New Songhees First Nation Reserve	3	0.06%	5	0.26%	31	0.46%	17	0.19%	9	0.12%	1	0.00%	**66**	**0.13%**
Sooke First Nation Reserve No. 1	0	0.00%	0	0.00%	1	0.01%	12	0.14%	9	0.12%	8	0.04%	**30**	**0.06%**
Sooke First Nation Reserve No. 2	0	0.00%	0	0.00%	3	0.04%	7	0.08%	8	0.10%	29	0.13%	**47**	**0.09%**
South Saanich First Nation Reserve	7	0.15%	10	0.53%	20	0.30%	46	0.52%	37	0.48%	89	0.41%	**209**	**0.40%**
Union Bay First Nation Reserve	0	0.00%	0	0.00%	2	0.03%	7	0.08%	8	0.10%	14	0.06%	**31**	**0.06%**
Municipality														
Central Saanich	1,548	32.49%	269	14.23%	644	9.66%	634	7.19%	409	5.31%	663	3.04%	**4,167**	**8.06%**
Colwood	233	4.89%	95	5.03%	293	4.39%	521	5.91%	290	3.77%	338	1.55%	**1,770**	**3.42%**
Esquimalt	67	1.41%	55	2.91%	217	3.25%	292	3.31%	60	0.78%	14	0.06%	**705**	**1.36%**
Highlands	28	0.59%	13	0.69%	50	0.75%	189	2.14%	554	7.20%	2,980	13.64%	**3,814**	**7.38%**
Juan de Fuca EA in the CMSA	8	0.17%	8	0.42%	40	0.60%	154	1.75%	490	6.36%	3,615	16.55%	**4,315**	**8.35%**
Langford	244	5.12%	125	6.61%	485	7.27%	713	8.09%	719	9.34%	1,813	8.30%	**4,099**	**7.93%**
Metchosin	228	4.78%	130	6.88%	307	4.60%	628	7.12%	1,142	14.83%	4,543	20.80%	**6,978**	**13.50%**
North Saanich	874	18.34%	161	8.52%	381	5.71%	723	8.20%	758	9.85%	824	3.77%	**3,721**	**7.20%**
Oak Bay	21	0.44%	38	2.01%	287	4.30%	503	5.70%	158	2.05%	38	0.17%	**1,045**	**2.02%**
Saanich	963	20.21%	612	32.38%	2,438	36.55%	2,505	28.41%	1,547	20.09%	2,643	12.10%	**10,708**	**20.72%**
Sidney	102	2.14%	54	2.86%	243	3.64%	101	1.15%	14	0.18%	0	0.00%	**514**	**0.99%**
Sooke	90	1.89%	71	3.76%	297	4.45%	729	8.27%	1,065	13.83%	2,823	12.93%	**5,075**	**9.82%**
Victoria	277	5.81%	186	9.84%	722	10.82%	656	7.44%	91	1.18%	14	0.06%	**1,946**	**3.77%**
View Royal	27	0.57%	31	1.64%	169	2.53%	303	3.44%	219	2.84%	754	3.45%	**1,503**	**2.91%**
Total	**4,765**		**1,890**		**6,670**		**8,818**		**7,699**		**21,841**		**51,683**	

Figure 34. Area of Tree Cover Density Greater than 50% within each Municipality– 1986, 2005 and 2011



3.2.4 Parks

Table 20 and Figure 35 detail the changes in tree cover density for the parks[11] in the study area between the three time periods. The results indicate that the number of hectare cells falling in highest density class (>75% tree cover) has increased by 463 ha over the 19 year time period between 1986 and 2005, however the values have fallen for the adjacent density classes – the >50 – 75% class decreased by 347 ha and the >25-50% class decreased by 46 ha[12]. The reduction is potentially due to forest being converted to other recreational uses (e.g., playing fields or parking lot expansion). The results should be interpreted with caution, however, because the higher resolution 2005 imagery facilitates the identification of more detail in the land cover and therefore the change may reflect differences in the classification accuracy.

Between 2005 and 2011 the highest density class (>75%) decreased by 62 ha while the lowest density class (0-5% increased by 36 ha.

[11] Parks included: federal, provincial, regional, and municipal parks; provincial ecoreserves; and protected areas.

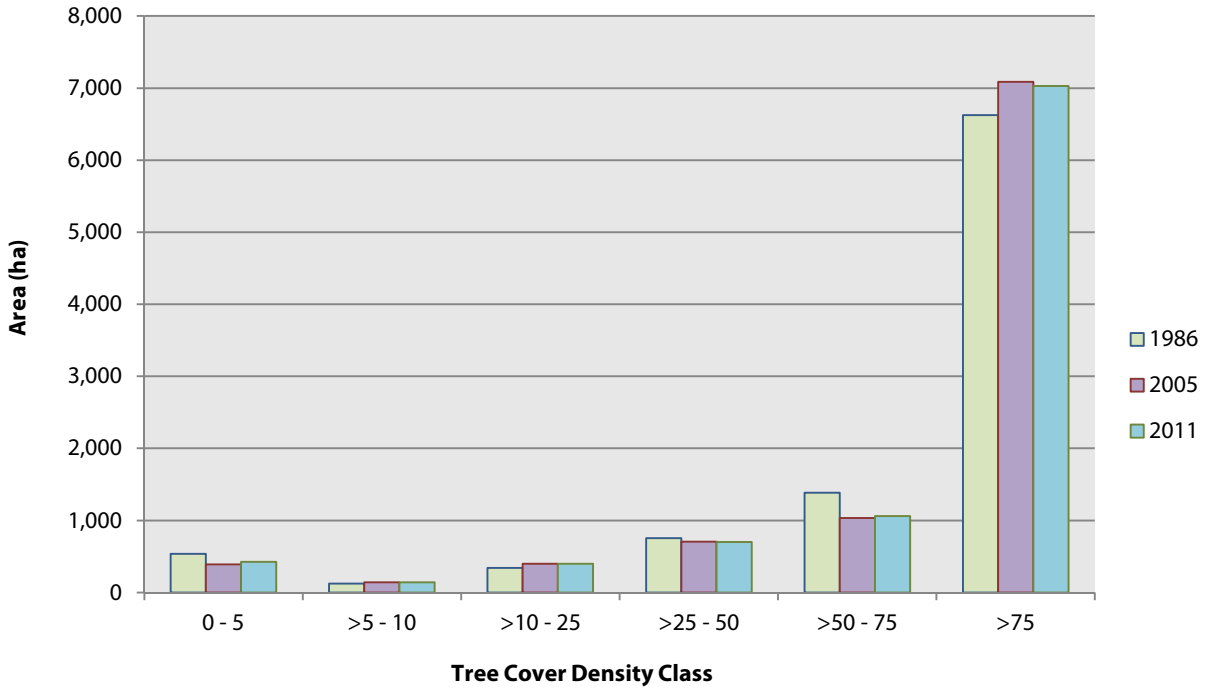
[12] In the 2007 report a similar reduction in the higher density classes was found (there were 321 fewer ha in the >75% class between 1986 and 2005). Due to improvements in the 2005 classification (e.g., the reduction of shadow) a similar shift has been found in the current results, however, it is in the >50-75 and >25-50 classes.

Table 20. Tree Cover Density in Parks in the Core Municipal Study Area – 1986, 2005 and 2011

	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
Tree Cover Density Class (%)	Hectares	Percent of Parks	Hectares	Percent of Parks			Hectares	Percent of Parks		
0 - 5	535	5.5%	389	4.0%	-146	-27.3%	425	4.4%	36	9.3%
>5 - 10	124	1.3%	141	1.4%	17	13.7%	143	1.5%	2	1.4%
>10 - 25	342	3.5%	398	4.1%	56	16.4%	401	4.1%	3	0.8%
>25 - 50	753	7.7%	707	7.2%	-46	-6.1%	703	7.2%	-4	-0.6%
>50 - 75	1,383	14.2%	1,036	10.6%	-347	-25.1%	1,061	10.9%	25	2.4%
>75	6,626	67.9%	7,089	72.6%	463	7.0%	7,027	72.0%	-62	-0.9%
Total	**9,763**	**100.0%**	**9,760**	**100.0%**			**9,760**	**100.0%**		

*Negative numbers indicate a decrease and positive an increase in the number of hectares within each class over the six year time period. Percent change quantifies change in the class (i.e., the difference between two time periods divided by the area of that class in the earlier time period), whereas percent difference compares the class to the overall composition in the area of interest (i.e., a 2011 % of parks value is subtracted from the 2005 value).

Figure 35. Tree Cover Density Class Frequency in Parks in the Core Municipal Study Area – 1986, 2005 and 2011



3.3 Impervious Surface Density

The impervious density statistics are based on the percentage of impervious surface in each one-hectare grid cell. For interpretation purposes, the density values have been grouped into the following classes: 0-5, >5-10, >10-25, >25-50, >50-75, and >75. Density values have been summarized for each time period for: the CMSA, by jurisdiction and within parks. In addition, the Juan de Fuca West density values are presented.

3.3.1 Core Municipal Study Area

Impervious surface density values for the CMSA for the three time periods are presented in Table 21 and illustrated in Figure 36. It should be noted that a much higher degree of confidence can be place in the 2005 versus 2011 comparison than between 1986 and 2005 due to quality issues associated with the 1986 air photo. Between 1986 and 2005, the results indicate that:

- The number of cells with minimal impervious surface (the 0-5% class) decreased by 6.9%. In other words, there are 2,276 hectares where pervious surfaces, present in 1986, have been replaced with enough impervious surfaces to move these cells into a higher density class in the 2005 time period.
- All of the other classes indicate an increase in density with a total of 16 one-hectares moving to the two highest density classes (>50-75% and >75% impervious).

- The changes between 2005 and 2011 indicate a continuing trend toward a greater amount of impervious surface in the CMSA:

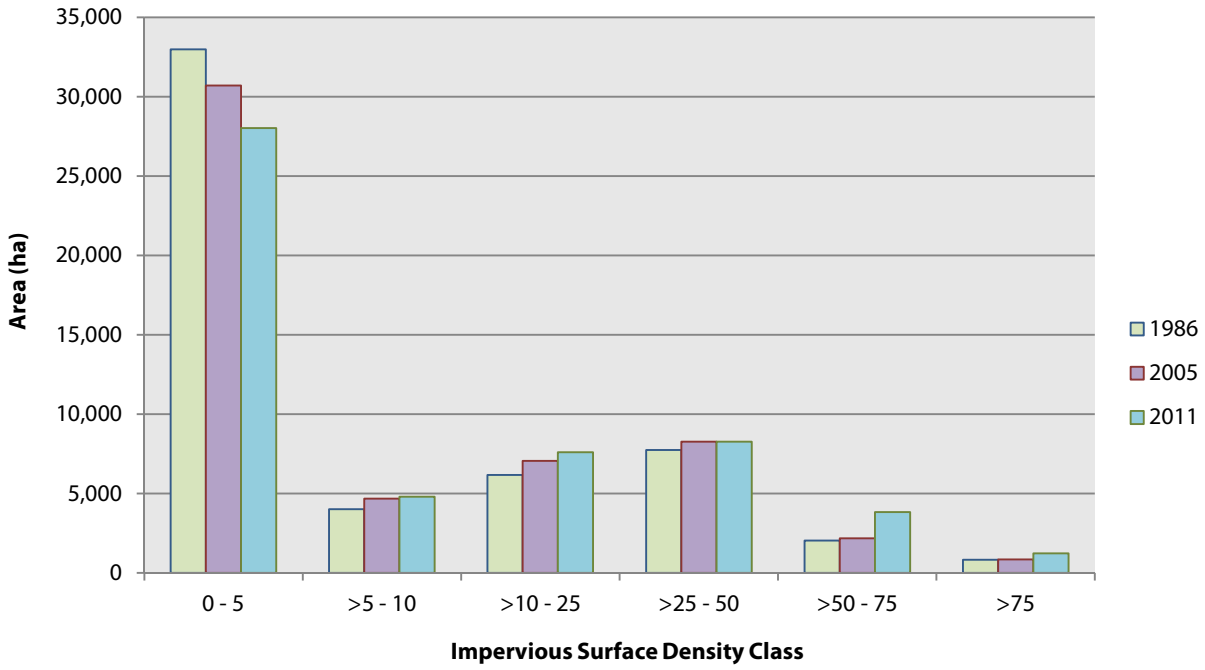
- The lowest density class (0-5%) has decreased by 2,678 ha representing a percentage decrease of 8.7%. In the 19 years between 1986 and 2005 the annual decrease in this class was 119.8 ha per year. Between 2005 and 2011 the annual change has increased to 446.3 ha per year. The results indicate that the number of undisturbed areas (i.e., minimal impervious surface) in the CMSA is decreasing and that this decrease is occurring at a faster rate (when compared to the earlier time period).
- The two upper classes are increasing – the >75% class has increased by 376 ha and the >50-75% class by 1,648 ha).
- The rate of change in the top two classes (>50-75% and >75% impervious) appears to be increasing – in the 19 years between 1986 and 2005 the increase was 8.5 ha per year, whereas in the six years between 2005 and 2011 the rate of increase was 337.3 ha per year. It should be noted that due to issues in the 1986 source imagery the rate of change between 1986 and 2005 may have been underestimated.

Table 21. Impervious Surface Density in the Core Municipal Study Area – 1986, 2005 and 2011

	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
Impervious Surface Density Class (%)	**Hectares**	**Percent of CMSA**	**Hectares**	**Percent of CMSA**			**Hectares**	**Percent of CMSA**		
0 - 5	32,976	61.3%	30,700	57.1%	-2,276	-6.9%	28,022	52.1%	-2,678	-8.7%
>5 - 10	4,020	7.5%	4,679	8.7%	659	16.4%	4,812	8.9%	133	2.8%
>10 - 25	6,180	11.5%	7,069	13.1%	889	14.4%	7,604	14.1%	535	7.6%
>25 - 50	7,739	14.4%	8,276	15.4%	537	6.9%	8,262	15.4%	-14	-0.2%
>50 - 75	2,042	3.8%	2,184	4.1%	142	7.0%	3,832	7.1%	1,648	75.5%
>75	839	1.6%	858	1.6%	19	2.3%	1,234	2.3%	376	43.8%
Total	**53,796**	**100.0%**	**53,766**	**100.0%**			**53,766**	**100.0%**		

*Negative numbers indicate a decrease and positive an increase in the number of hectares within each class over the six year time period. Percent change quantifies change in the class (i.e., the difference between two time periods divided by the area of that class in the earlier time period), whereas percent difference compares the class to the overall composition in the area of interest (i.e., a 2011 % of CMSA value is subtracted from the 2005 value).

Figure 36. Impervious Surface Density Class Frequency in the Core Municipal Study Area – 1986, 2005 and 2011



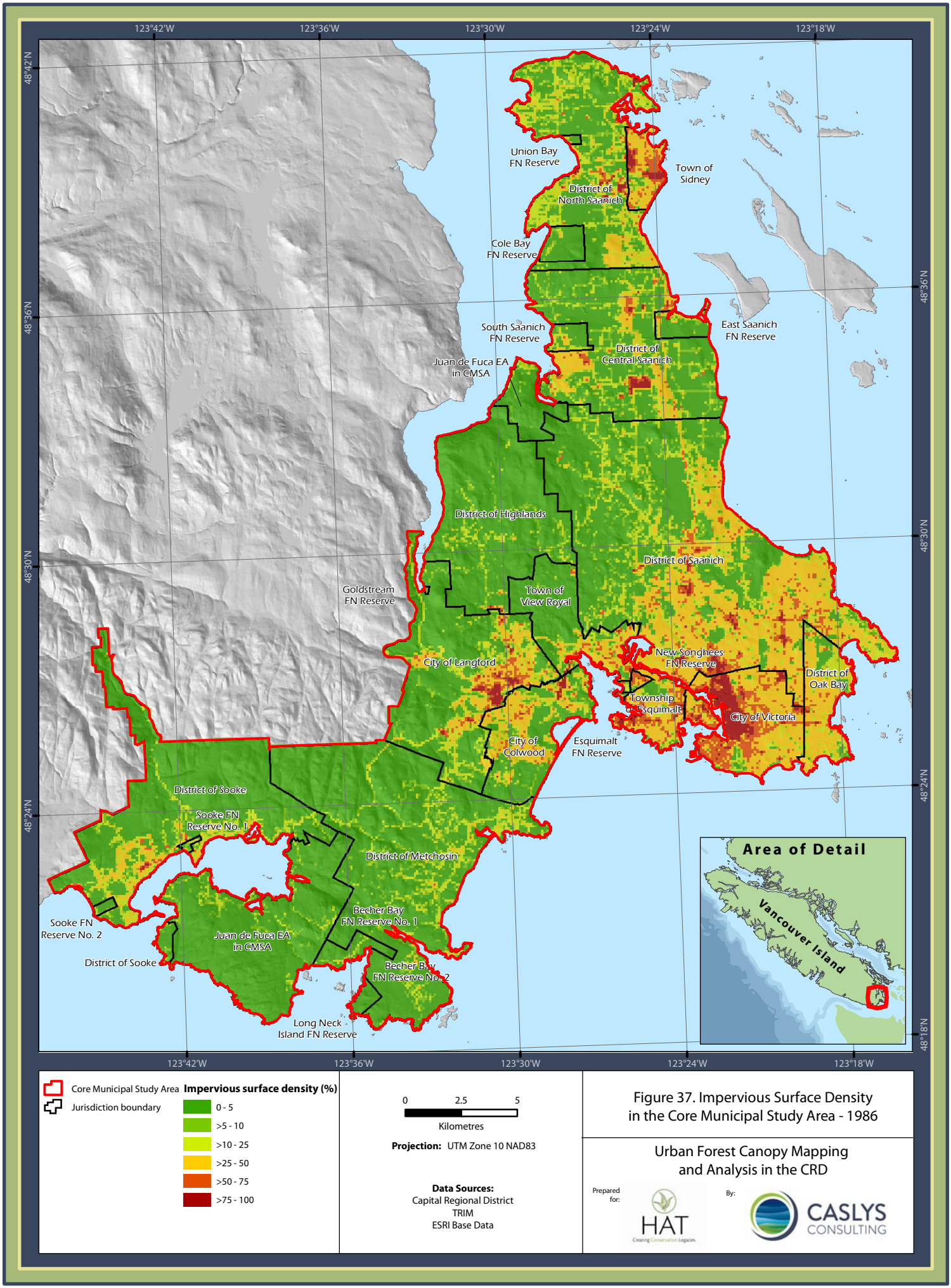


Figure 37. Impervious Surface Density in the Core Municipal Study Area - 1986

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT

By: CASLYS CONSULTING

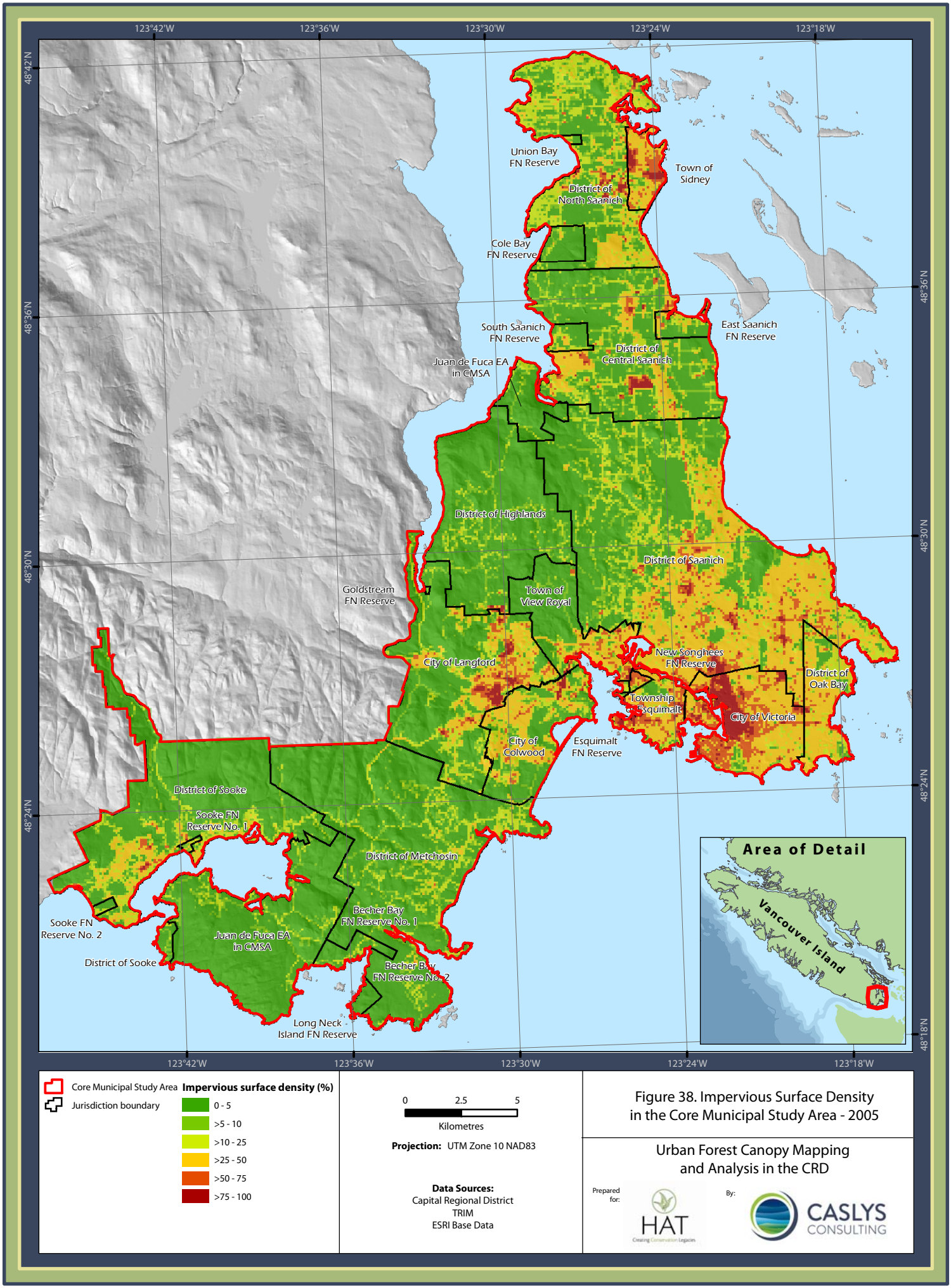


Figure 38. Impervious Surface Density in the Core Municipal Study Area - 2005

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT

By: CASLYS CONSULTING

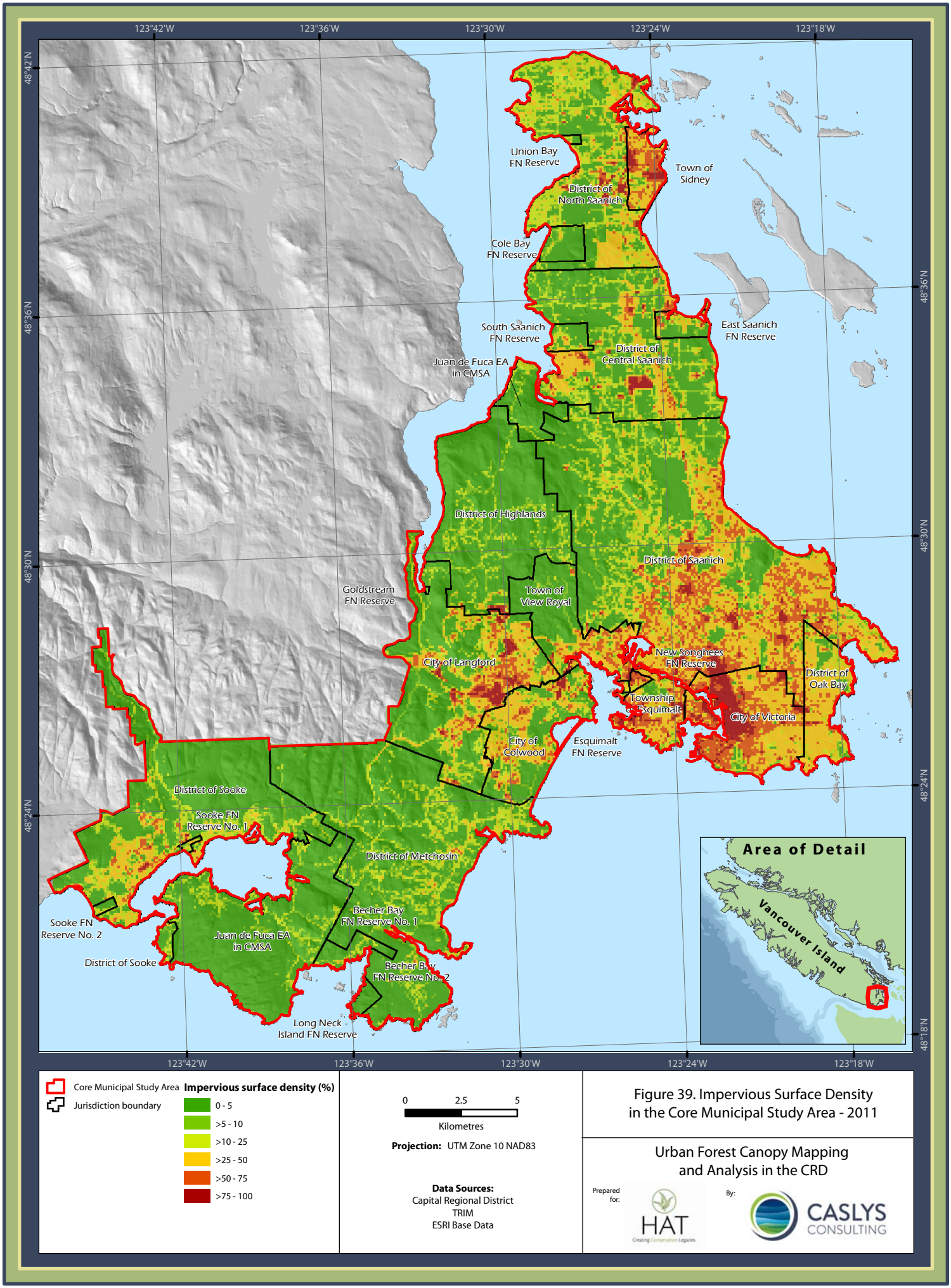


Figure 39. Impervious Surface Density in the Core Municipal Study Area - 2011

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT

By: CASLYS CONSULTING

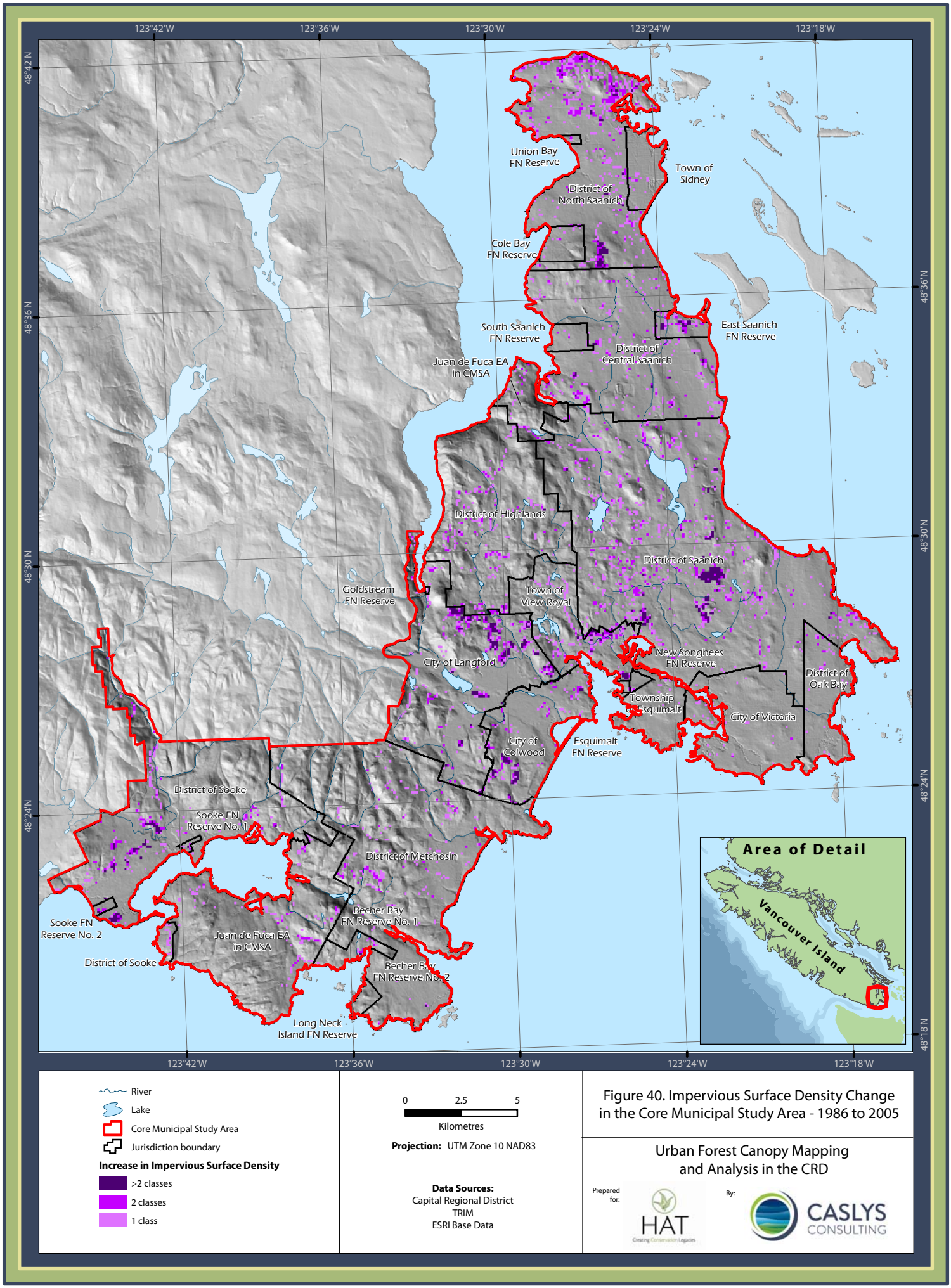


Figure 40. Impervious Surface Density Change in the Core Municipal Study Area - 1986 to 2005

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT

By: CASLYS CONSULTING

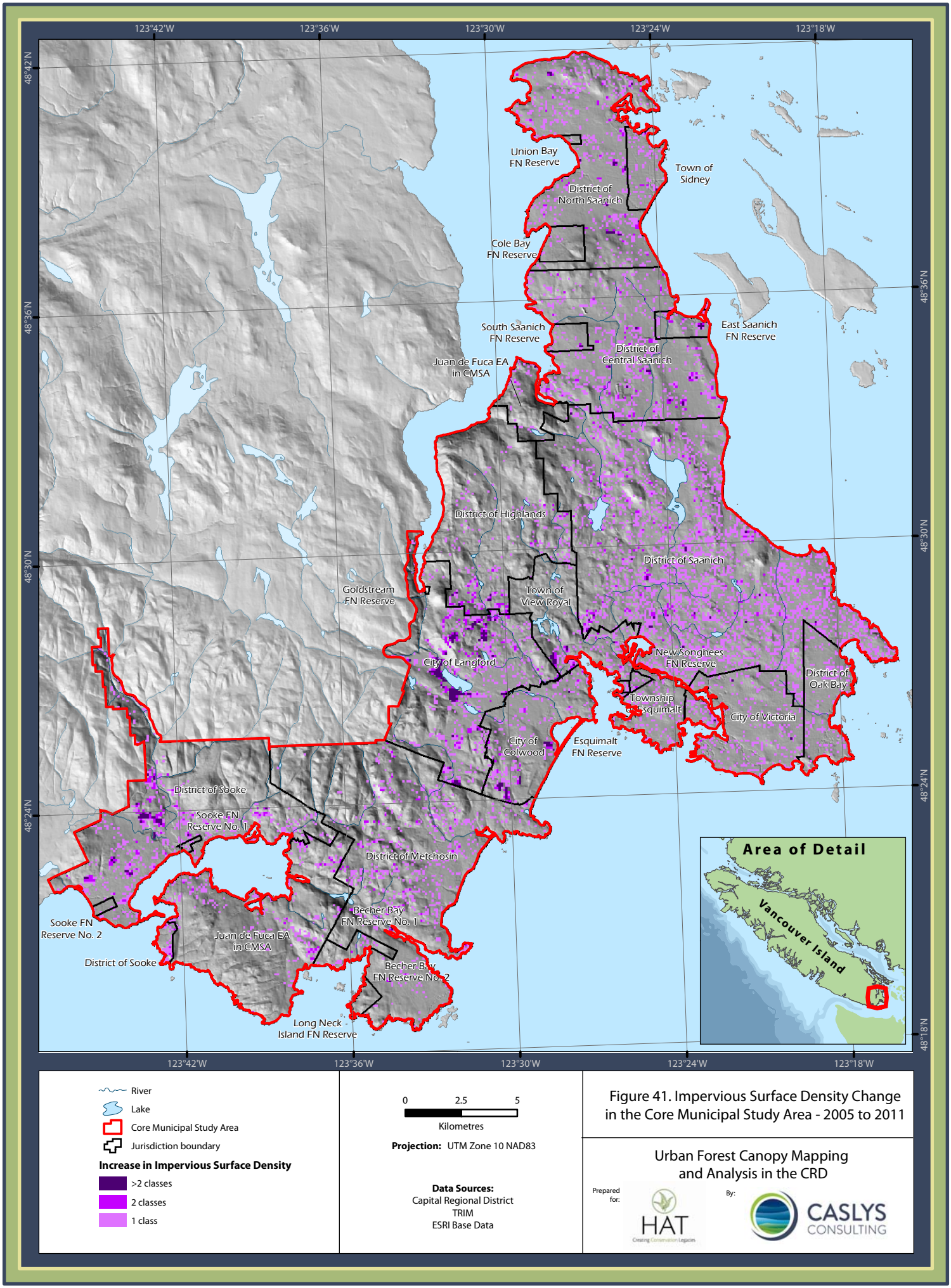


Figure 41. Impervious Surface Density Change in the Core Municipal Study Area - 2005 to 2011

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT Creating Conservation Legacies

By: CASLYS CONSULTING

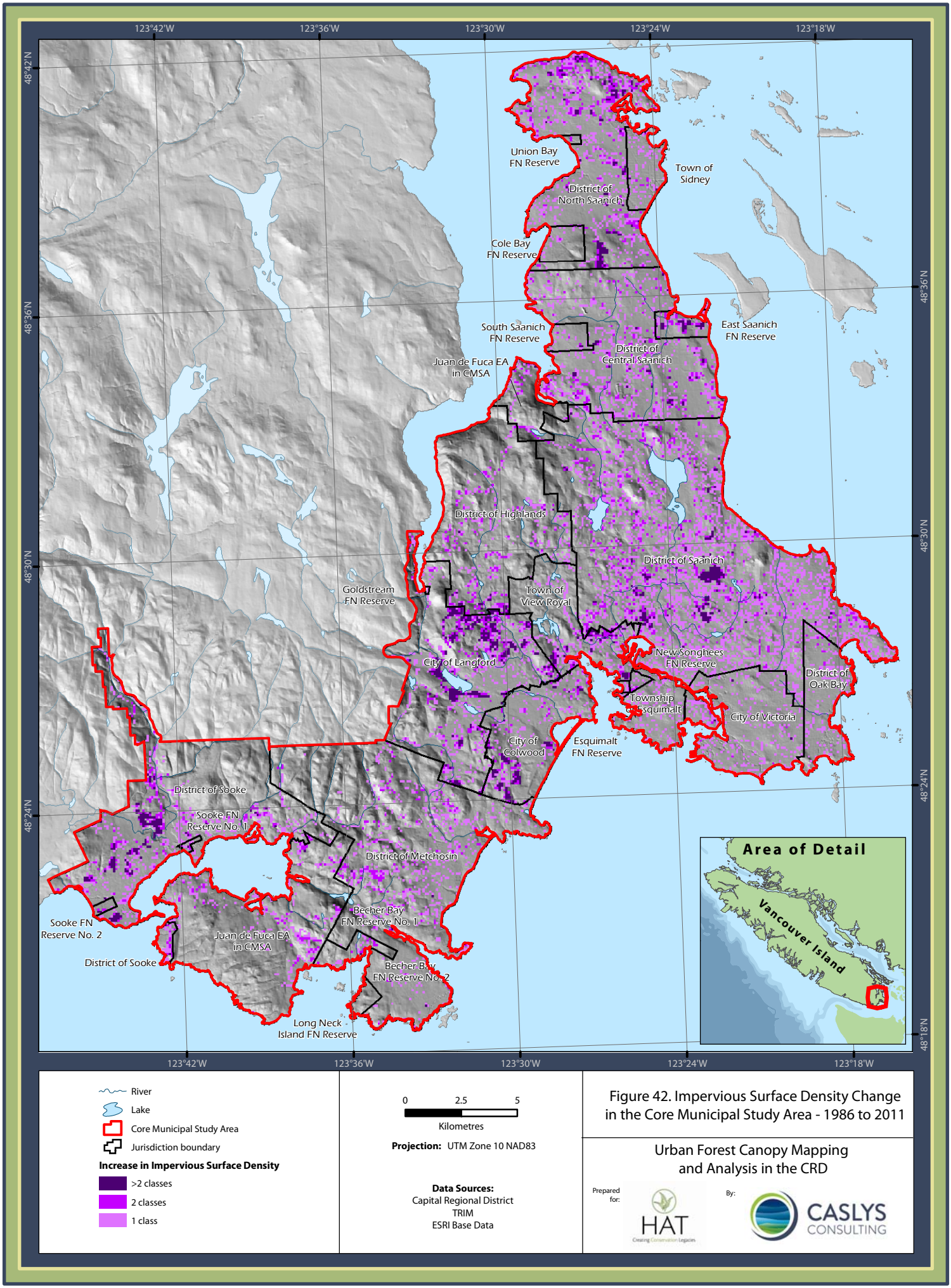


Figure 42. Impervious Surface Density Change in the Core Municipal Study Area - 1986 to 2011

Urban Forest Canopy Mapping and Analysis in the CRD

Prepared for: HAT Creating Conservation Legacies

By: CASLYS CONSULTING

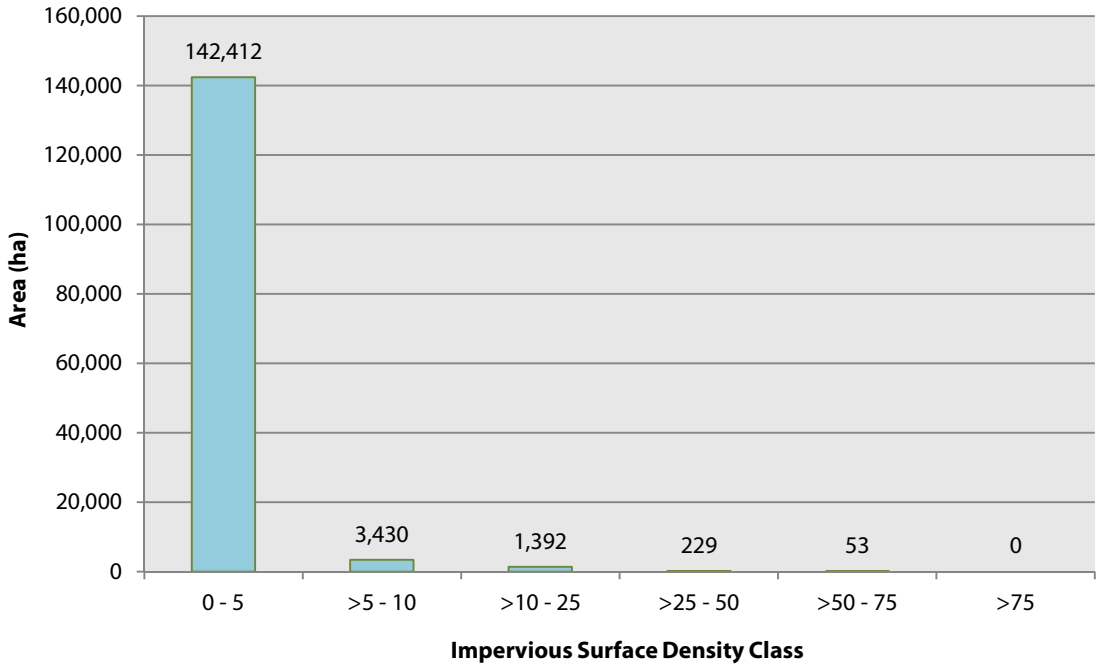
3.3.2 Juan de Fuca Electoral Area

As indicated in Table 22 and Figure 43, there is a minimal amount of impervious surface in JDFW - the vast majority of the land base falls within the bottom two impervious surface density class – 96.5% of the land base has less than 5% impervious surface, 2.3% in the >5 – 10% class and 1.1% n the remaining four classes. Figure 44 maps impervious surface density in JDFW.

Table 22. Impervious Surface Density in Juan de Fuca West

Impervious Surface Density Class (%)	Hectares	Percent of JDFW
0 - 5	142,412	96.5%
>5 - 10	3,430	2.3%
>10 - 25	1,392	0.9%
>25 - 50	229	0.2%
>50 - 75	53	0.0%
>75	0	0.0%
Total	**147,516**	**100.0%**

Figure 43. Impervious Surface Density Class Frequency in Juan de Fuca West



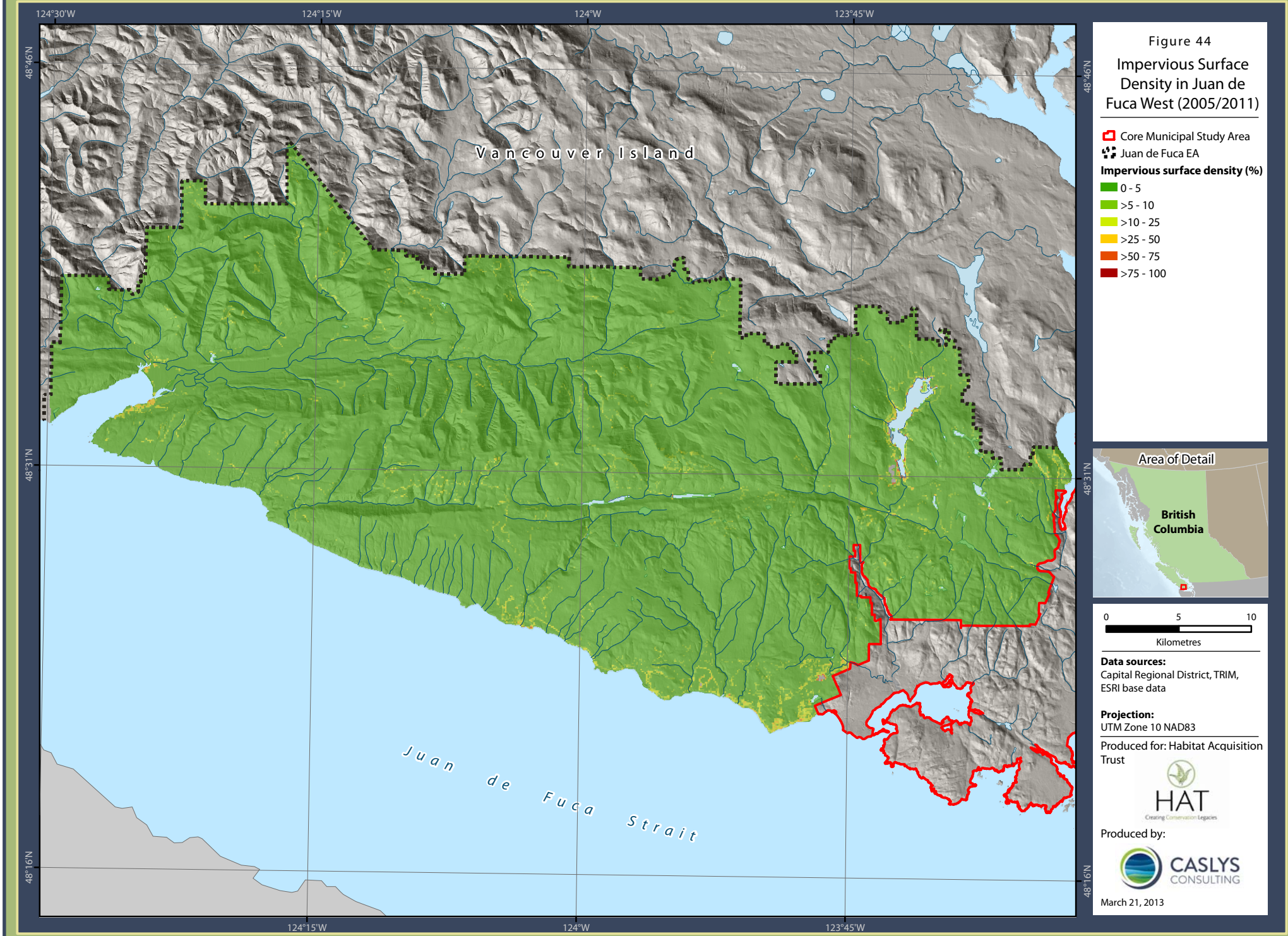


Figure 44

Impervious Surface Density in Juan de Fuca West (2005/2011)

Core Municipal Study Area

Juan de Fuca EA

Impervious surface density (%)

- 0 - 5
- >5 - 10
- >10 - 25
- >25 - 50
- >50 - 75
- >75 - 100

0 5 10

Kilometres

Data sources:
Capital Regional District, TRIM, ESRI base data

Projection:
UTM Zone 10 NAD83

Produced for: Habitat Acquisition Trust

HAT
Creating Conservation Legacies

Produced by:

CASLYS CONSULTING

March 21, 2013

3.3.3 Jurisdictions

Impervious surface density values for the three time periods were summarized by jurisdiction and are presented in tables 23 to 25. Figure 45 illustrates the change in impervious surface density between the three time periods by grouping the two highest classes and plotting the level of change. The municipalities with the highest degree of change in these two classes were: Victoria (an increase of 188 ha); Langford (an increase of 282 ha); and Saanich (an increase of 1,148 ha).

Detailed summaries for each jurisdiction, comparing changes in impervious surface density for each of the three time periods, have been provided in Appendix B.

Table 23. Impervious Surface Density by Jurisdiction - 1986

Jurisdiction	0 - 5% (ha)	Percent of CMSA	>5 - 10% (ha)	Percent of CMSA	>10 - 25% (ha)	Percent of CMSA	>25 - 50% (ha)	Percent of CMSA	>50 - 75% (ha)	Percent of CMSA	>75% (ha)	Percent of CMSA	Total (ha)	Percent of CMSA
First Nations Reserves														
Becher Bay First Nation Reserve No. 1	232	0.74%	17	0.44%	22	0.37%	2	0.03%	0	0.00%	0	0.00%	**273**	**0.53%**
Becher Bay First Nation Reserve No. 2	117	0.37%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	**117**	**0.23%**
Cole Bay First Nation Reserve	234	0.75%	20	0.52%	12	0.20%	5	0.07%	0	0.00%	0	0.00%	**271**	**0.52%**
East Saanich First Nation Reserve	167	0.53%	20	0.52%	37	0.61%	22	0.29%	5	0.25%	0	0.00%	**251**	**0.49%**
Esquimalt First Nation Reserve	4	0.01%	3	0.08%	9	0.15%	2	0.03%	2	0.10%	0	0.00%	**20**	**0.04%**
Goldstream First Nation Reserve	6	0.02%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	**6**	**0.01%**
Long Neck Island First Nation Reserve	1	0.00%	1	0.03%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	**2**	**0.00%**
New Songhees First Nation Reserve	9	0.03%	3	0.08%	7	0.12%	15	0.20%	28	1.39%	4	0.49%	**66**	**0.13%**
Sooke First Nation Reserve No. 1	11	0.04%	7	0.18%	7	0.12%	5	0.07%	0	0.00%	0	0.00%	**30**	**0.06%**
Sooke First Nation Reserve No. 2	35	0.11%	6	0.16%	6	0.10%	0	0.00%	0	0.00%	0	0.00%	**47**	**0.09%**
South Saanich First Nation Reserve	139	0.44%	12	0.31%	36	0.60%	21	0.27%	1	0.05%	0	0.00%	**209**	**0.40%**
Union Bay First Nation Reserve	18	0.06%	3	0.08%	7	0.12%	3	0.04%	0	0.00%	0	0.00%	**31**	**0.06%**
Municipality														
Central Saanich	2,452	7.82%	510	13.27%	514	8.54%	540	7.06%	97	4.83%	54	6.67%	**4,167**	**8.06%**
Colwood	760	2.42%	134	3.49%	252	4.19%	518	6.77%	79	3.93%	27	3.34%	**1,770**	**3.42%**
Esquimalt	78	0.25%	29	0.75%	80	1.33%	317	4.14%	147	7.32%	54	6.67%	**705**	**1.36%**
Highlands	3,429	10.94%	202	5.25%	153	2.54%	17	0.22%	10	0.50%	3	0.37%	**3,814**	**7.38%**
Juan de Fuca EA in the CMSA	3,903	12.45%	261	6.79%	150	2.49%	1	0.01%	0	0.00%	0	0.00%	**4,315**	**8.35%**
Langford	2,509	8.00%	281	7.31%	499	8.29%	542	7.08%	185	9.21%	83	10.26%	**4,099**	**7.93%**
Metchosin	5,644	18.00%	613	15.95%	642	10.67%	74	0.97%	5	0.25%	0	0.00%	**6,978**	**13.50%**
North Saanich	1,747	5.57%	451	11.73%	986	16.38%	420	5.49%	76	3.78%	41	5.07%	**3,721**	**7.20%**
Oak Bay	136	0.43%	40	1.04%	232	3.86%	571	7.46%	61	3.04%	5	0.62%	**1,045**	**2.02%**
Saanich	4,692	14.96%	844	21.96%	1,545	25.67%	2,950	38.56%	547	27.23%	130	16.07%	**10,708**	**20.72%**
Sidney	19	0.06%	14	0.36%	53	0.88%	233	3.05%	139	6.92%	56	6.92%	**514**	**0.99%**
Sooke	3,970	12.66%	278	7.23%	511	8.49%	281	3.67%	33	1.64%	6	0.74%	**5,079**	**9.83%**
Victoria	54	0.17%	29	0.75%	122	2.03%	873	11.41%	534	26.58%	334	41.29%	**1,946**	**3.76%**
View Royal	991	3.16%	66	1.72%	136	2.26%	238	3.11%	60	2.99%	12	1.48%	**1,503**	**2.91%**
Total	**31,357**		**3,844**		**6,018**		**7,650**		**2,009**		**809**		**51,687**	

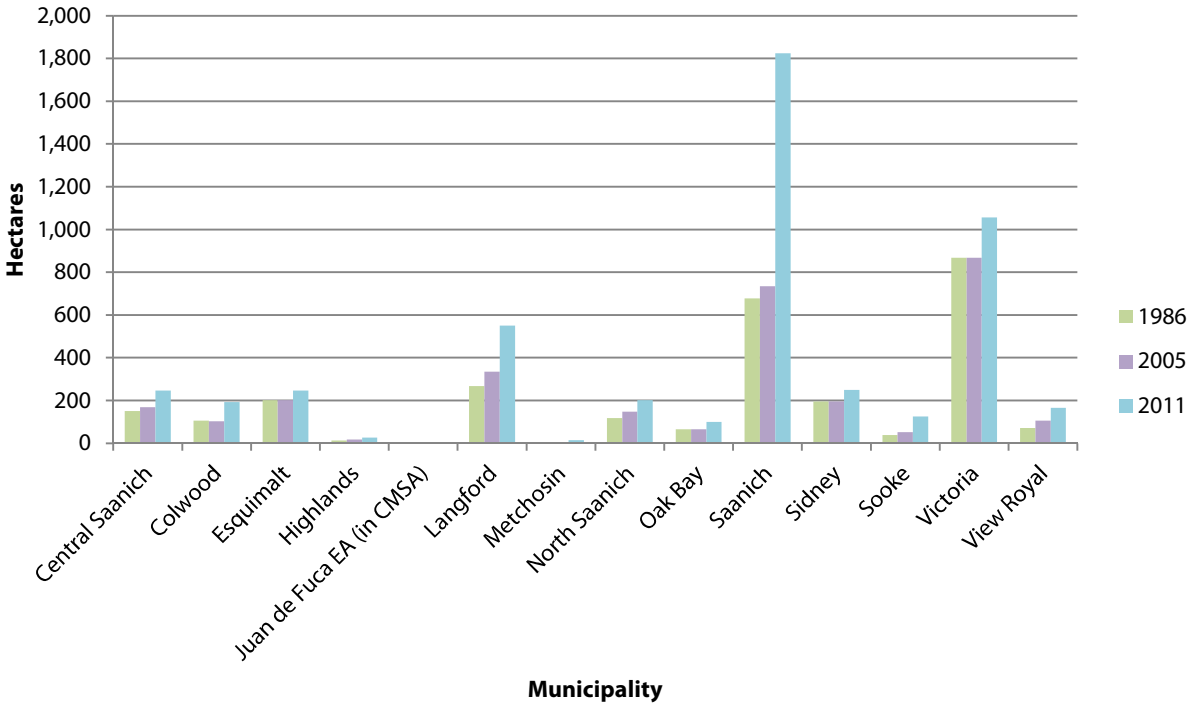
Table 24. Impervious Surface Density by Jurisdiction - 2005

Jurisdiction	0 - 5% (ha)	Percent of CMSA	>5 - 10% (ha)	Percent of CMSA	>10 - 25% (ha)	Percent of CMSA	>25 - 50% (ha)	Percent of CMSA	>50 - 75% (ha)	Percent of CMSA	>75% (ha)	Percent of CMSA	Total (ha)	Percent of CMSA
First Nations Reserve														
Becher Bay First Nation Reserve No. 1	220	0.76%	20	0.44%	30	0.43%	3	0.04%	0	0.00%	0	0.00%	273	0.53%
Becher Bay First Nation Reserve No. 2	117	0.40%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	117	0.23%
Cole Bay First Nation Reserve	220	0.76%	29	0.64%	17	0.24%	5	0.06%	0	0.00%	0	0.00%	271	0.52%
East Saanich First Nation Reserve	122	0.42%	26	0.58%	54	0.78%	40	0.48%	9	0.41%	0	0.00%	251	0.49%
Esquimalt First Nation Reserve	4	0.01%	3	0.07%	8	0.12%	3	0.04%	2	0.09%	0	0.00%	20	0.04%
Goldstream First Nation Reserve	3	0.01%	3	0.07%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	6	0.01%
Long Neck Island First Nation Reserve	2	0.01%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	2	0.00%
New Songhees First Nation Reserve	5	0.02%	4	0.09%	10	0.14%	15	0.18%	28	1.28%	4	0.47%	66	0.13%
Sooke First Nation Reserve No. 1	6	0.02%	9	0.20%	8	0.12%	7	0.08%	0	0.00%	0	0.00%	30	0.06%
Sooke First Nation Reserve No. 2	30	0.10%	5	0.11%	11	0.16%	1	0.01%	0	0.00%	0	0.00%	47	0.09%
South Saanich First Nation Reserve	132	0.46%	17	0.38%	38	0.55%	21	0.25%	1	0.05%	0	0.00%	209	0.40%
Union Bay First Nation Reserve	16	0.06%	4	0.09%	8	0.12%	3	0.04%	0	0.00%	0	0.00%	31	0.06%
Municipality														
Central Saanich	2,284	7.89%	544	12.09%	601	8.65%	569	6.89%	109	4.99%	60	6.99%	4,167	8.06%
Colwood	666	2.30%	149	3.31%	279	4.01%	574	6.96%	76	3.48%	26	3.03%	1,770	3.42%
Esquimalt	74	0.26%	27	0.60%	85	1.22%	317	3.84%	148	6.78%	54	6.29%	705	1.36%
Highlands	3,250	11.23%	328	7.29%	205	2.95%	13	0.16%	9	0.41%	9	1.05%	3,814	7.38%
Juan de Fuca EA in the CMSA	3,773	13.04%	342	7.60%	199	2.86%	1	0.01%	0	0.00%	0	0.00%	4,315	8.35%
Langford	2,260	7.81%	304	6.76%	544	7.83%	656	7.95%	236	10.81%	99	11.54%	4,099	7.93%
Metchosin	5,470	18.90%	703	15.63%	727	10.46%	73	0.88%	5	0.23%	0	0.00%	6,978	13.50%
North Saanich	1,355	4.68%	498	11.07%	1,218	17.53%	502	6.08%	97	4.44%	51	5.94%	3,721	7.20%
Oak Bay	122	0.42%	38	0.84%	245	3.53%	575	6.97%	59	2.70%	6	0.70%	1,045	2.02%
Saanich	4,106	14.19%	956	21.25%	1,782	25.64%	3,130	37.93%	599	27.43%	135	15.73%	10,708	20.72%
Sidney	17	0.06%	15	0.33%	47	0.68%	240	2.91%	139	6.36%	56	6.53%	514	0.99%
Sooke	3,735	12.91%	355	7.89%	588	8.46%	345	4.18%	45	2.06%	7	0.82%	5,075	9.82%
Victoria	51	0.18%	27	0.60%	127	1.83%	873	10.58%	534	24.45%	334	38.93%	1,946	3.77%
View Royal	899	3.11%	93	2.07%	119	1.71%	287	3.48%	88	4.03%	17	1.98%	1,503	2.91%
Total	**28,939**		**4,499**		**6,950**		**8,253**		**2,184**		**858**		**51,683**	

Table 25. Impervious Surface Density by Jurisdiction - 2011

Jurisdiction	0 - 5% (ha)	Percent of CMSA	>5 - 10% (ha)	Percent of CMSA	>10 - 25% (ha)	Percent of CMSA	>25 - 50% (ha)	Percent of CMSA	>50 - 75% (ha)	Percent of CMSA	>75% (ha)	Percent of CMSA	Total (ha)	Percent of CMSA
First Nations Reserve														
Becher Bay First Nation Reserve No. 1	208	0.79%	22	0.48%	36	0.48%	7	0.08%	0	0.00%	0	0.00%	**273**	**0.53%**
Becher Bay First Nation Reserve No. 2	117	0.44%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	**117**	**0.23%**
Cole Bay First Nation Reserve	212	0.80%	31	0.68%	23	0.31%	5	0.06%	0	0.00%	0	0.00%	**271**	**0.52%**
East Saanich First Nation Reserve	108	0.41%	25	0.55%	49	0.66%	44	0.53%	21	0.55%	4	0.32%	**251**	**0.49%**
Esquimalt First Nation Reserve	2	0.01%	3	0.07%	5	0.07%	8	0.10%	2	0.05%	0	0.00%	**20**	**0.04%**
Goldstream First Nation Reserve	3	0.01%	3	0.07%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	**6**	**0.01%**
Long Neck Island First Nation Reserve	2	0.01%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	**2**	**0.00%**
New Songhees First Nation Reserve	3	0.01%	2	0.04%	10	0.13%	17	0.21%	25	0.65%	9	0.73%	**66**	**0.13%**
Sooke First Nation Reserve No. 1	6	0.02%	5	0.11%	10	0.13%	8	0.10%	1	0.03%	0	0.00%	**30**	**0.06%**
Sooke First Nation Reserve No. 2	29	0.11%	4	0.09%	12	0.16%	2	0.02%	0	0.00%	0	0.00%	**47**	**0.09%**
South Saanich First Nation Reserve	124	0.47%	18	0.39%	36	0.48%	28	0.34%	3	0.08%	0	0.00%	**209**	**0.40%**
Union Bay First Nation Reserve	16	0.06%	2	0.04%	10	0.13%	3	0.04%	0	0.00%	0	0.00%	**31**	**0.06%**
Municipality														
Central Saanich	1,973	7.48%	544	11.88%	781	10.52%	623	7.56%	168	4.38%	78	6.32%	**4,167**	**8.06%**
Colwood	584	2.21%	147	3.21%	269	3.62%	577	7.00%	153	3.99%	40	3.24%	**1,770**	**3.42%**
Esquimalt	51	0.19%	36	0.79%	74	1.00%	297	3.61%	178	4.65%	69	5.59%	**705**	**1.36%**
Highlands	3,083	11.69%	380	8.30%	298	4.01%	26	0.32%	9	0.23%	18	1.46%	**3,814**	**7.38%**
Juan de Fuca EA in the CMSA	3,565	13.52%	392	8.56%	345	4.65%	13	0.16%	0	0.00%	0	0.00%	**4,315**	**8.35%**
Langford	1,976	7.49%	288	6.29%	544	7.33%	741	9.00%	379	9.89%	171	13.86%	**4,099**	**7.93%**
Metchosin	5,089	19.30%	815	17.79%	920	12.39%	139	1.69%	15	0.39%	0	0.00%	**6,978**	**13.50%**
North Saanich	1,199	4.55%	420	9.17%	1,219	16.42%	681	8.27%	122	3.18%	80	6.48%	**3,721**	**7.20%**
Oak Bay	111	0.42%	32	0.70%	167	2.25%	635	7.71%	89	2.32%	11	0.89%	**1,045**	**2.02%**
Saanich	3,608	13.68%	876	19.13%	1,707	22.99%	2,692	32.68%	1,571	41.00%	254	20.58%	**10,708**	**20.72%**
Sidney	13	0.05%	12	0.26%	37	0.50%	202	2.45%	182	4.75%	68	5.51%	**514**	**0.99%**
Sooke	3,397	12.88%	413	9.02%	668	9.00%	472	5.73%	113	2.95%	12	0.97%	**5,075**	**9.82%**
Victoria	38	0.14%	26	0.57%	92	1.24%	734	8.91%	665	17.35%	391	31.69%	**1,946**	**3.77%**
View Royal	857	3.25%	84	1.83%	114	1.54%	283	3.44%	136	3.55%	29	2.35%	**1,503**	**2.91%**
Total	**26,374**		**4,580**		**7,426**		**8,237**		**3,832**		**1,234**		**51,683**	

Figure 45. Area of Impervious Surface Density Greater than 50% within each Jurisdiction – 1986, 2005 and 2011



4.0 DATA MAINTENANCE RECOMMENDATIONS

The following recommendations should be considered to ensure a high level of confidence can be placed in future interpretations of the data.

- The 2005 and 2011 land cover datasets are extremely useful products for land use management and biodiversity planning. The land cover mapping should, however, be updated on a regular basis to help quantify the amount of change resulting from urban expansion and development, and help decision-makers manage this change. This is of particular relevance concerning the rapid rate of change that has occurred in recent years.
- New air photo imagery is being flown in 2013. During this data collection program, in addition to the photography, LIDAR data are being collected. LIDAR would allow tree cover and buildings to be mapped more accurately. In addition, tree canopy heights could be quantified and the accuracy of riparian model could be improved.
- The spatial datasets and associated summary statistics (i.e., for the municipalities, parks and protected areas) should be reviewed and updated on a regular basis to ensure the information is complete, accurate and up-to-date.

5.0 LITERATURE CITED

Blyth, C. A. 2012. Saanich Land Cover Mapping. Summary Report. Prepared by Caslys Consulting Ltd. for the District of Saanich.

Caslys Consulting Ltd. 2007. Urban Forest Canopy Cover Mapping and Analysis in the Capital Regional District, British Columbia: 1986 – 2005. Prepared for the Urban Forest Stewardship Initiative, Victoria, B.C.

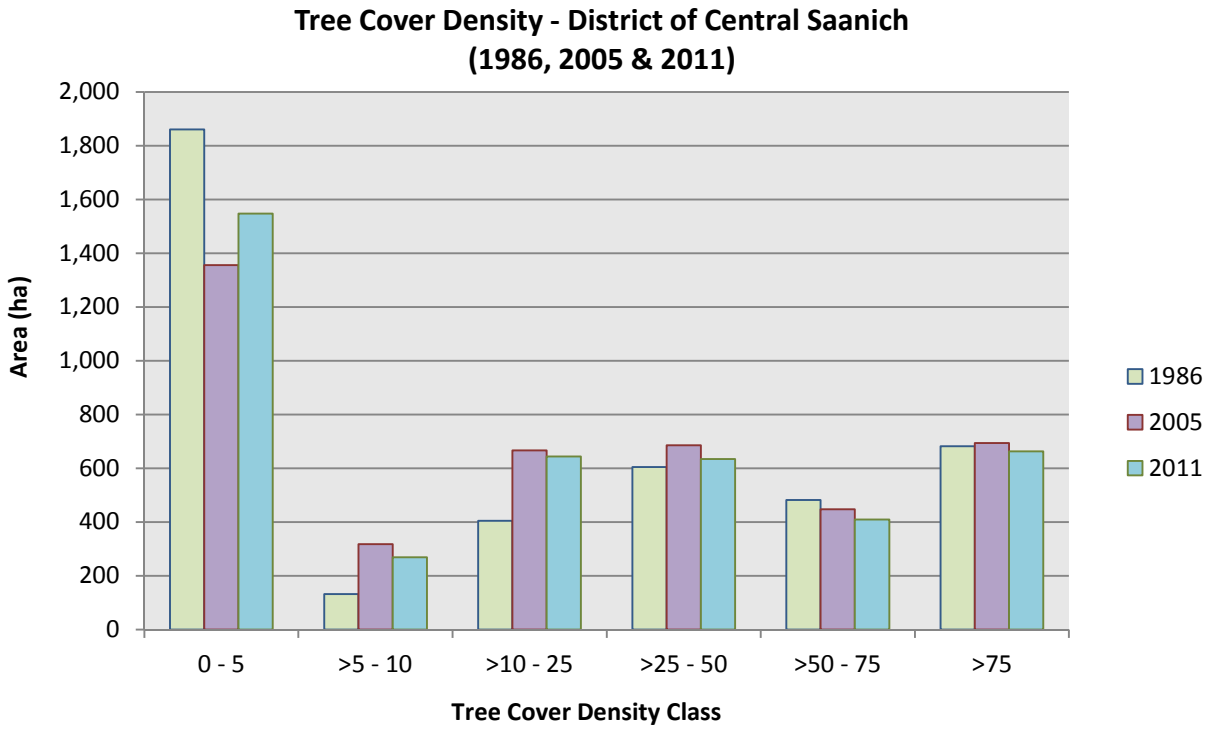
Appendix A

Detailed Municipal and First Nation Reserve
Tree Cover Density Summaries

Tree Cover Density – District of Central Saanich

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	1,861	44.7%	1,356	32.5%	-505	-27.1%	1,548	37.1%	192	14.2%
>5 - 10	132	3.2%	318	7.6%	186	140.9%	269	6.5%	-49	-15.4%
>10 - 25	405	9.7%	666	16.0%	261	64.4%	644	15.5%	-22	-3.3%
>25 - 50	605	14.5%	686	16.5%	81	13.4%	634	15.2%	-52	-7.6%
>50 - 75	482	11.6%	447	10.7%	-35	-7.3%	409	9.8%	-38	-8.5%
>75	682	16.4%	694	16.7%	12	1.8%	663	15.9%	-31	-4.5%
Total	**4,167**	**100.0%**	**4,167**	**100.0%**			**4,167**	**100.0%**		

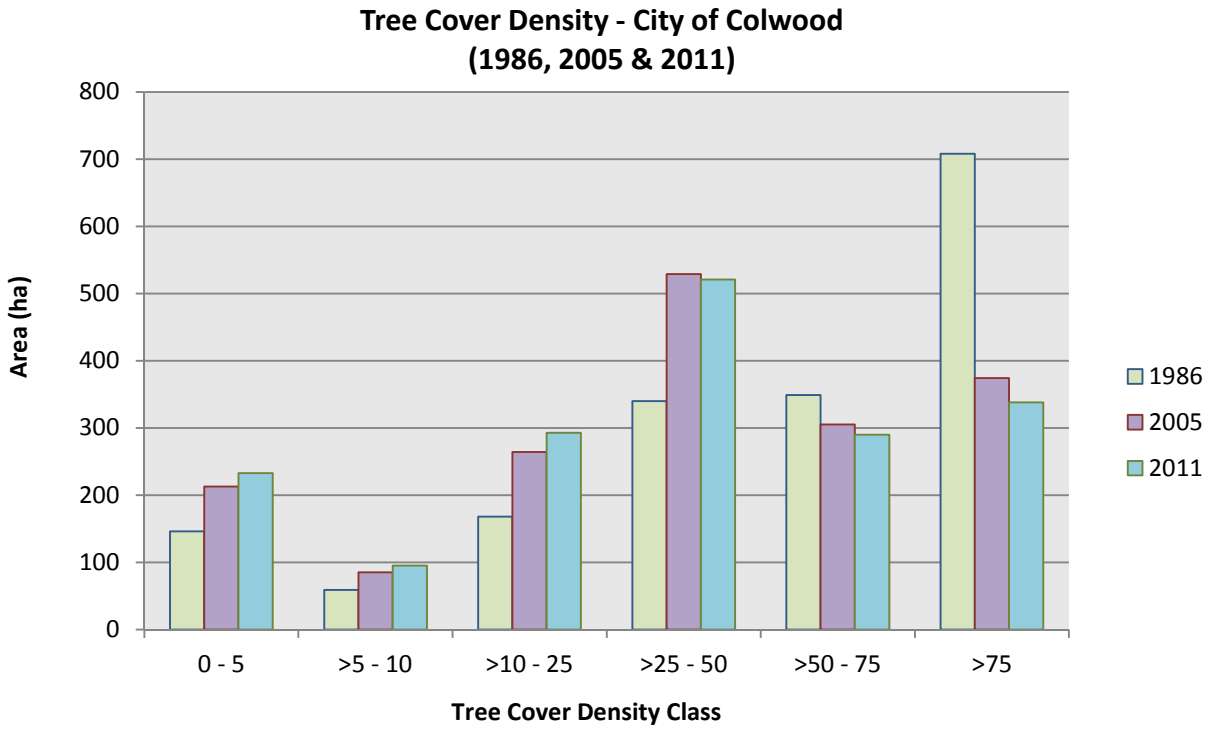
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – City of Colwood

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	146	8.2%	213	12.0%	67	45.9%	233	13.2%	20	9.4%
>5 - 10	59	3.3%	85	4.8%	26	44.1%	95	5.4%	10	11.8%
>10 - 25	168	9.5%	264	14.9%	96	57.1%	293	16.6%	29	11.0%
>25 - 50	340	19.2%	529	29.9%	189	55.6%	521	29.4%	-8	-1.5%
>50 - 75	349	19.7%	305	17.2%	-44	-12.6%	290	16.4%	-15	-4.9%
>75	708	40.0%	374	21.1%	-334	-47.2%	338	19.1%	-36	-9.6%
Total	**1,770**	**100.0%**	**1,770**	**100.0%**			**1,770**	**100.0%**		

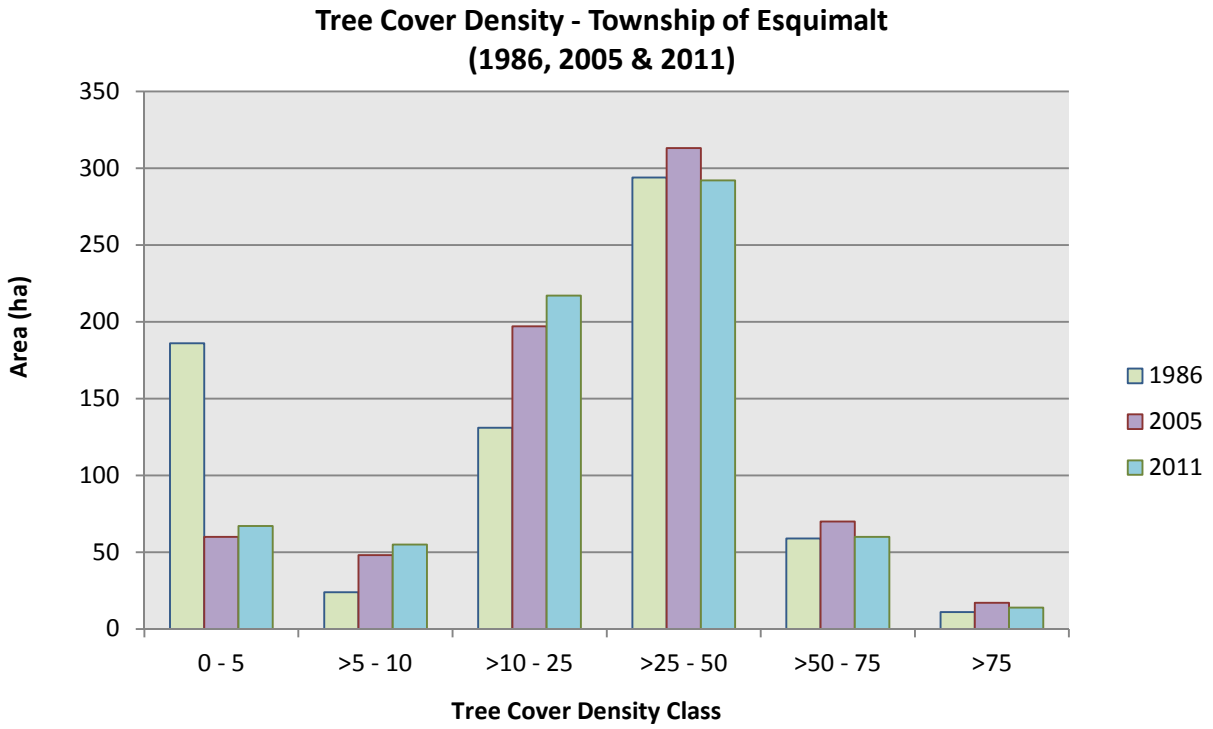
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – Township of Esquimalt

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	186	26.4%	60	8.5%	-126	-67.7%	67	9.5%	7	11.7%
>5 - 10	24	3.4%	48	6.8%	24	100.0%	55	7.8%	7	14.6%
>10 - 25	131	18.6%	197	27.9%	66	50.4%	217	30.8%	20	10.2%
>25 - 50	294	41.7%	313	44.4%	19	6.5%	292	41.4%	-21	-6.7%
>50 - 75	59	8.4%	70	9.9%	11	18.6%	60	8.5%	-10	-14.3%
>75	11	1.6%	17	2.4%	6	54.5%	14	2.0%	-3	-17.6%
Total	**705**	**100.0%**	**705**	**100.0%**			**705**	**100.0%**		

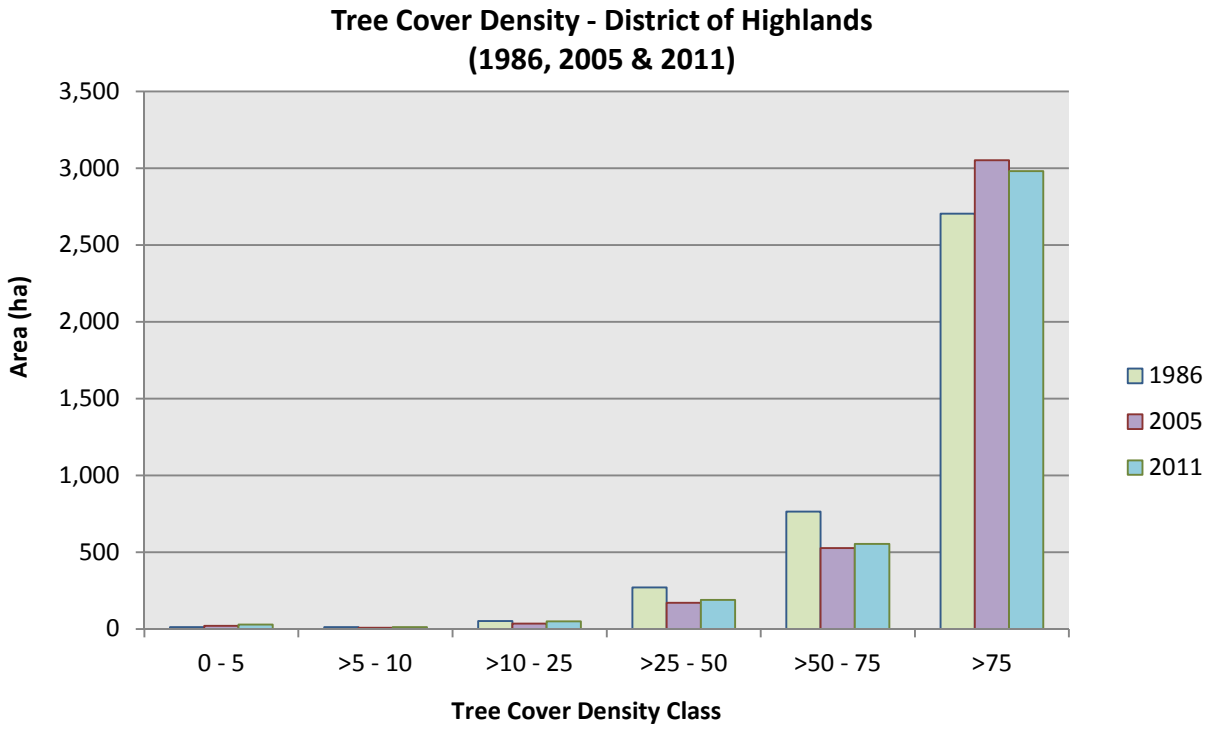
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – District of Highlands

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	13	0.3%	21	0.6%	8	61.5%	28	0.7%	7	33.3%
>5 - 10	12	0.3%	9	0.2%	-3	-25.0%	13	0.3%	4	44.4%
>10 - 25	52	1.4%	36	0.9%	-16	-30.8%	50	1.3%	14	38.9%
>25 - 50	270	7.1%	171	4.5%	-99	-36.7%	189	5.0%	18	10.5%
>50 - 75	764	20.0%	526	13.8%	-238	-31.2%	554	14.5%	28	5.3%
>75	2,703	70.9%	3,051	80.0%	348	12.9%	2,980	78.1%	-71	-2.3%
Total	**3,814**	**100.0%**	**3,814**	**100.0%**			**3,814**	**100.0%**		

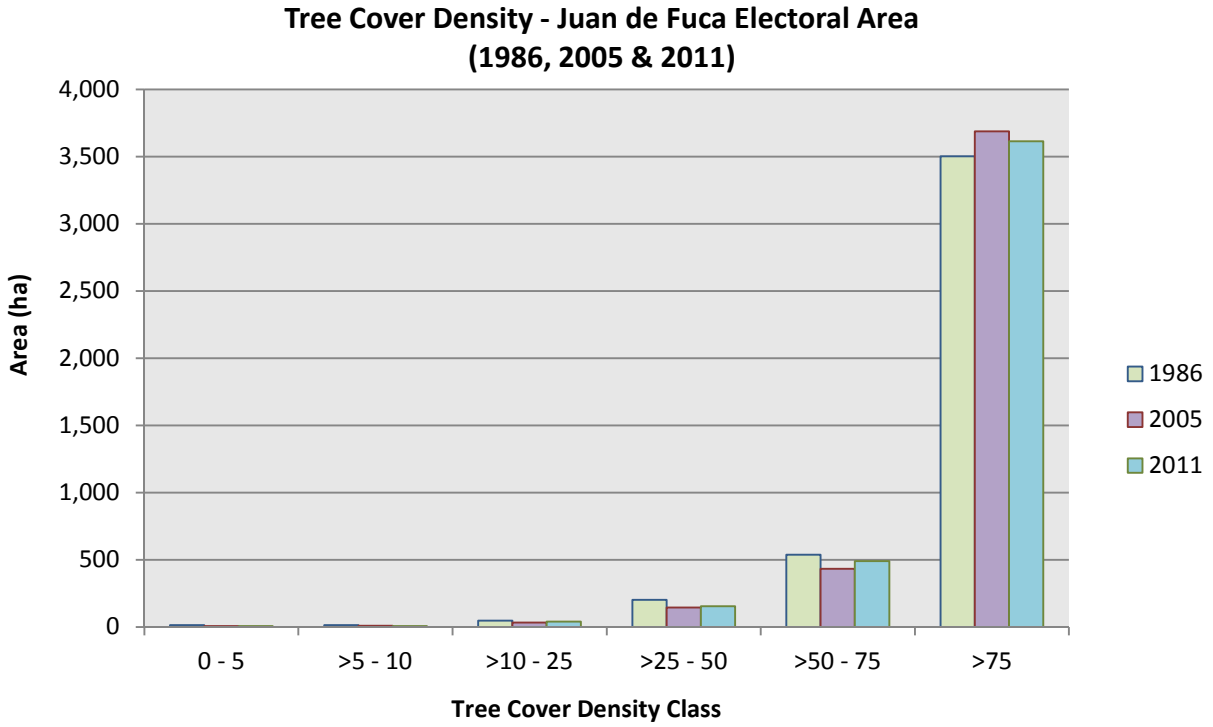
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – Juan de Fuca Electoral Area (portion within the CMSA)

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Jurisdiction	Hectares	Percent of Jurisdiction			Hectares	Percent of Jurisdiction		
0 - 5	13	0.3%	6	0.1%	-7	-53.8%	8	0.2%	2	33.3%
>5 - 10	13	0.3%	10	0.2%	-3	-23.1%	8	0.2%	-2	-20.0%
>10 - 25	48	1.1%	33	0.8%	-15	-31.3%	40	0.9%	7	21.2%
>25 - 50	202	4.7%	145	3.4%	-57	-28.2%	154	3.6%	9	6.2%
>50 - 75	537	12.4%	433	10.0%	-104	-19.4%	490	11.4%	57	13.2%
>75	3,502	81.2%	3,688	85.5%	186	5.3%	3,615	83.8%	-73	-2.0%
Total	**4,315**	**100.0%**	**4,315**	**100.0%**			**4,315**	**100.0%**		

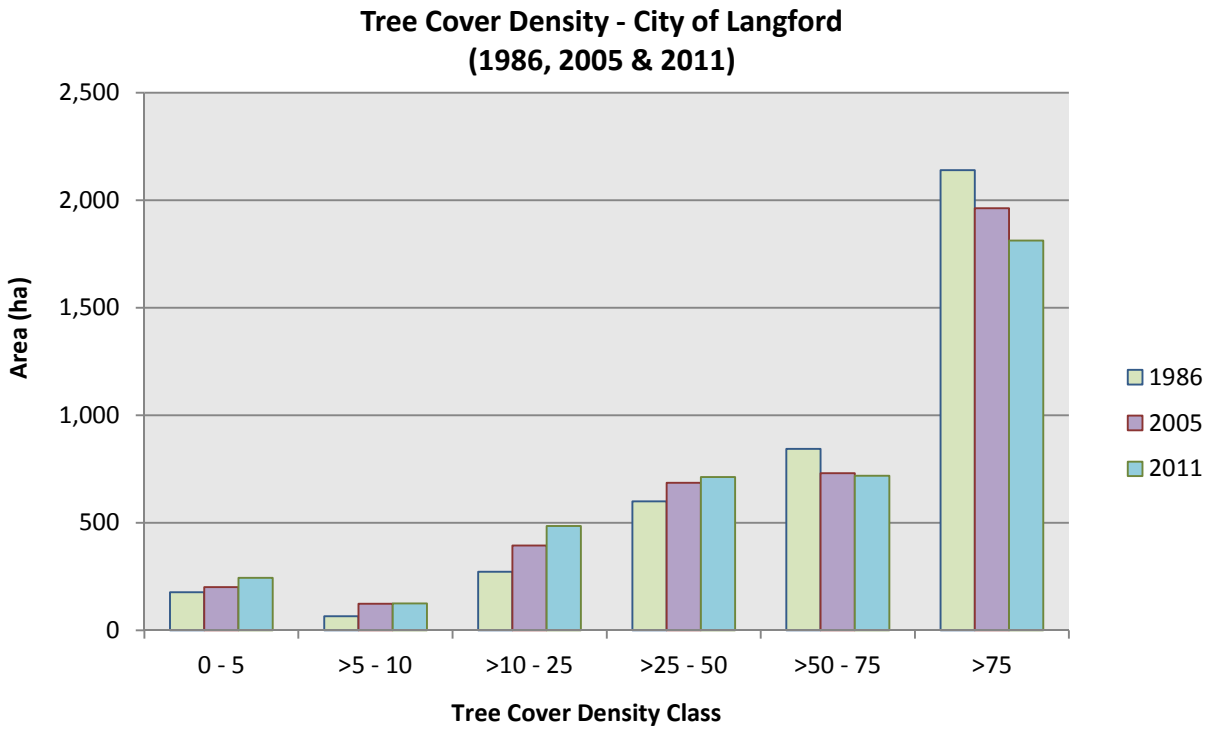
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – City of Langford

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	177	4.3%	201	4.9%	24	13.6%	244	6.0%	43	21.4%
>5 - 10	66	1.6%	124	3.0%	58	87.9%	125	3.0%	1	0.8%
>10 - 25	272	6.6%	394	9.6%	122	44.9%	485	11.8%	91	23.1%
>25 - 50	600	14.6%	686	16.7%	86	14.3%	713	17.4%	27	3.9%
>50 - 75	844	20.6%	731	17.8%	-113	-13.4%	719	17.5%	-12	-1.6%
>75	2,140	52.2%	1,963	47.9%	-177	-8.3%	1,813	44.2%	-150	-7.6%
Total	**4,099**	**100.0%**	**4,099**	**100.0%**			**4,099**	**100.0%**		

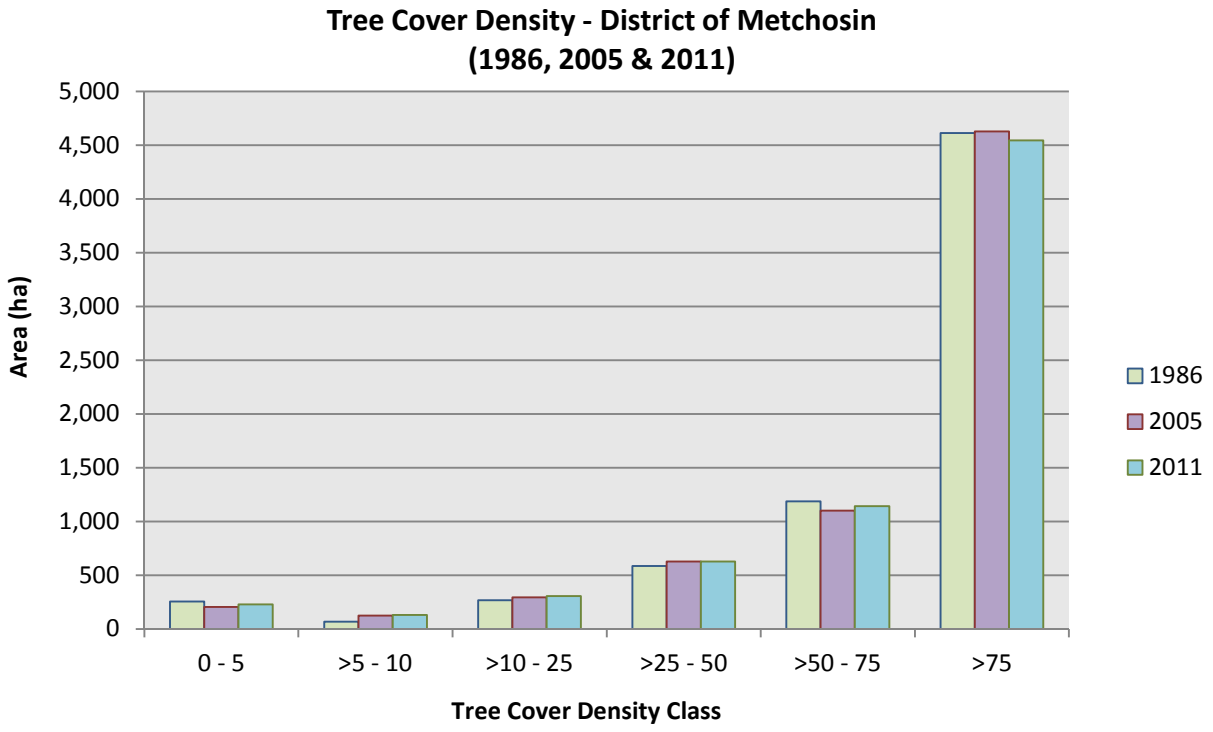
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – District of Metchosin

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	256	3.7%	205	2.9%	-51	-19.9%	228	3.3%	23	11.2%
>5 - 10	69	1.0%	124	1.8%	55	79.7%	130	1.9%	6	4.8%
>10 - 25	267	3.8%	294	4.2%	27	10.1%	307	4.4%	13	4.4%
>25 - 50	586	8.4%	628	9.0%	42	7.2%	628	9.0%	0	0.0%
>50 - 75	1,187	17.0%	1,100	15.8%	-87	-7.3%	1,142	16.4%	42	3.8%
>75	4,613	66.1%	4,627	66.3%	14	0.3%	4,543	65.1%	-84	-1.8%
Total	**6,978**	**100.0%**	**6,978**	**100.0%**			**6,978**	**100.0%**		

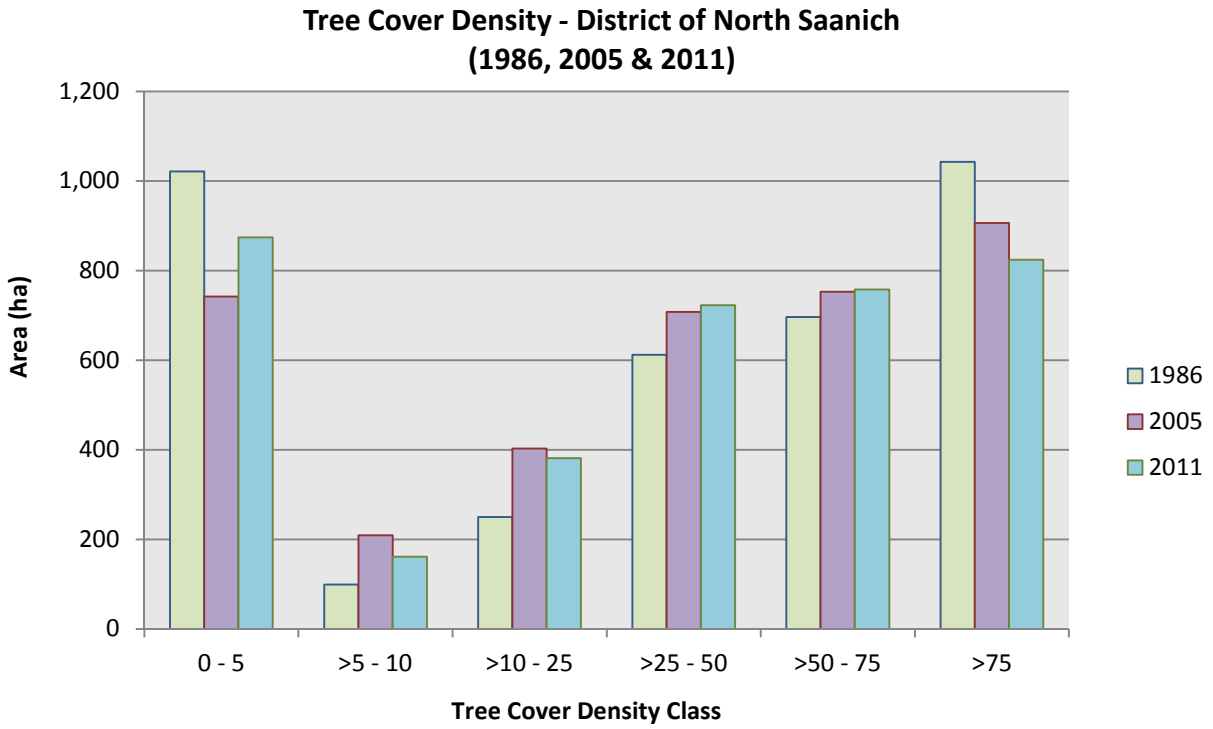
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – District of North Saanich

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	1,021	27.4%	742	19.9%	-279	-27.3%	874	23.5%	132	17.8%
>5 - 10	99	2.7%	209	5.6%	110	111.1%	161	4.3%	-48	-23.0%
>10 - 25	250	6.7%	403	10.8%	153	61.2%	381	10.2%	-22	-5.5%
>25 - 50	612	16.4%	708	19.0%	96	15.7%	723	19.4%	15	2.1%
>50 - 75	696	18.7%	753	20.2%	57	8.2%	758	20.4%	5	0.7%
>75	1,043	28.0%	906	24.3%	-137	-13.1%	824	22.1%	-82	-9.1%
Total	**3,721**	**100.0%**	**3,721**	**100.0%**			**3,721**	**100.0%**		

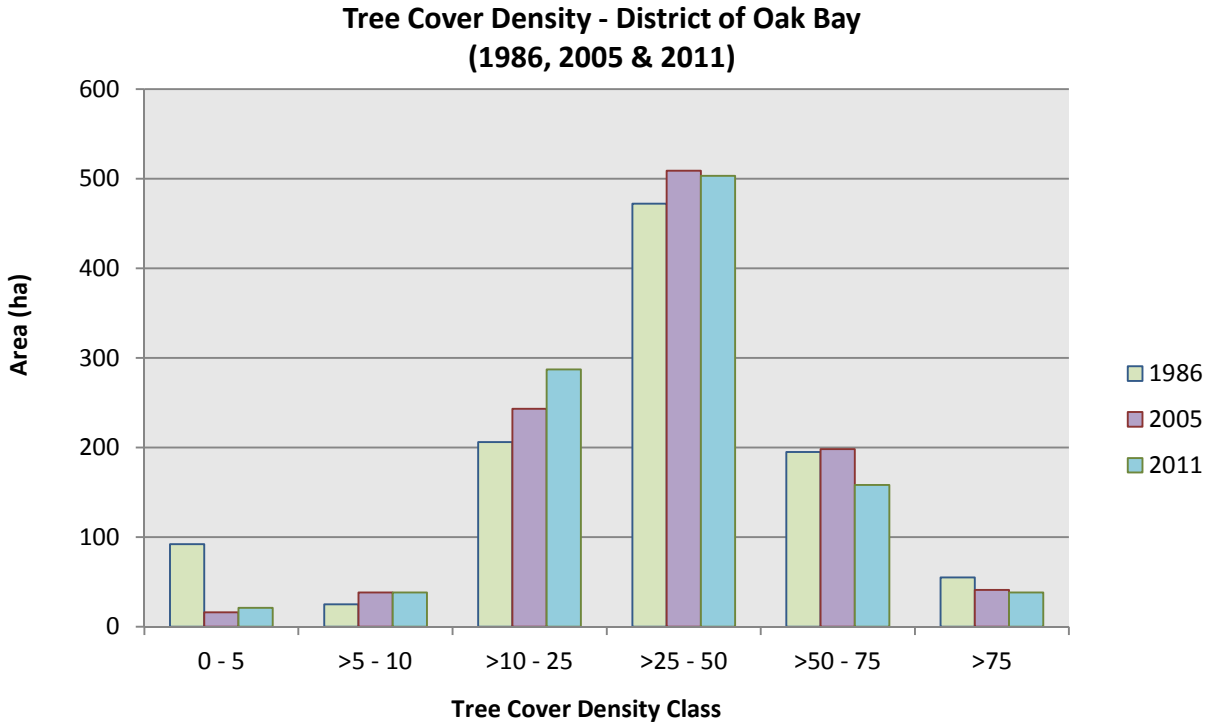
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – District of Oak Bay

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	92	8.8%	16	1.5%	-76	-82.6%	21	2.0%	5	31.3%
>5 - 10	25	2.4%	38	3.6%	13	52.0%	38	3.6%	0	0.0%
>10 - 25	206	19.7%	243	23.3%	37	18.0%	287	27.5%	44	18.1%
>25 - 50	472	45.2%	509	48.7%	37	7.8%	503	48.1%	-6	-1.2%
>50 - 75	195	18.7%	198	18.9%	3	1.5%	158	15.1%	-40	-20.2%
>75	55	5.3%	41	3.9%	-14	-25.5%	38	3.6%	-3	-7.3%
Total	**1,045**	**100.0%**	**1,045**	**100.0%**			**1,045**	**100.0%**		

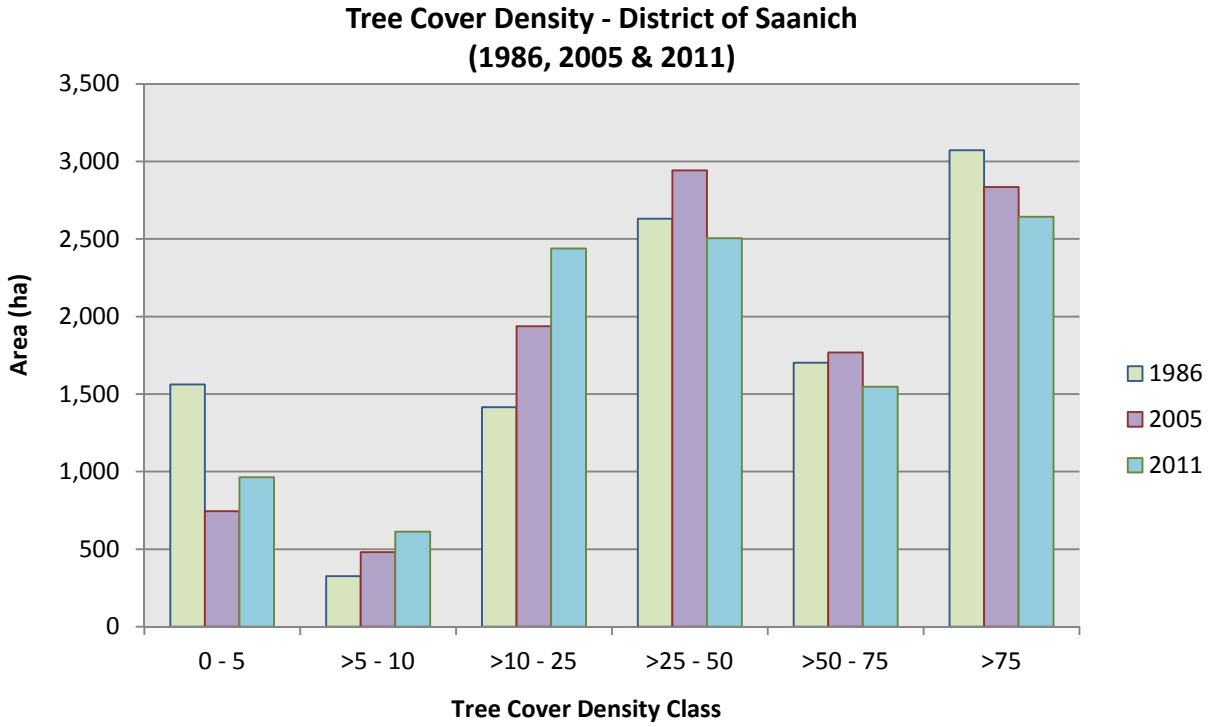
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – District of Saanich

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	1,562	14.6%	745	7.0%	-817	-52.3%	963	9.0%	218	29.3%
>5 - 10	325	3.0%	480	4.5%	155	47.7%	612	5.7%	132	27.5%
>10 - 25	1,416	13.2%	1,938	18.1%	522	36.9%	2,438	22.8%	500	25.8%
>25 - 50	2,630	24.6%	2,943	27.5%	313	11.9%	2,505	23.4%	-438	-14.9%
>50 - 75	1,702	15.9%	1,768	16.5%	66	3.9%	1,547	14.4%	-221	-12.5%
>75	3,073	28.7%	2,834	26.5%	-239	-7.8%	2,643	24.7%	-191	-6.7%
Total	**10,708**	**100.0%**	**10,708**	**100.0%**			**10,708**	**100.0%**		

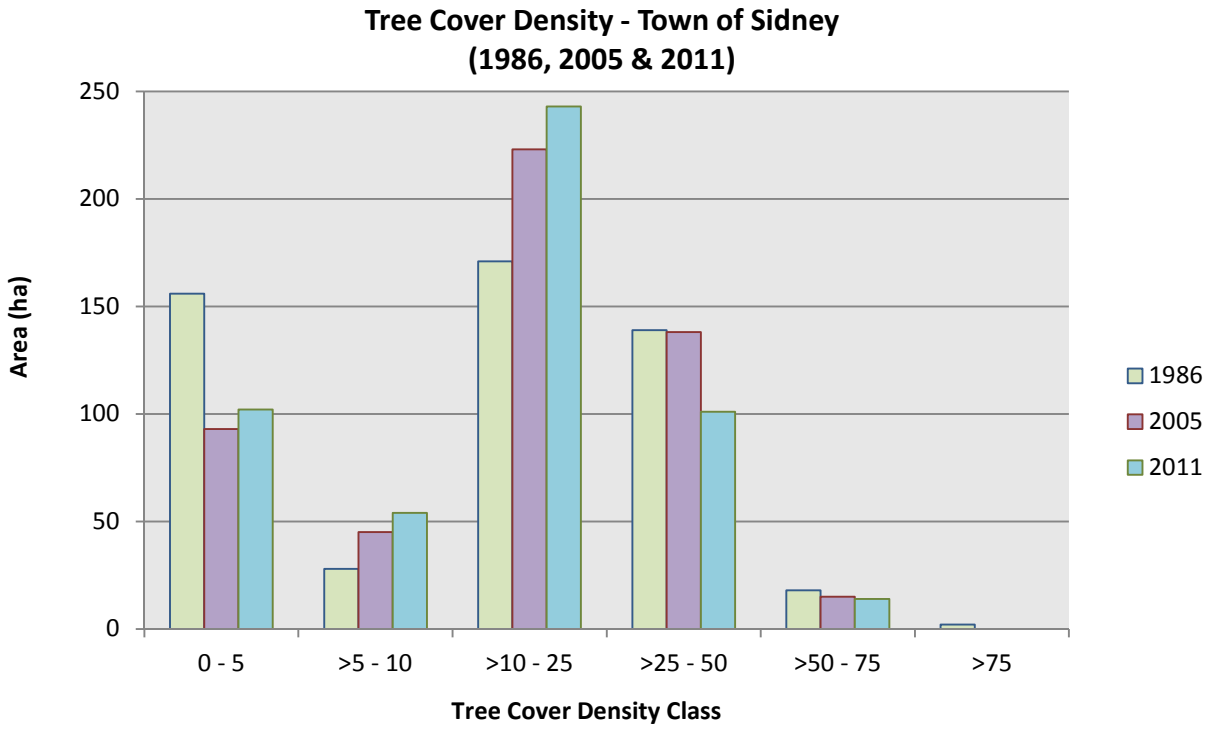
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – Town of Sidney

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	156	30.4%	93	18.1%	-63	-40.4%	102	19.8%	9	9.7%
>5 - 10	28	5.4%	45	8.8%	17	60.7%	54	10.5%	9	20.0%
>10 - 25	171	33.3%	223	43.4%	52	30.4%	243	47.3%	20	9.0%
>25 - 50	139	27.0%	138	26.8%	-1	-0.7%	101	19.6%	-37	-26.8%
>50 - 75	18	3.5%	15	2.9%	-3	-16.7%	14	2.7%	-1	-6.7%
>75	2	0.4%	0	0.0%	-2	-100.0%	0	0.0%	0	-
Total	**514**	**100.0%**	**514**	**100.0%**			**514**	**100.0%**		

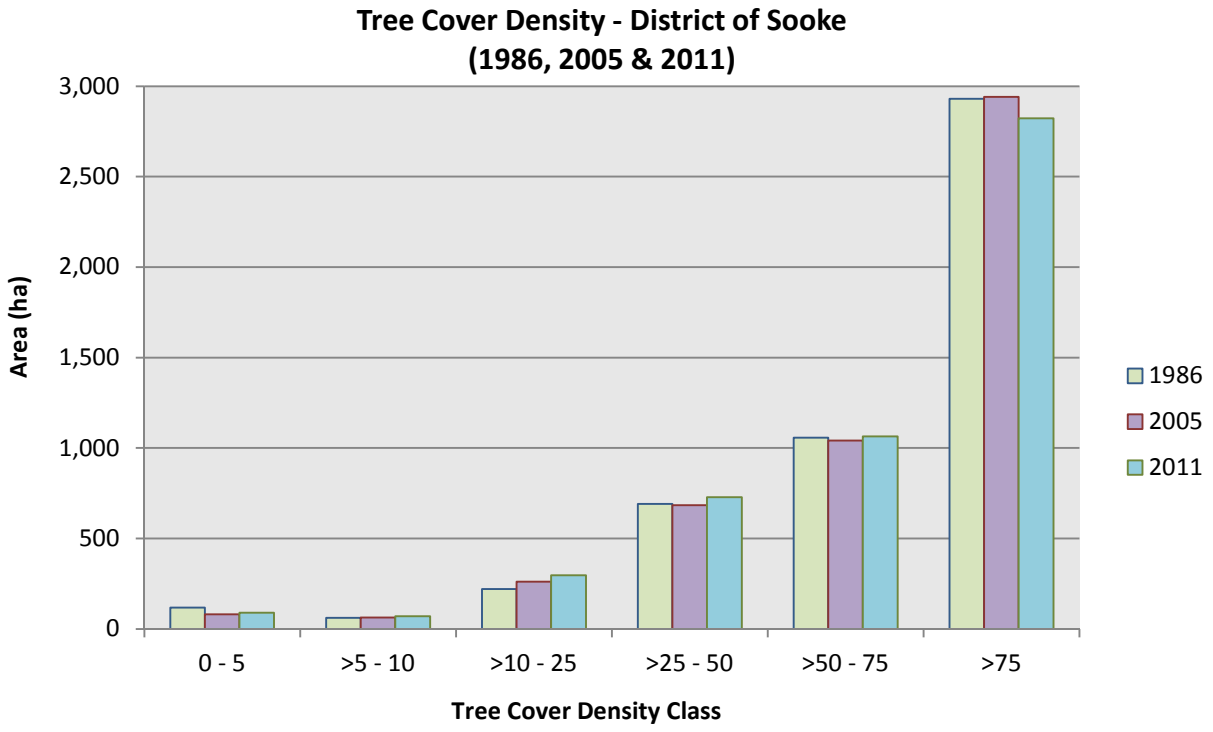
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – District of Sooke

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	119	2.3%	82	1.6%	-37	-31.1%	90	1.8%	8	9.8%
>5 - 10	61	1.2%	64	1.3%	3	4.9%	71	1.4%	7	10.9%
>10 - 25	220	4.3%	262	5.2%	42	19.1%	297	5.9%	35	13.4%
>25 - 50	691	13.6%	684	13.5%	-7	-1.0%	729	14.4%	45	6.6%
>50 - 75	1,057	20.8%	1,042	20.5%	-15	-1.4%	1,065	21.0%	23	2.2%
>75	2,931	57.7%	2,941	58.0%	10	0.3%	2,823	55.6%	-118	-4.0%
Total	**5,079**	**100.0%**	**5,075**	**100.0%**			**5,075**	**100.0%**		

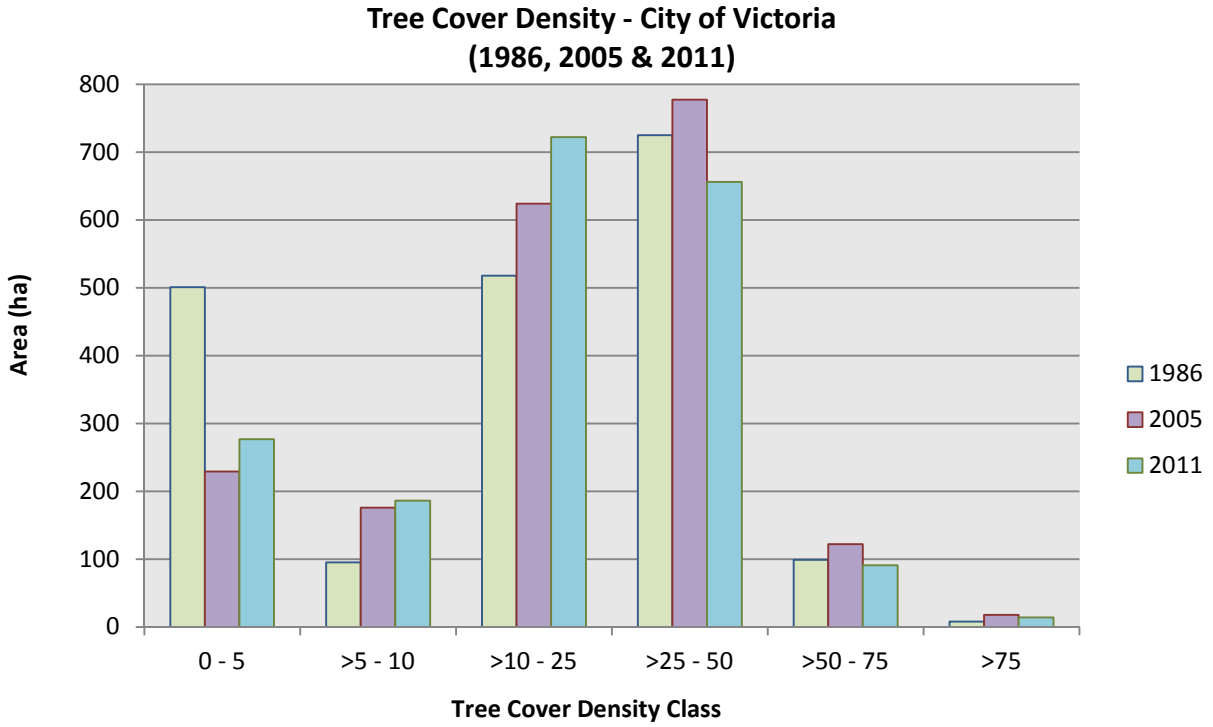
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – City of Victoria

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	501	25.7%	229	11.8%	-272	-54.3%	277	14.2%	48	21.0%
>5 - 10	95	4.9%	176	9.0%	81	85.3%	186	9.6%	10	5.7%
>10 - 25	518	26.6%	624	32.1%	106	20.5%	722	37.1%	98	15.7%
>25 - 50	725	37.3%	777	39.9%	52	7.2%	656	33.7%	-121	-15.6%
>50 - 75	99	5.1%	122	6.3%	23	23.2%	91	4.7%	-31	-25.4%
>75	8	0.4%	18	0.9%	10	125.0%	14	0.7%	-4	-22.2%
Total	**1,946**	**100.0%**	**1,946**	**100.0%**			**1,946**	**100.0%**		

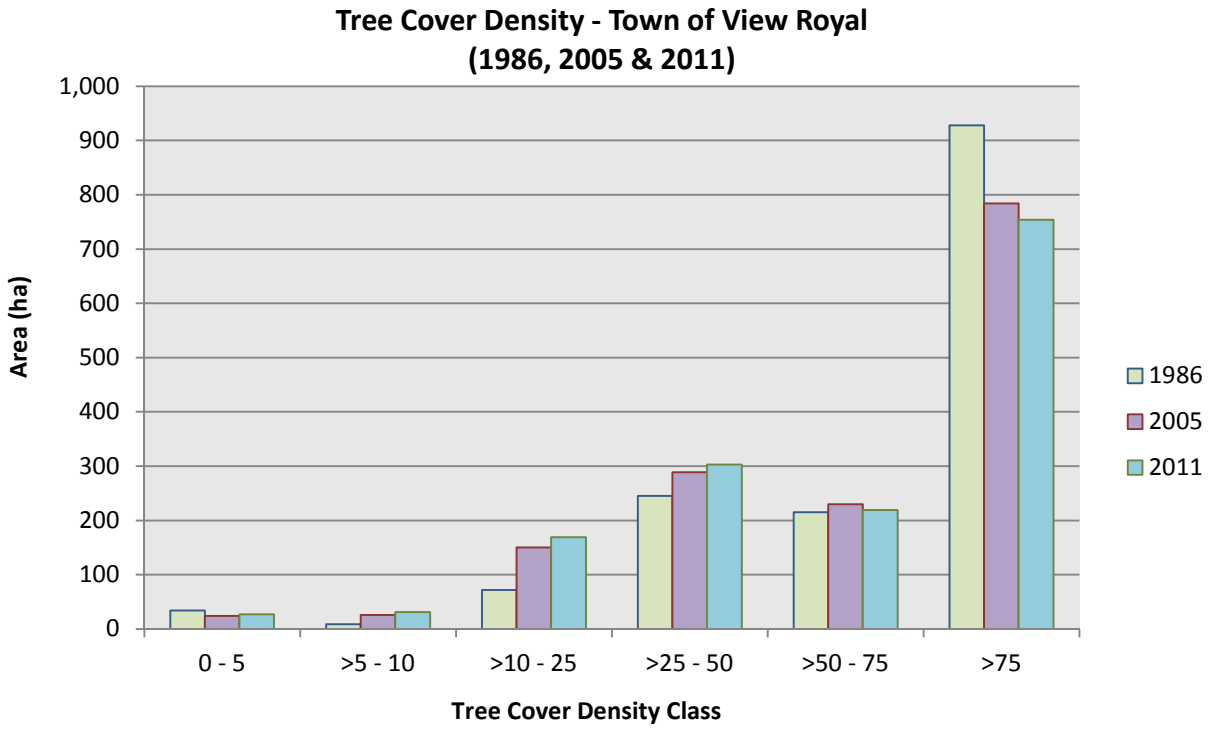
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – Town of View Royal

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	34	2.3%	24	1.6%	-10	-29.4%	27	1.8%	3	12.5%
>5 - 10	9	0.6%	26	1.7%	17	188.9%	31	2.1%	5	19.2%
>10 - 25	72	4.8%	150	10.0%	78	108.3%	169	11.2%	19	12.7%
>25 - 50	245	16.3%	289	19.2%	44	18.0%	303	20.2%	14	4.8%
>50 - 75	215	14.3%	230	15.3%	15	7.0%	219	14.6%	-11	-4.8%
>75	928	61.7%	784	52.2%	-144	-15.5%	754	50.2%	-30	-3.8%
Total	**1,503**	**100.0%**	**1,503**	**100.0%**			**1,503**	**100.0%**		

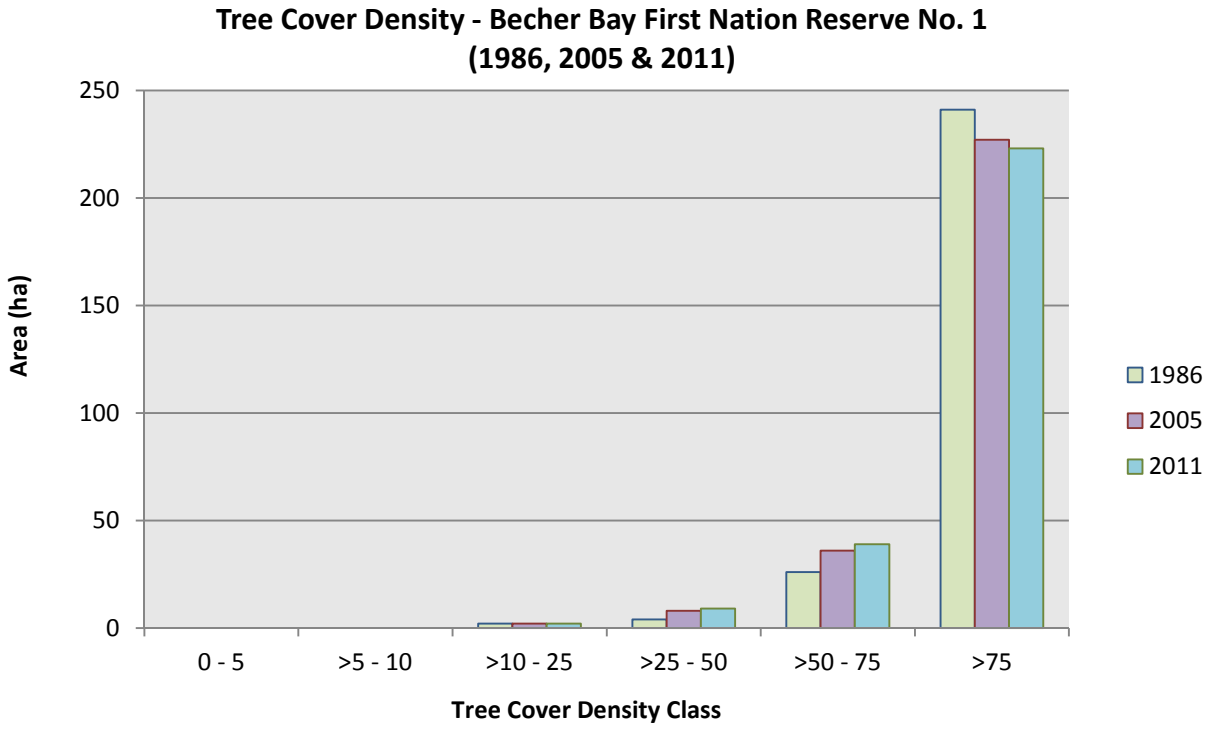
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density - Becher Bay First Nation Reserve No. 1

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>5 - 10	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>10 - 25	2	0.7%	2	0.7%	0	0.0%	2	0.7%	0	0.0%
>25 - 50	4	1.5%	8	2.9%	4	100.0%	9	3.3%	1	12.5%
>50 - 75	26	9.5%	36	13.2%	10	38.5%	39	14.3%	3	8.3%
>75	241	88.3%	227	83.2%	-14	-5.8%	223	81.7%	-4	-1.8%
Total	**273**	**100.0%**	**273**	**100.0%**			**273**	**100.0%**		

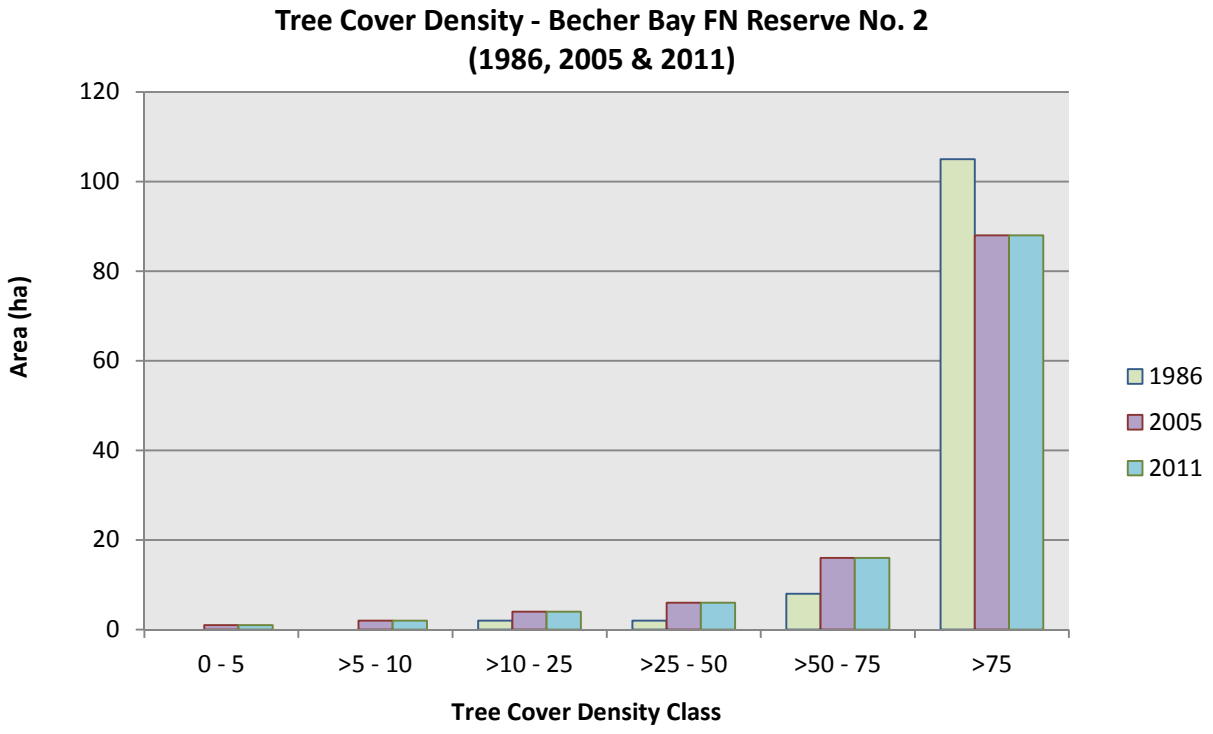
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – Becher Bay First Nation Reserve No. 2

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	0	0.0%	1	0.9%	1	-	1	0.9%	0	0.0%
>5 - 10	0	0.0%	2	1.7%	2	-	2	1.7%	0	0.0%
>10 - 25	2	1.7%	4	3.4%	2	100.0%	4	3.4%	0	0.0%
>25 - 50	2	1.7%	6	5.1%	4	200.0%	6	5.1%	0	0.0%
>50 - 75	8	6.8%	16	13.7%	8	100.0%	16	13.7%	0	0.0%
>75	105	89.7%	88	75.2%	-17	-16.2%	88	75.2%	0	0.0%
Total	**117**	**100.0%**	**117**	**100.0%**			**117**	**100.0%**		

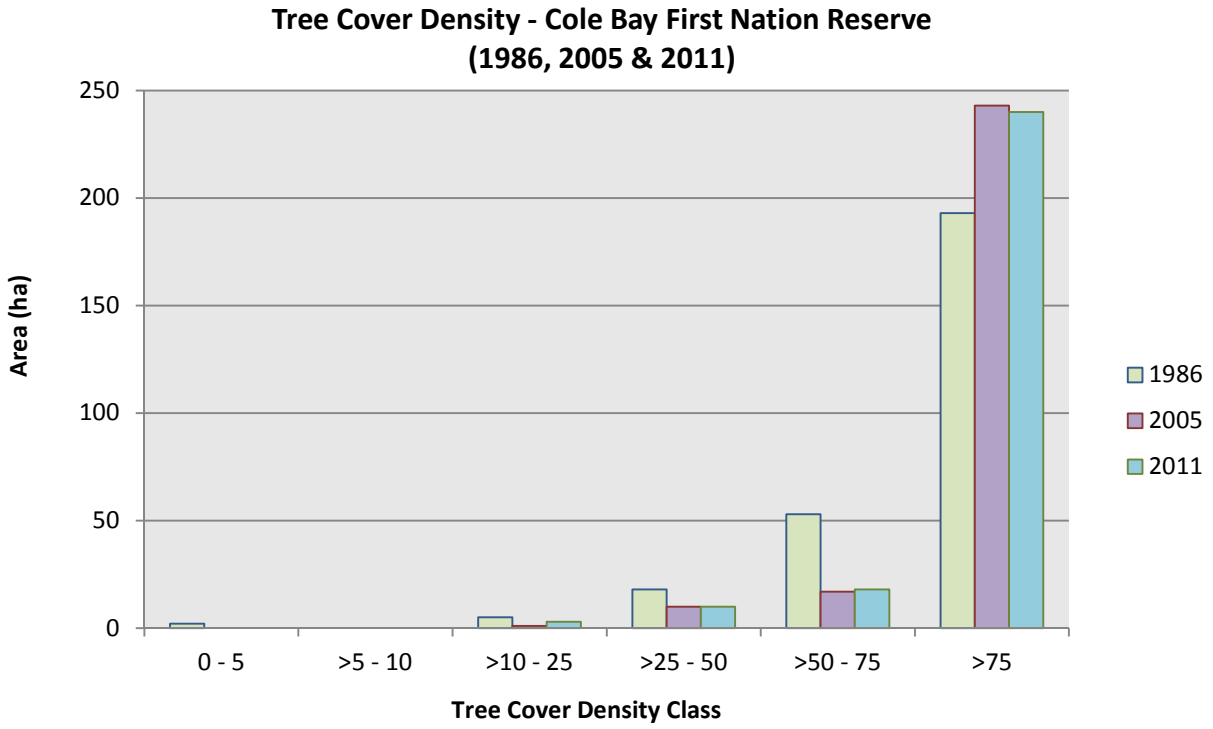
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – Cole Bay First Nation Reserve

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	2	0.7%	0	0.0%	-2	-100.0%	0	0.0%	0	-
>5 - 10		0.0%	0	0.0%	0	-	0	0.0%	0	-
>10 - 25	5	1.8%	1	0.4%	-4	-80.0%	3	1.1%	2	200.0%
>25 - 50	18	6.6%	10	3.7%	-8	-44.4%	10	3.7%	0	0.0%
>50 - 75	53	19.6%	17	6.3%	-36	-67.9%	18	6.6%	1	5.9%
>75	193	71.2%	243	89.7%	50	25.9%	240	88.6%	-3	-1.2%
Total	**271**	**100.0%**	**271**	**100.0%**			**271**	**100.0%**		

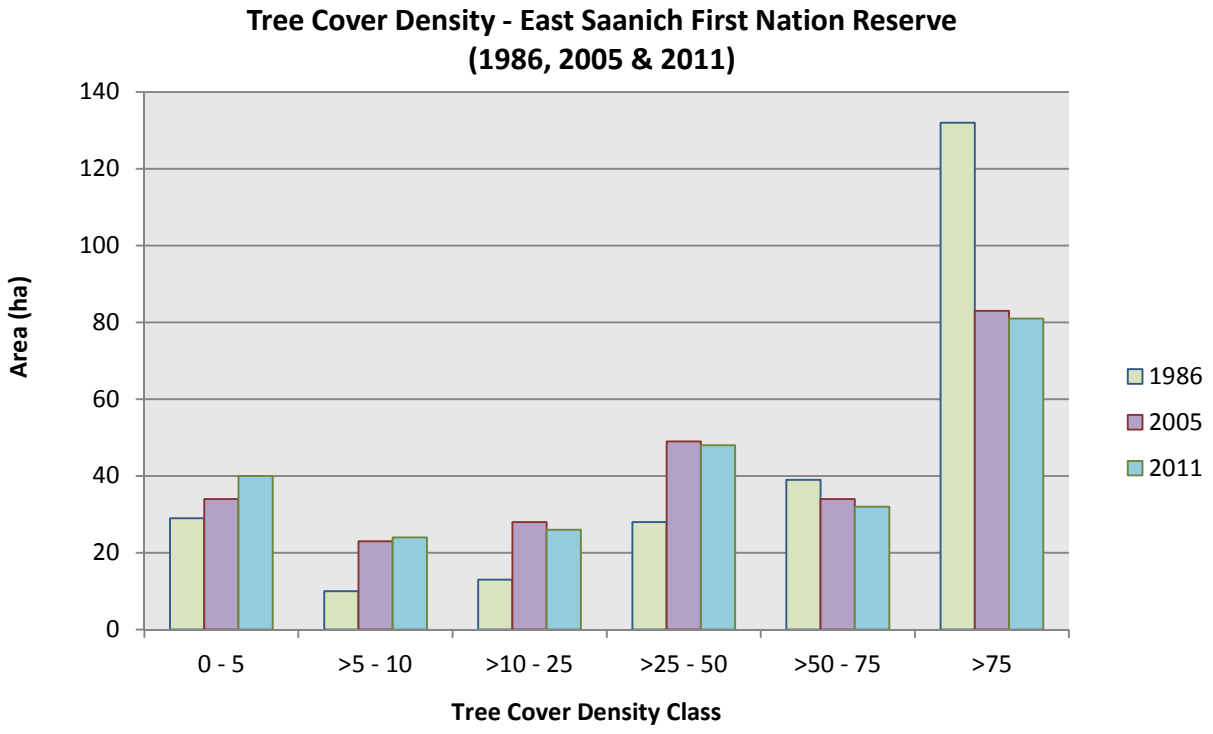
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – East Saanich First Nation Reserve

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	29	11.6%	34	13.5%	5	17.2%	40	15.9%	6	17.6%
>5 - 10	10	4.0%	23	9.2%	13	130.0%	24	9.6%	1	4.3%
>10 - 25	13	5.2%	28	11.2%	15	115.4%	26	10.4%	-2	-7.1%
>25 - 50	28	11.2%	49	19.5%	21	75.0%	48	19.1%	-1	-2.0%
>50 - 75	39	15.5%	34	13.5%	-5	-12.8%	32	12.7%	-2	-5.9%
>75	132	52.6%	83	33.1%	-49	-37.1%	81	32.3%	-2	-2.4%
Total	**251**	**100.0%**	**251**	**100.0%**			**251**	**100.0%**		

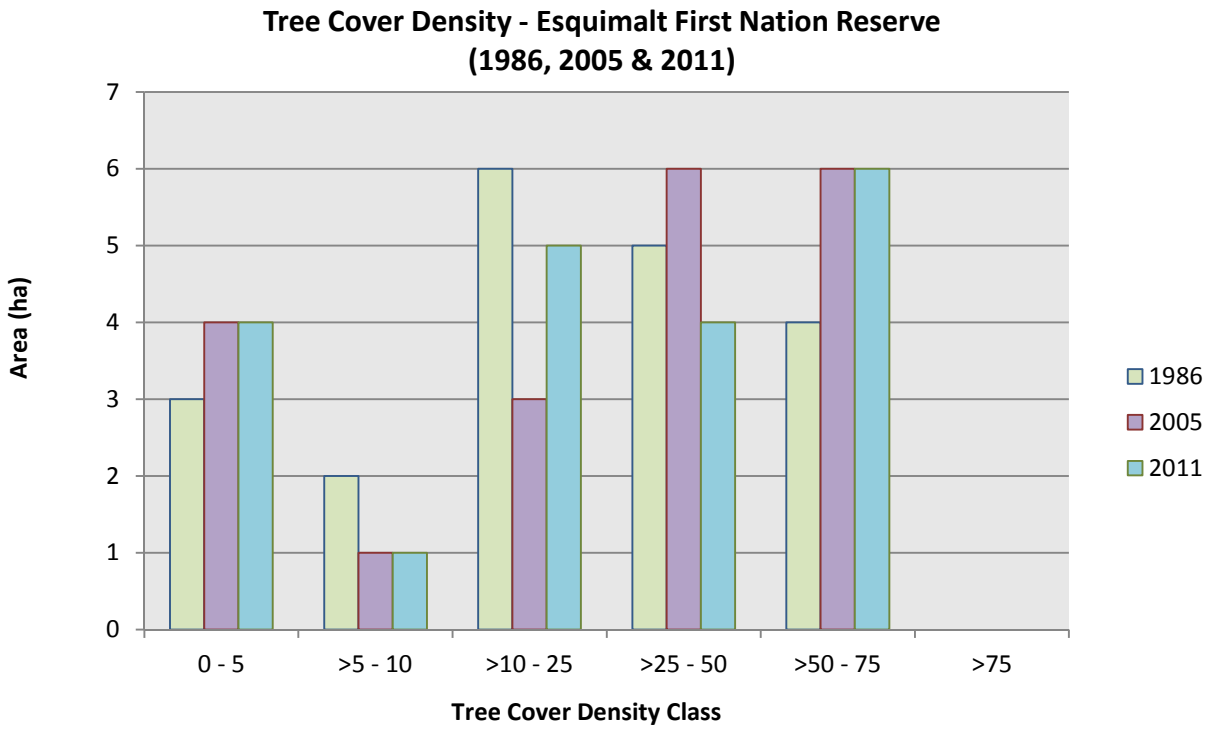
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density Esquimalt First Nation Reserve

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	3	15.0%	4	20.0%	1	33.3%	4	20.0%	0	0.0%
>5 - 10	2	10.0%	1	5.0%	-1	-50.0%	1	5.0%	0	0.0%
>10 - 25	6	30.0%	3	15.0%	-3	-50.0%	5	25.0%	2	66.7%
>25 - 50	5	25.0%	6	30.0%	1	20.0%	4	20.0%	-2	-33.3%
>50 - 75	4	20.0%	6	30.0%	2	50.0%	6	30.0%	0	0.0%
>75		0.0%		0.0%	0	-		0.0%	0	-
Total	**20**	**100.0%**	**20**	**100.0%**			**20**	**100.0%**		

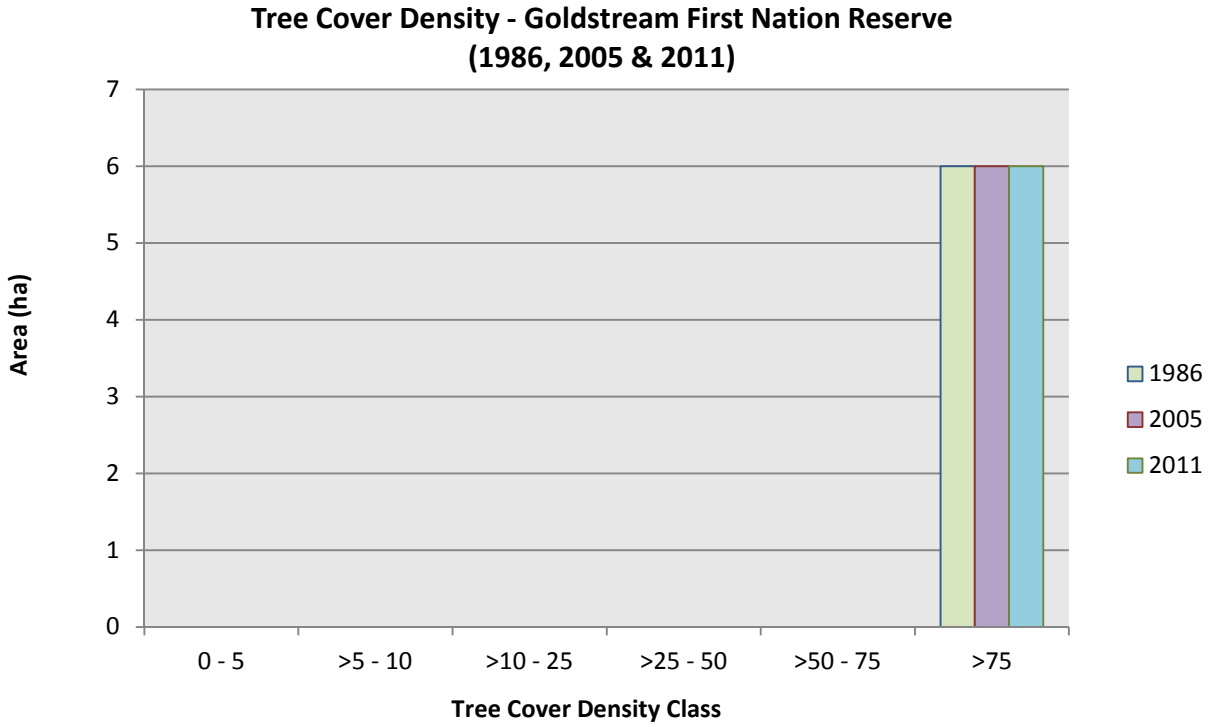
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density - Goldstream First Nation Reserve

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>5 - 10	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>10 - 25	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>25 - 50	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>50 - 75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>75	6	100.0%	6	100.0%	0	0.0%	6	100.0%	0	0.0%
Total	**6**	**100.0%**	**6**	**100.0%**			**6**	**100.0%**		

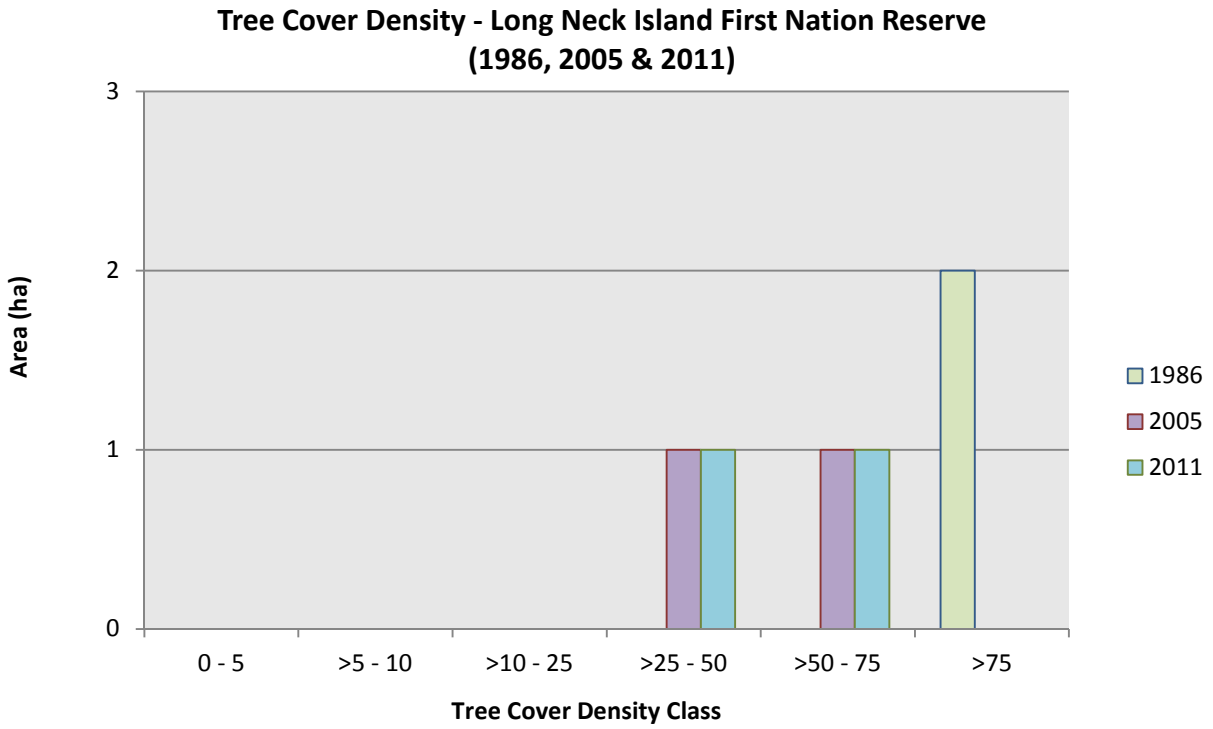
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – Long Neck Island First Nation Reserve

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>5 - 10	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>10 - 25	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>25 - 50	0	0.0%	1	50.0%	1	-	1	50.0%	0	0.0%
>50 - 75	0	0.0%	1	50.0%	1	-	1	50.0%	0	0.0%
>75	2	100.0%	0	0.0%	-2	-100.0%	0	0.0%	0	-
Total	**2**	**100.0%**	**2**	**100.0%**			**2**	**100.0%**		

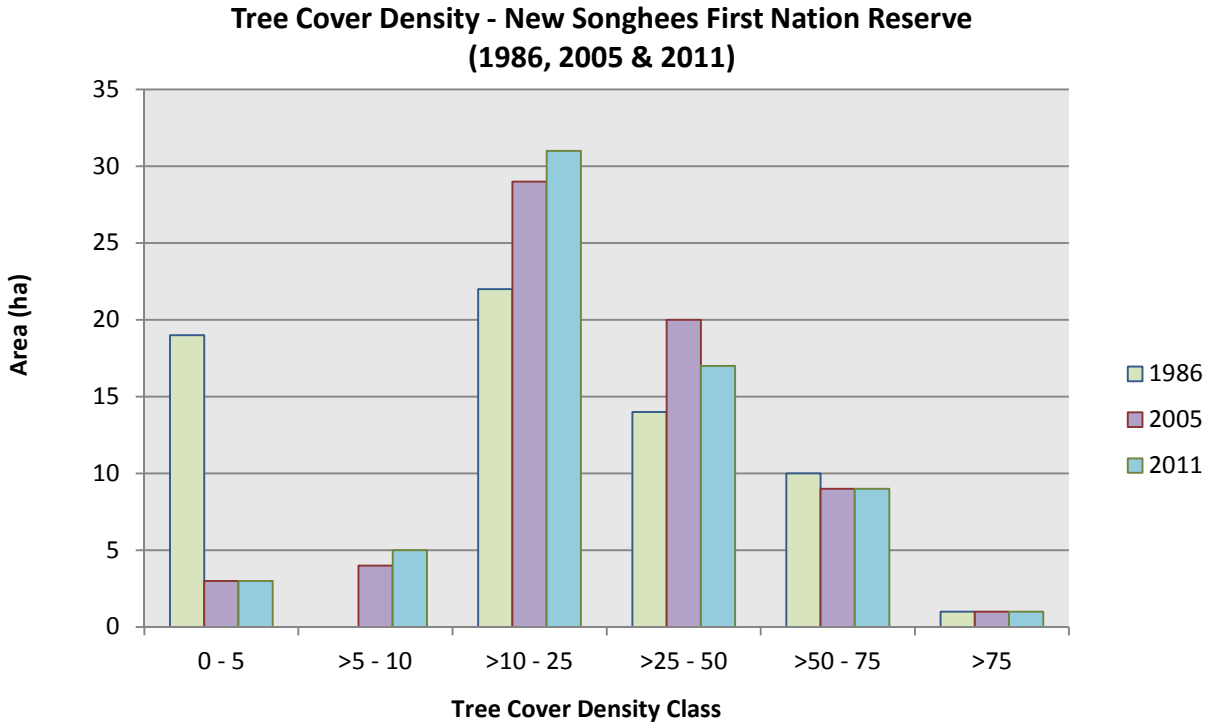
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – New Songhees First Nation Reserve

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	19	28.8%	3	4.5%	-16	-84.2%	3	4.5%	0	0.0%
>5 - 10	0	0.0%	4	6.1%	4	-	5	7.6%	1	25.0%
>10 - 25	22	33.3%	29	43.9%	7	31.8%	31	47.0%	2	6.9%
>25 - 50	14	21.2%	20	30.3%	6	42.9%	17	25.8%	-3	-15.0%
>50 - 75	10	15.2%	9	13.6%	-1	-10.0%	9	13.6%	0	0.0%
>75	1	1.5%	1	1.5%	0	0.0%	1	1.5%	0	0.0%
Total	**66**	**100.0%**	**66**	**100.0%**			**66**	**100.0%**		

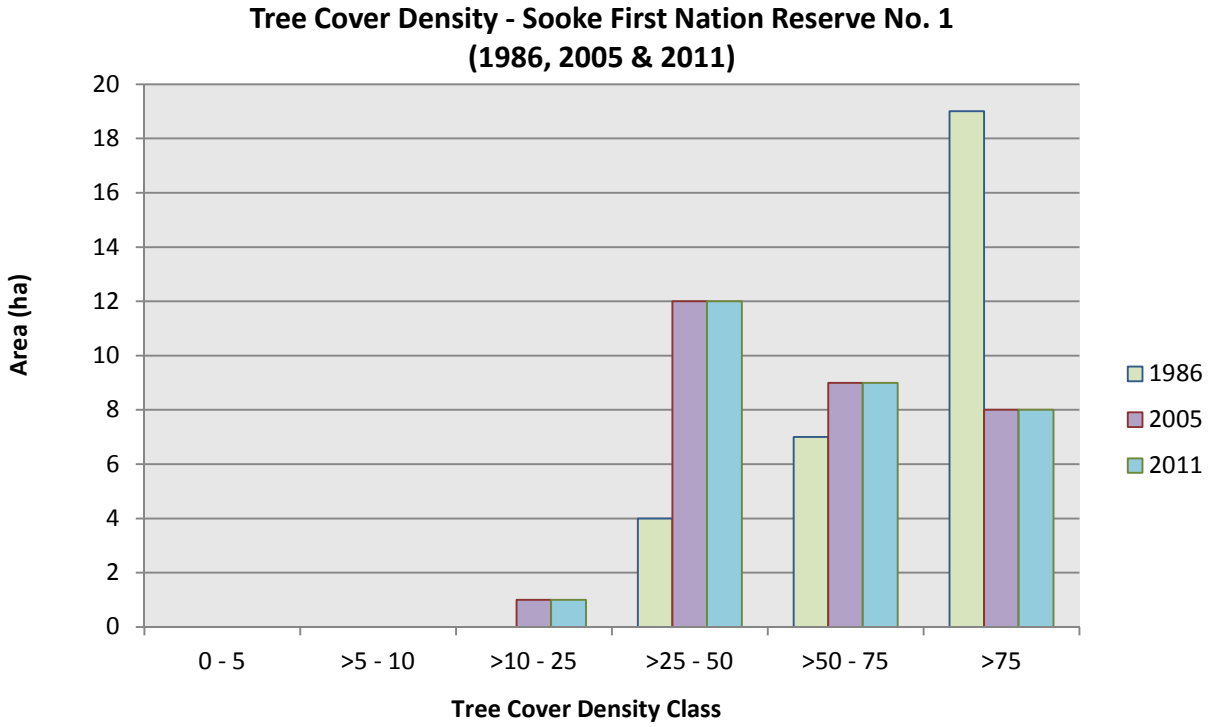
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – Sooke First Nation Reserve No. 1

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>5 - 10	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>10 - 25	0	0.0%	1	3.3%	1	-	1	3.3%	0	0.0%
>25 - 50	4	13.3%	12	40.0%	8	200.0%	12	40.0%	0	0.0%
>50 - 75	7	23.3%	9	30.0%	2	28.6%	9	30.0%	0	0.0%
>75	19	63.3%	8	26.7%	-11	-57.9%	8	26.7%	0	0.0%
Total	**30**	**100.0%**	**30**	**100.0%**			**30**	**100.0%**		

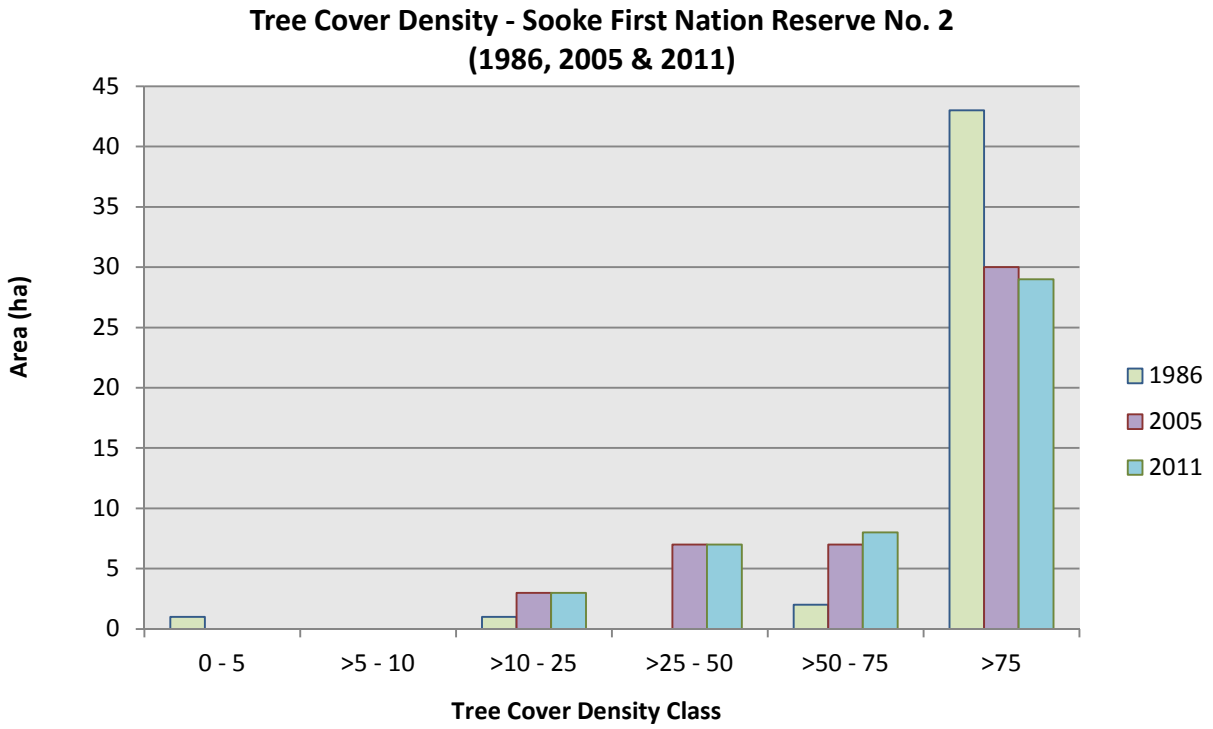
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – Sooke First Nation Reserve No. 2

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	1	2.1%	0	0.0%	-1	-100.0%	0	0.0%	0	-
>5 - 10	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>10 - 25	1	2.1%	3	6.4%	2	200.0%	3	6.4%	0	0.0%
>25 - 50	0	0.0%	7	14.9%	7	-	7	14.9%	0	0.0%
>50 - 75	2	4.3%	7	14.9%	5	250.0%	8	17.0%	1	14.3%
>75	43	91.5%	30	63.8%	-13	-30.2%	29	61.7%	-1	-3.3%
Total	**47**	**100.0%**	**47**	**100.0%**			**47**	**100.0%**		

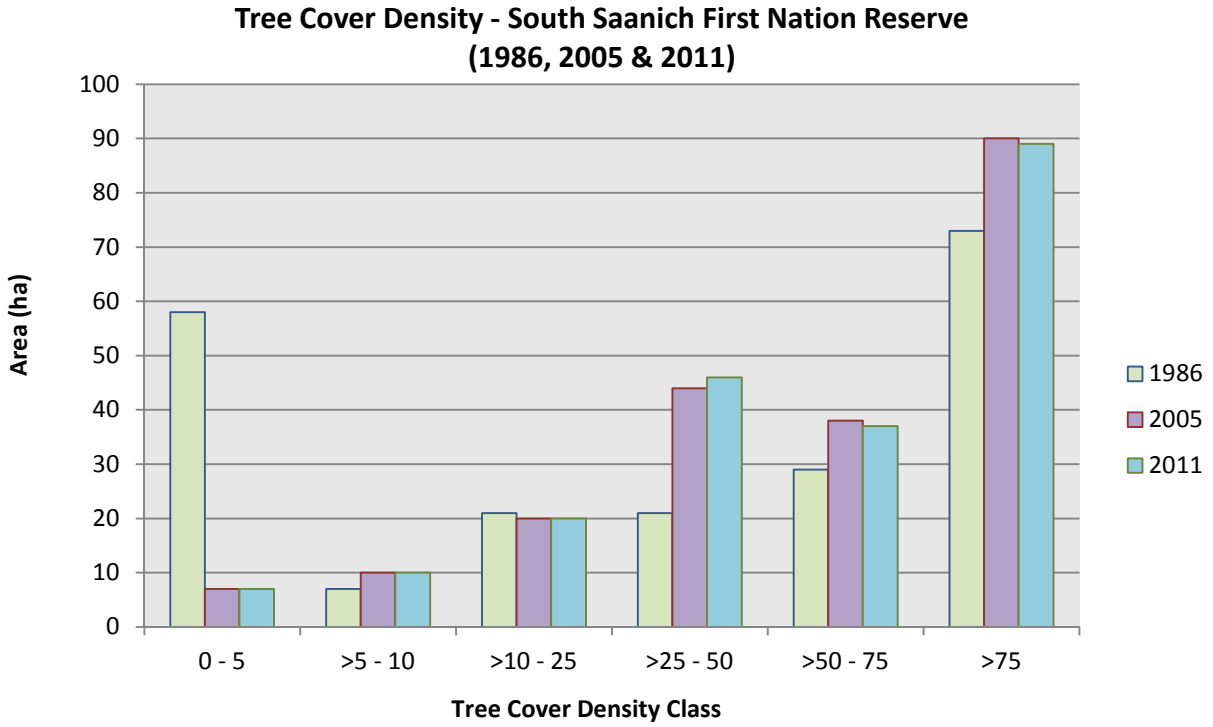
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – South Saanich First Nation Reserve

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	58	27.8%	7	3.3%	-51	-87.9%	7	3.3%	0	0.0%
>5 - 10	7	3.3%	10	4.8%	3	42.9%	10	4.8%	0	0.0%
>10 - 25	21	10.0%	20	9.6%	-1	-4.8%	20	9.6%	0	0.0%
>25 - 50	21	10.0%	44	21.1%	23	109.5%	46	22.0%	2	4.5%
>50 - 75	29	13.9%	38	18.2%	9	31.0%	37	17.7%	-1	-2.6%
>75	73	34.9%	90	43.1%	17	23.3%	89	42.6%	-1	-1.1%
Total	**209**	**100.0%**	**209**	**100.0%**			**209**	**100.0%**		

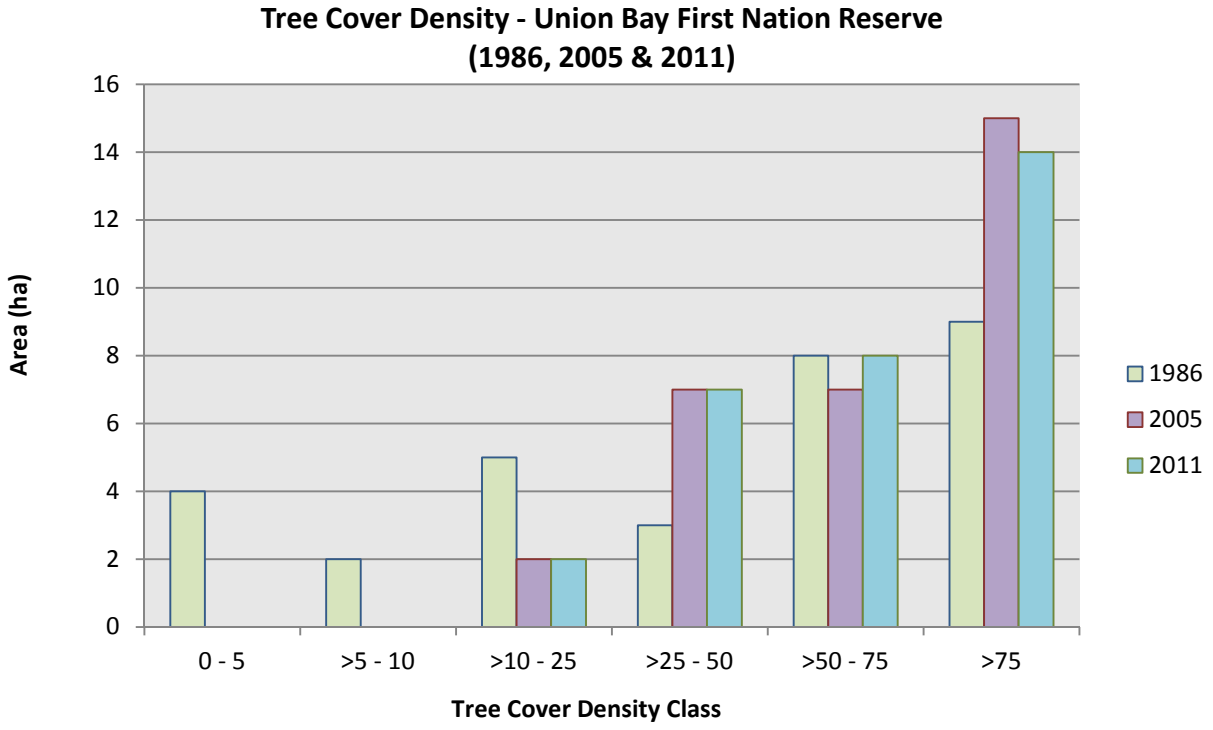
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Tree Cover Density – Union Bay First Nation Reserve

Tree Cover Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	4	12.9%	0	0.0%	-4	-100.0%	0	0.0%	0	-
>5 - 10	2	6.5%	0	0.0%	-2	-100.0%	0	0.0%	0	-
>10 - 25	5	16.1%	2	6.5%	-3	-60.0%	2	6.5%	0	0.0%
>25 - 50	3	9.7%	7	22.6%	4	133.3%	7	22.6%	0	0.0%
>50 - 75	8	25.8%	7	22.6%	-1	-12.5%	8	25.8%	1	14.3%
>75	9	29.0%	15	48.4%	6	66.7%	14	45.2%	-1	-6.7%
Total	**31**	**100.0%**	**31**	**100.0%**			**31**	**100.0%**		

* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



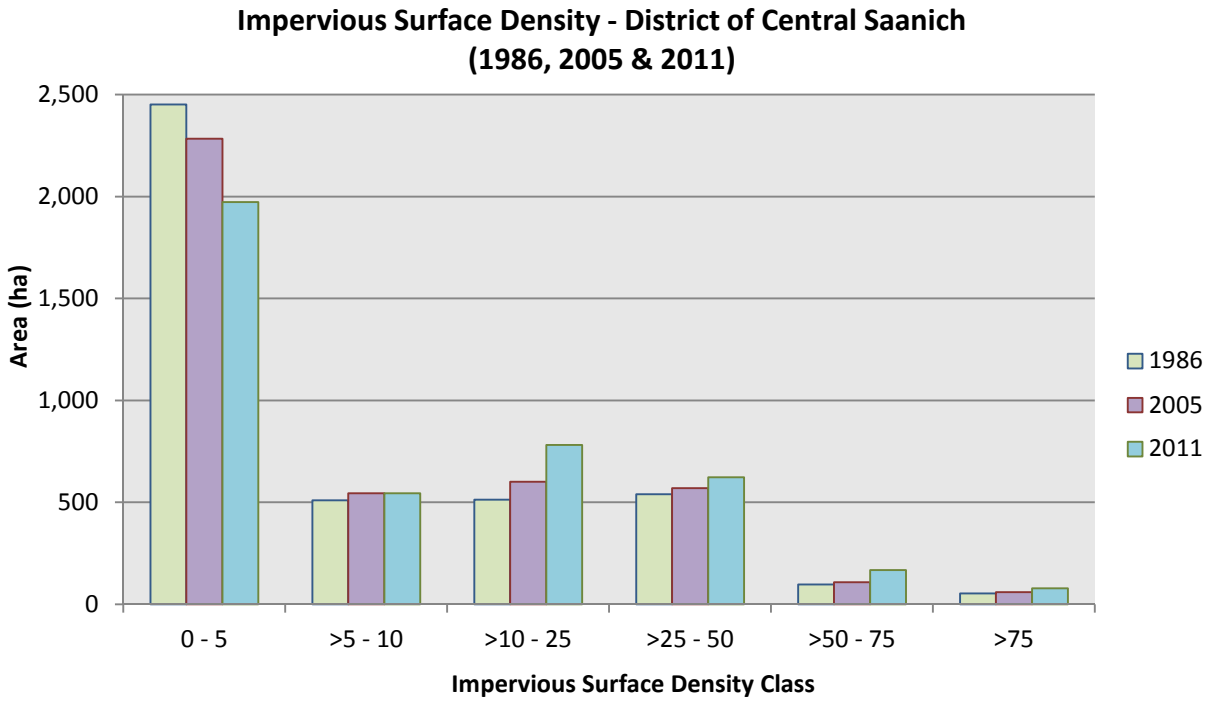
Appendix B

Detailed Municipal and First Nation Reserve
Impervious Surface Density Summaries

Impervious Surface Density – District of Central Saanich

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	2,452	58.8%	2,284	54.8%	-168	-6.9%	1,973	47.3%	-311	-13.6%
>5 - 10	510	12.2%	544	13.1%	34	6.7%	544	13.1%	0	0.0%
>10 - 25	514	12.3%	601	14.4%	87	16.9%	781	18.7%	180	30.0%
>25 - 50	540	13.0%	569	13.7%	29	5.4%	623	15.0%	54	9.5%
>50 - 75	97	2.3%	109	2.6%	12	12.4%	168	4.0%	59	54.1%
>75	54	1.3%	60	1.4%	6	11.1%	78	1.9%	18	30.0%
Total	**4,167**	**100.0%**	**4,167**	**100.0%**			**4,167**	**100.0%**		

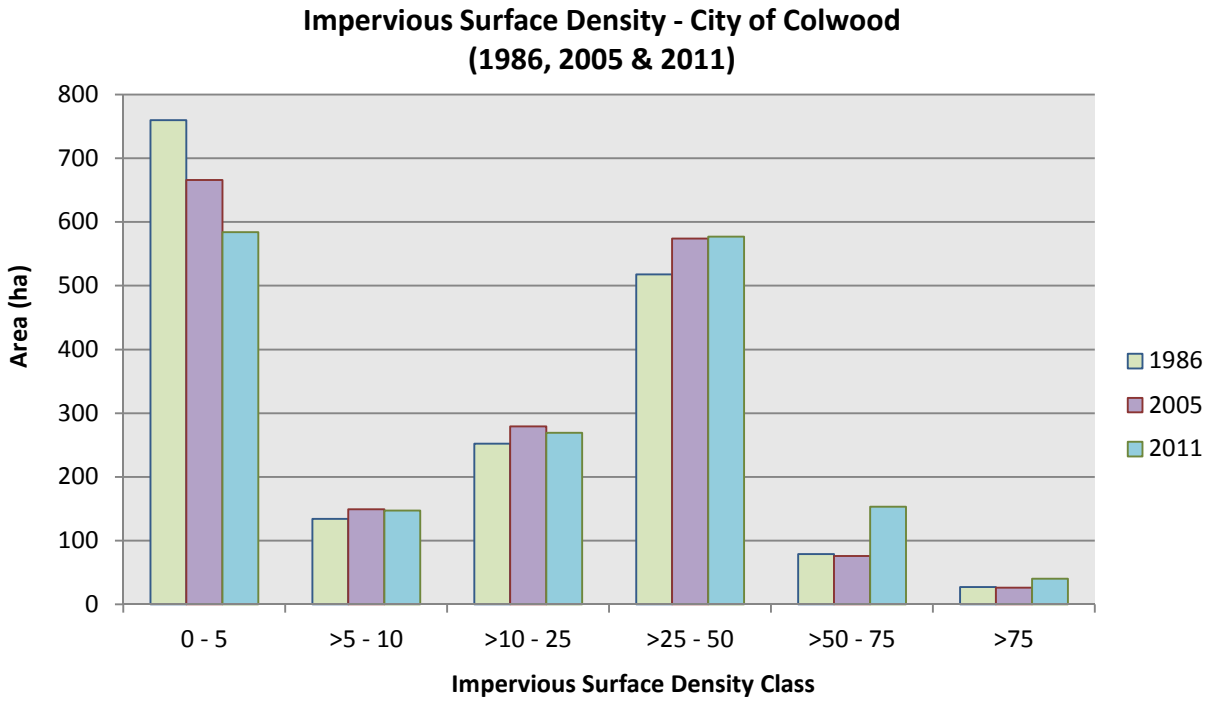
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – City of Colwood

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	760	42.9%	666	37.6%	-94	-12.4%	584	33.0%	-82	-12.3%
>5 - 10	134	7.6%	149	8.4%	15	11.2%	147	8.3%	-2	-1.3%
>10 - 25	252	14.2%	279	15.8%	27	10.7%	269	15.2%	-10	-3.6%
>25 - 50	518	29.3%	574	32.4%	56	10.8%	577	32.6%	3	0.5%
>50 - 75	79	4.5%	76	4.3%	-3	-3.8%	153	8.6%	77	101.3%
>75	27	1.5%	26	1.5%	-1	-3.7%	40	2.3%	14	53.8%
Total	**1,770**	**100.0%**	**1,770**	**100.0%**			**1,770**	**100.0%**		

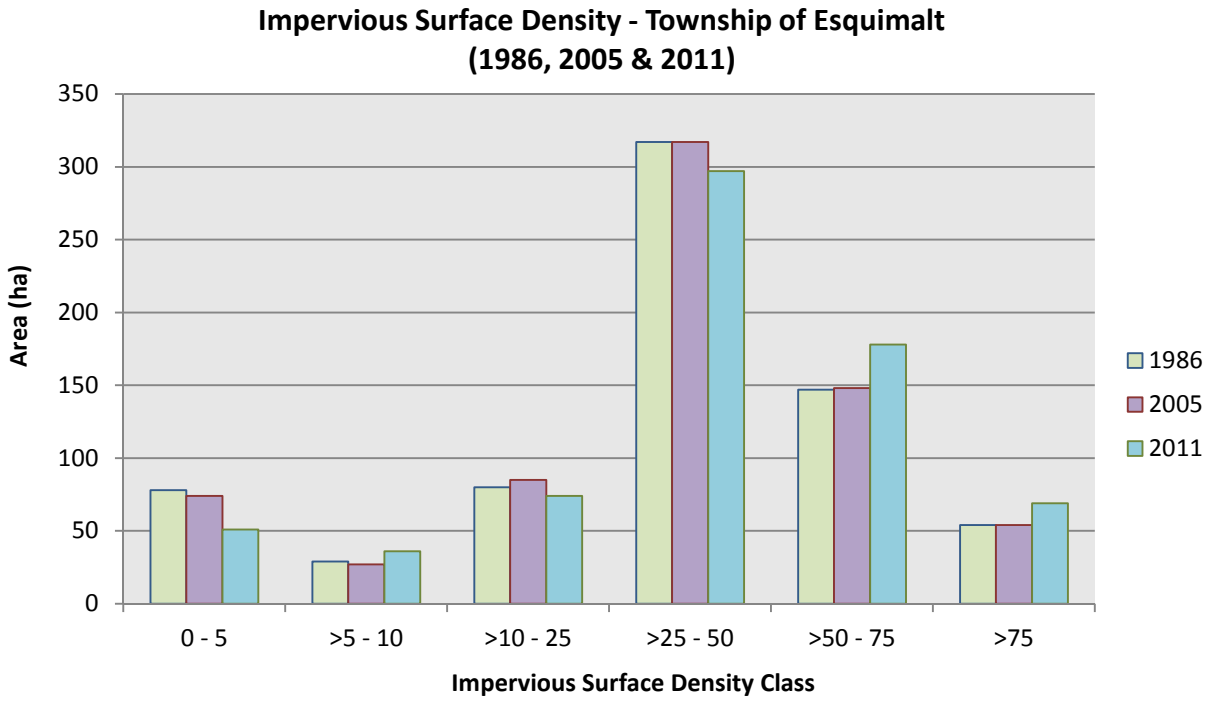
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – Township of Esquimalt

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	78	11.1%	74	10.5%	-4	-5.1%	51	7.2%	-23	-31.1%
>5 - 10	29	4.1%	27	3.8%	-2	-6.9%	36	5.1%	9	33.3%
>10 - 25	80	11.3%	85	12.1%	5	6.3%	74	10.5%	-11	-12.9%
>25 - 50	317	45.0%	317	45.0%	0	0.0%	297	42.1%	-20	-6.3%
>50 - 75	147	20.9%	148	21.0%	1	0.7%	178	25.2%	30	20.3%
>75	54	7.7%	54	7.7%	0	0.0%	69	9.8%	15	27.8%
Total	**705**	**100.0%**	**705**	**100.0%**			**705**	**100.0%**		

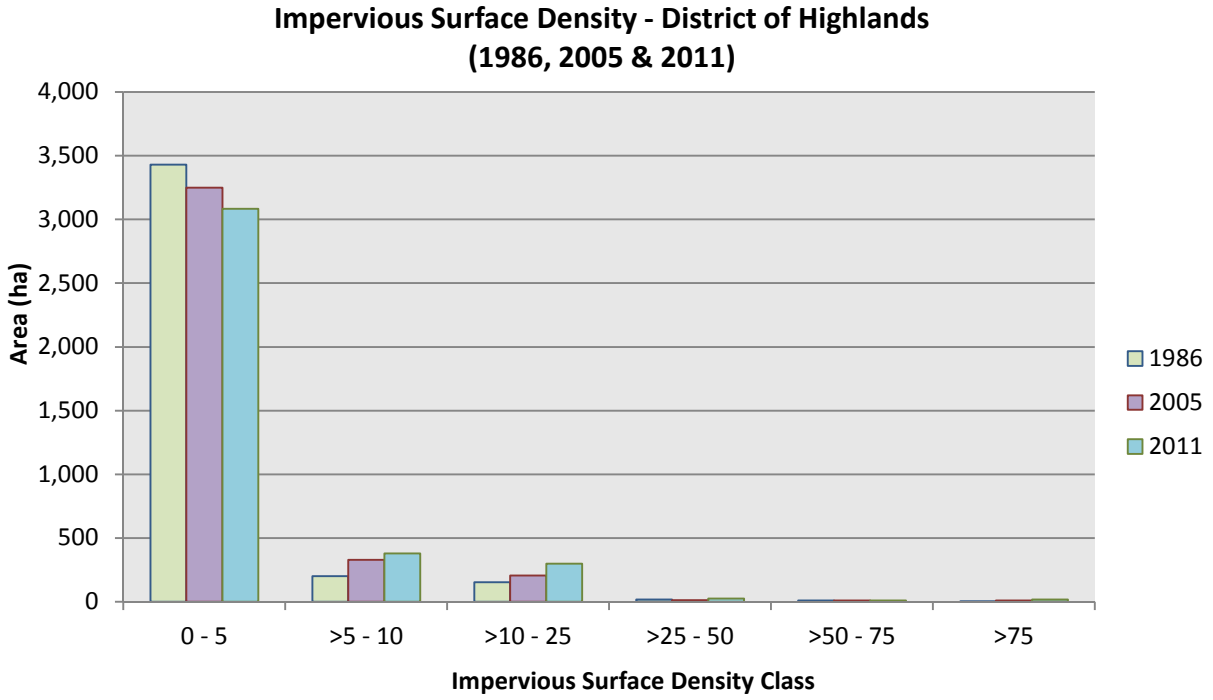
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – District of Highlands

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	3,429	89.9%	3,250	85.2%	-179	-5.2%	3,083	80.8%	-167	-5.1%
>5 - 10	202	5.3%	328	8.6%	126	62.4%	380	10.0%	52	15.9%
>10 - 25	153	4.0%	205	5.4%	52	34.0%	298	7.8%	93	45.4%
>25 - 50	17	0.4%	13	0.3%	-4	-23.5%	26	0.7%	13	100.0%
>50 - 75	10	0.3%	9	0.2%	-1	-10.0%	9	0.2%	0	0.0%
>75	3	0.1%	9	0.2%	6	200.0%	18	0.5%	9	100.0%
Total	**3,814**	**100.0%**	**3,814**	**100.0%**			**3,814**	**100.0%**		

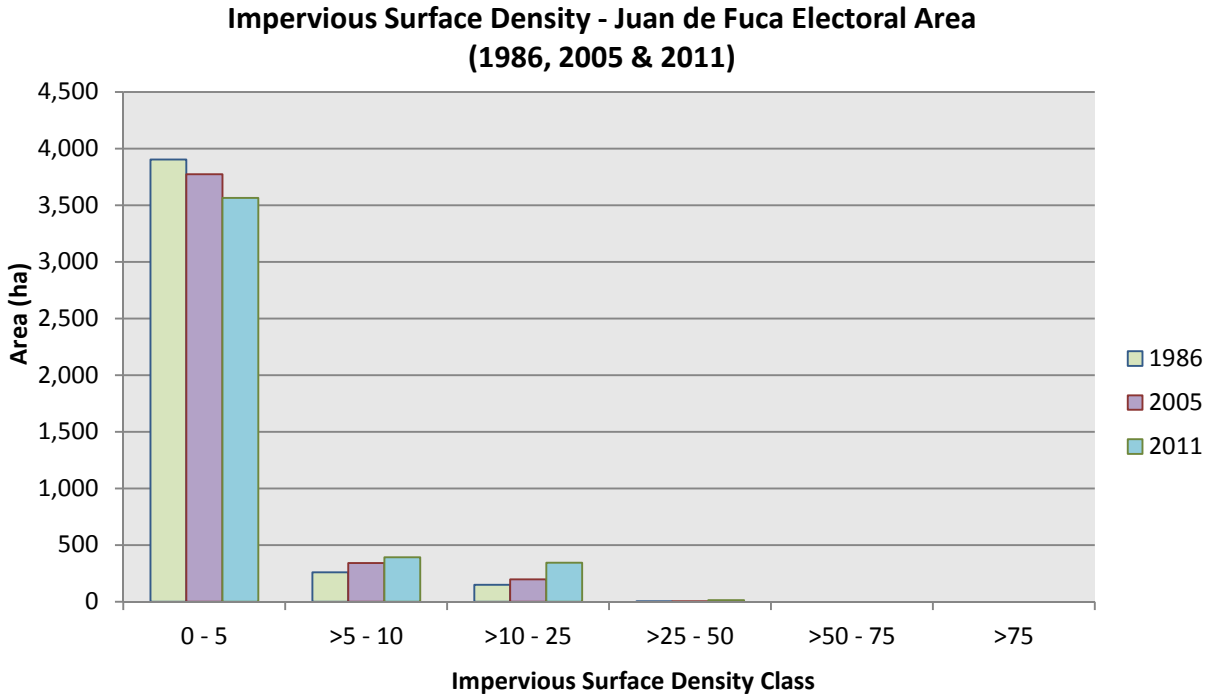
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – Juan de Fuca Electoral Area (portion within the CMSA)

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Jurisdiction	Hectares	Percent of Jurisdiction			Hectares	Percent of Jurisdiction		
0 - 5	3,903	90.5%	3,773	87.4%	-130	-3.3%	3,565	82.6%	-208	-5.5%
>5 - 10	261	6.0%	342	7.9%	81	31.0%	392	9.1%	50	14.6%
>10 - 25	150	3.5%	199	4.6%	49	32.7%	345	8.0%	146	73.4%
>25 - 50	1	0.0%	1	0.0%	0	0.0%	13	0.3%	12	1200.0%
>50 - 75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
Total	**4,315**	**100.0%**	**4,315**	**100.0%**			**4,315**	**100.0%**		

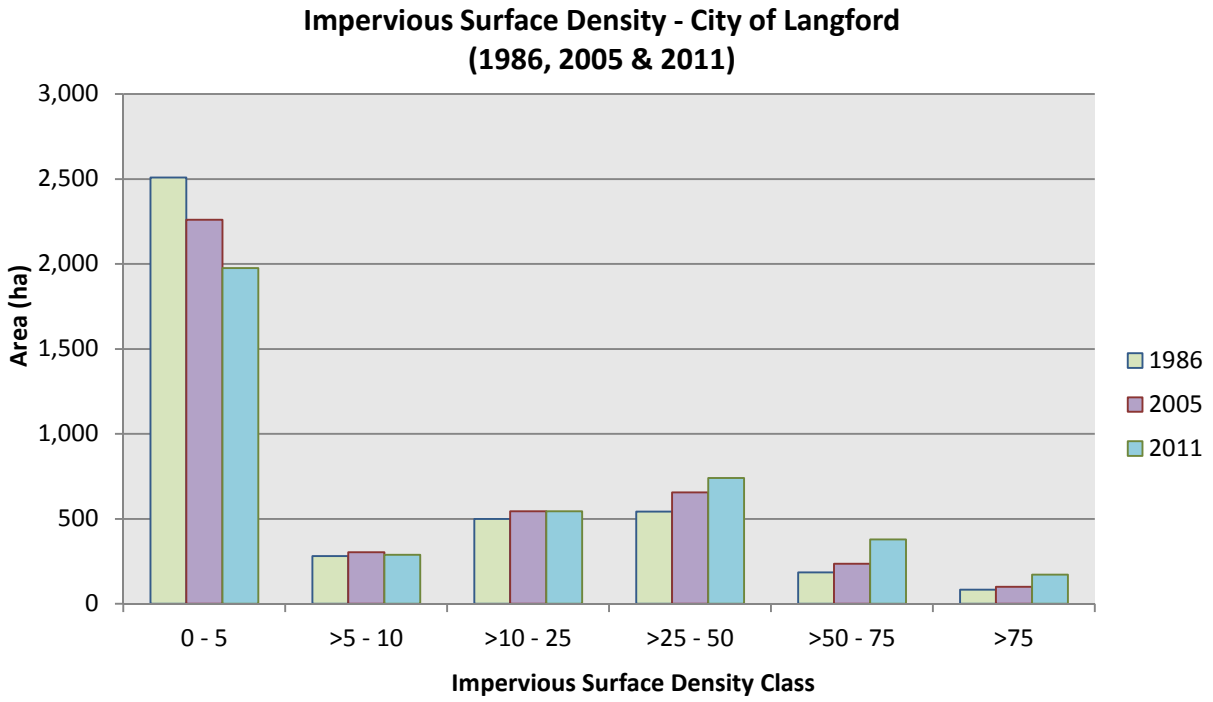
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – City of Langford

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	2,509	61.2%	2,260	55.1%	-249	-9.9%	1,976	48.2%	-284	-12.6%
>5 - 10	281	6.9%	304	7.4%	23	8.2%	288	7.0%	-16	-5.3%
>10 - 25	499	12.2%	544	13.3%	45	9.0%	544	13.3%	0	0.0%
>25 - 50	542	13.2%	656	16.0%	114	21.0%	741	18.1%	85	13.0%
>50 - 75	185	4.5%	236	5.8%	51	27.6%	379	9.2%	143	60.6%
>75	83	2.0%	99	2.4%	16	19.3%	171	4.2%	72	72.7%
Total	**4,099**	**100.0%**	**4,099**	**100.0%**			**4,099**	**100.0%**		

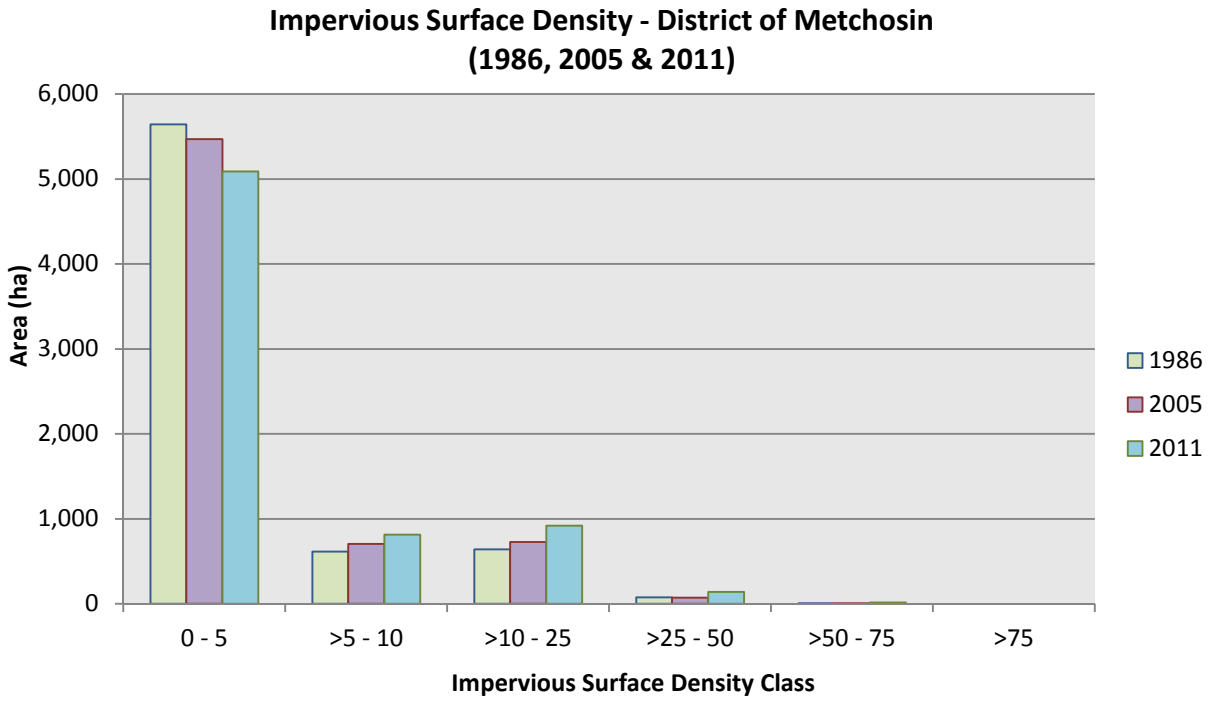
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – District of Metchosin

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	5,644	80.9%	5,470	78.4%	-174	-3.1%	5,089	72.9%	-381	-7.0%
>5 - 10	613	8.8%	703	10.1%	90	14.7%	815	11.7%	112	15.9%
>10 - 25	642	9.2%	727	10.4%	85	13.2%	920	13.2%	193	26.5%
>25 - 50	74	1.1%	73	1.0%	-1	-1.4%	139	2.0%	66	90.4%
>50 - 75	5	0.1%	5	0.1%	0	0.0%	15	0.2%	10	200.0%
>75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
Total	**6,978**	**100.0%**	**6,978**	**100.0%**			**6,978**	**100.0%**		

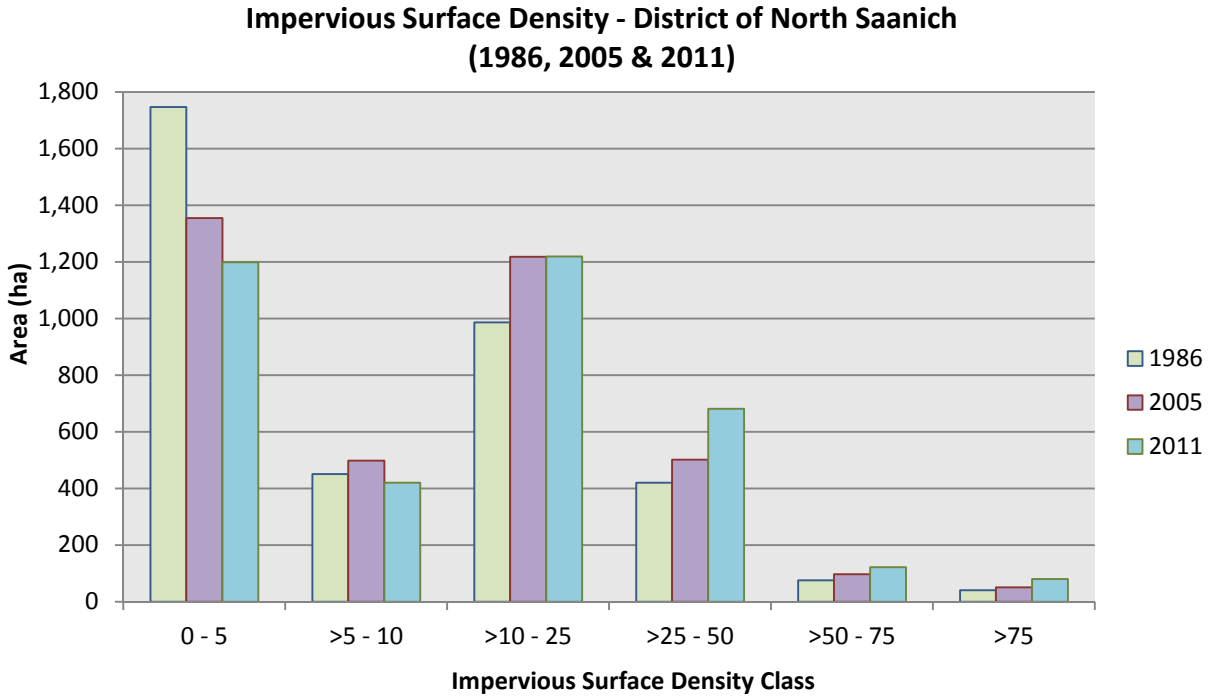
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – District of North Saanich

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	1,747	46.9%	1,355	36.4%	-392	-22.4%	1,199	32.2%	-156	-11.5%
>5 - 10	451	12.1%	498	13.4%	47	10.4%	420	11.3%	-78	-15.7%
>10 - 25	986	26.5%	1,218	32.7%	232	23.5%	1,219	32.8%	1	0.1%
>25 - 50	420	11.3%	502	13.5%	82	19.5%	681	18.3%	179	35.7%
>50 - 75	76	2.0%	97	2.6%	21	27.6%	122	3.3%	25	25.8%
>75	41	1.1%	51	1.4%	10	24.4%	80	2.1%	29	56.9%
Total	**3,721**	**100.0%**	**3,721**	**100.0%**			**3,721**	**100.0%**		

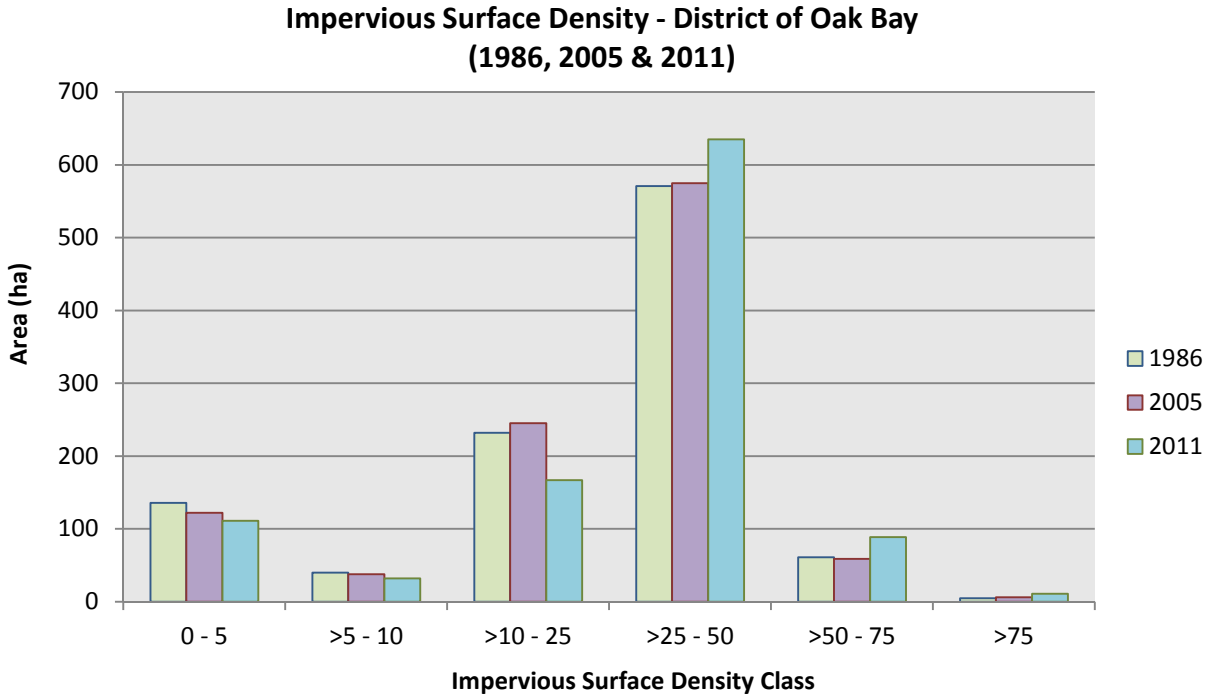
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – District of Oak Bay

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	136	13.0%	122	11.7%	-14	-10.3%	111	10.6%	-11	-9.0%
>5 - 10	40	3.8%	38	3.6%	-2	-5.0%	32	3.1%	-6	-15.8%
>10 - 25	232	22.2%	245	23.4%	13	5.6%	167	16.0%	-78	-31.8%
>25 - 50	571	54.6%	575	55.0%	4	0.7%	635	60.8%	60	10.4%
>50 - 75	61	5.8%	59	5.6%	-2	-3.3%	89	8.5%	30	50.8%
>75	5	0.5%	6	0.6%	1	20.0%	11	1.1%	5	83.3%
Total	**1,045**	**100.0%**	**1,045**	**100.0%**			**1,045**	**100.0%**		

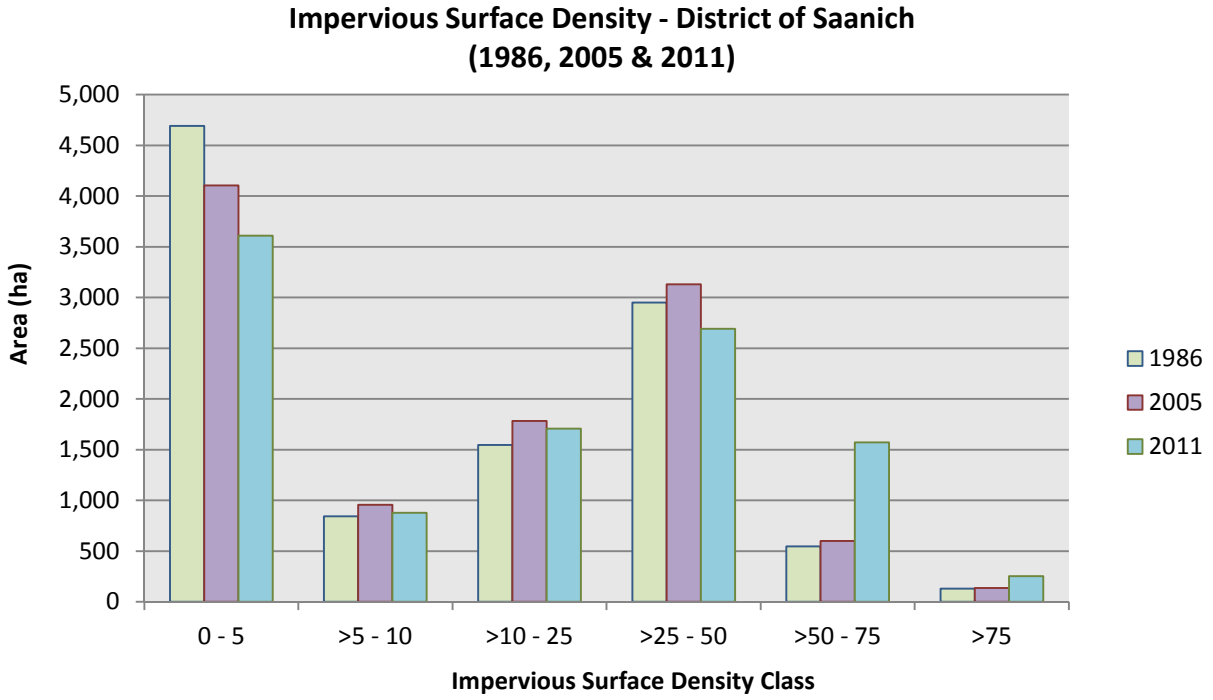
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – District of Saanich

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	4,692	43.8%	4,106	38.3%	-586	-12.5%	3,608	33.7%	-498	-12.1%
>5 - 10	844	7.9%	956	8.9%	112	13.3%	876	8.2%	-80	-8.4%
>10 - 25	1,545	14.4%	1,782	16.6%	237	15.3%	1,707	15.9%	-75	-4.2%
>25 - 50	2,950	27.5%	3,130	29.2%	180	6.1%	2,692	25.1%	-438	-14.0%
>50 - 75	547	5.1%	599	5.6%	52	9.5%	1,571	14.7%	972	162.3%
>75	130	1.2%	135	1.3%	5	3.8%	254	2.4%	119	88.1%
Total	**10,708**	**100.0%**	**10,708**	**100.0%**			**10,708**	**100.0%**		

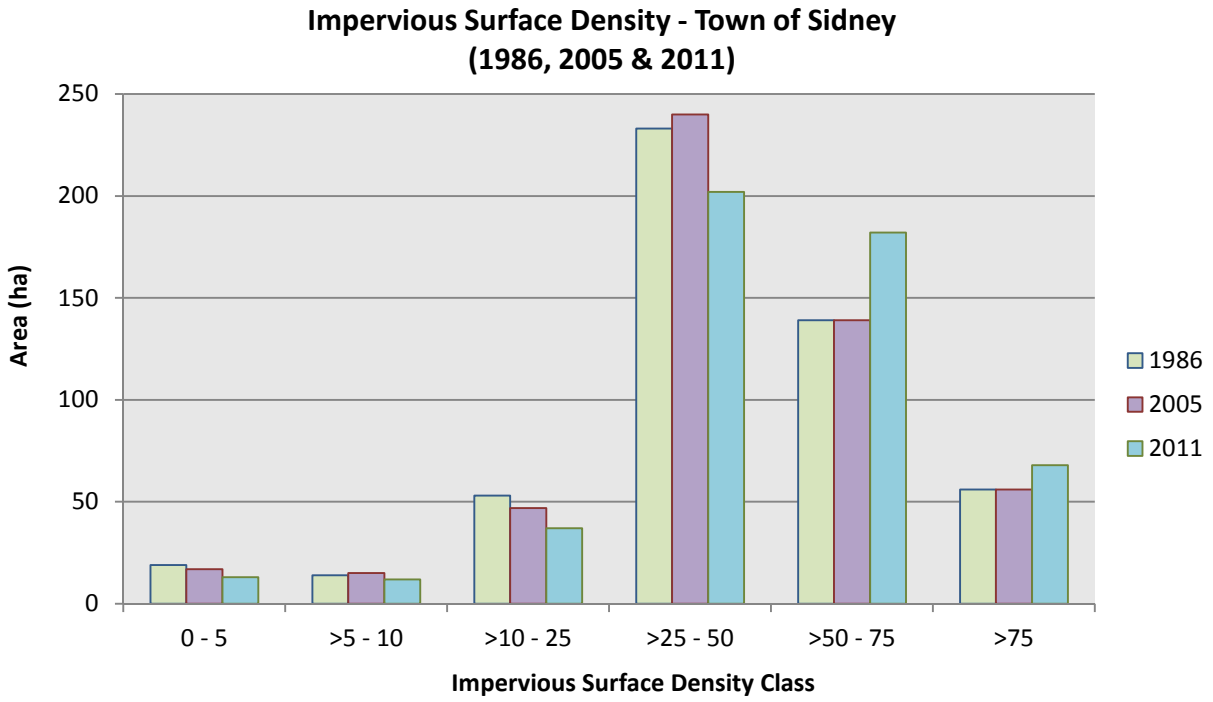
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – Town of Sidney

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	19	3.7%	17	3.3%	-2	-10.5%	13	2.5%	-4	-23.5%
>5 - 10	14	2.7%	15	2.9%	1	7.1%	12	2.3%	-3	-20.0%
>10 - 25	53	10.3%	47	9.1%	-6	-11.3%	37	7.2%	-10	-21.3%
>25 - 50	233	45.3%	240	46.7%	7	3.0%	202	39.3%	-38	-15.8%
>50 - 75	139	27.0%	139	27.0%	0	0.0%	182	35.4%	43	30.9%
>75	56	10.9%	56	10.9%	0	0.0%	68	13.2%	12	21.4%
Total	**514**	**100.0%**	**514**	**100.0%**			**514**	**100.0%**		

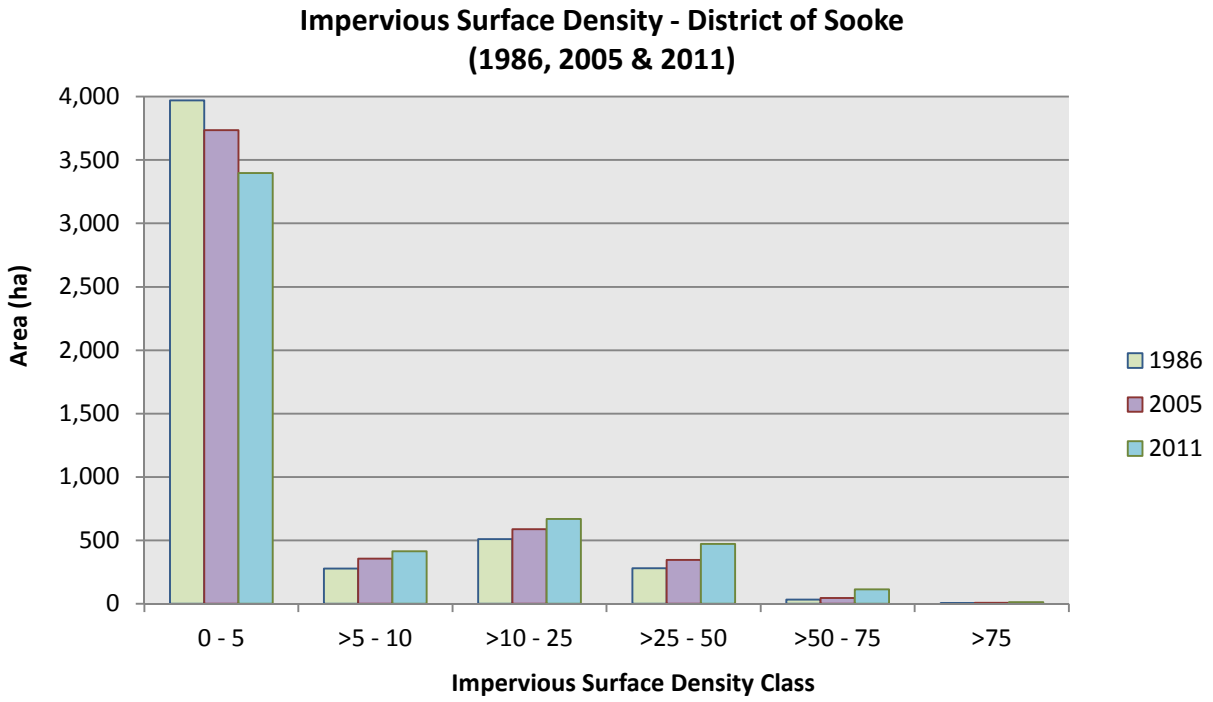
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – District of Sooke

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	3,970	78.2%	3,735	73.6%	-235	-5.9%	3,397	66.9%	-338	-9.0%
>5 - 10	278	5.5%	355	7.0%	77	27.7%	413	8.1%	58	16.3%
>10 - 25	511	10.1%	588	11.6%	77	15.1%	668	13.2%	80	13.6%
>25 - 50	281	5.5%	345	6.8%	64	22.8%	472	9.3%	127	36.8%
>50 - 75	33	0.6%	45	0.9%	12	36.4%	113	2.2%	68	151.1%
>75	6	0.1%	7	0.1%	1	16.7%	12	0.2%	5	71.4%
Total	**5,079**	**100.0%**	**5,075**	**100.0%**			**5,075**	**100.0%**		

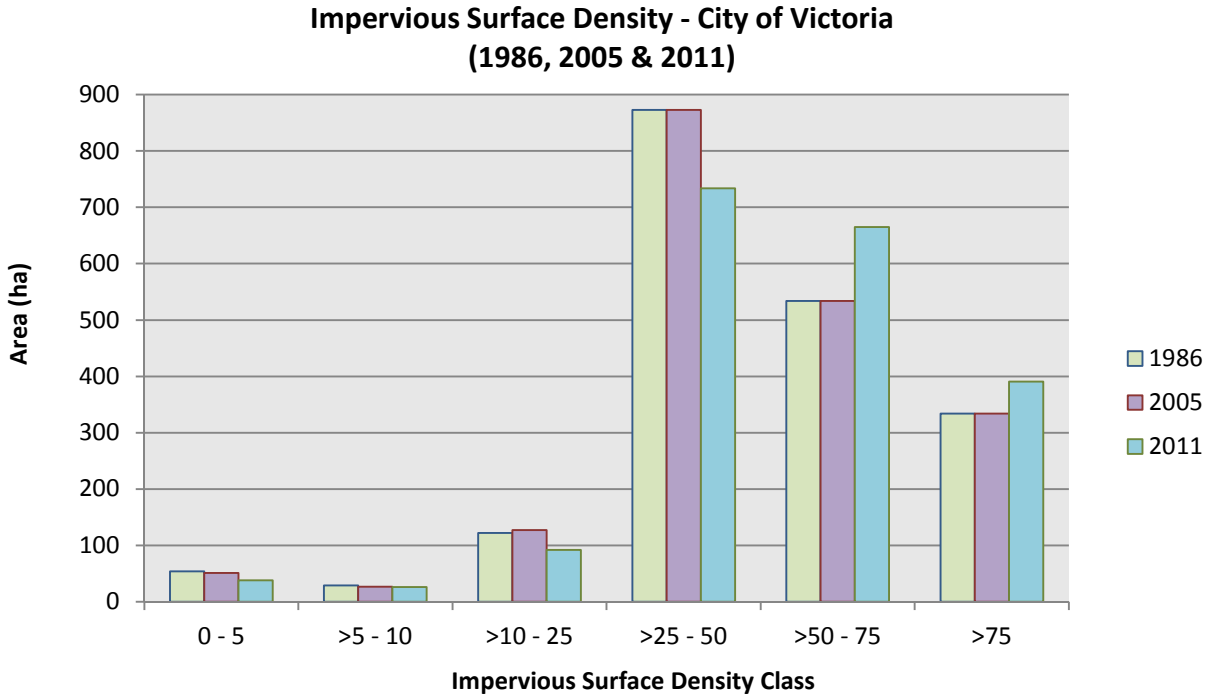
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – City of Victoria

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	54	2.8%	51	2.6%	-3	-5.6%	38	2.0%	-13	-25.5%
>5 - 10	29	1.5%	27	1.4%	-2	-6.9%	26	1.3%	-1	-3.7%
>10 - 25	122	6.3%	127	6.5%	5	4.1%	92	4.7%	-35	-27.6%
>25 - 50	873	44.9%	873	44.9%	0	0.0%	734	37.7%	-139	-15.9%
>50 - 75	534	27.4%	534	27.4%	0	0.0%	665	34.2%	131	24.5%
>75	334	17.2%	334	17.2%	0	0.0%	391	20.1%	57	17.1%
Total	**1,946**	**100.0%**	**1,946**	**100.0%**			**1,946**	**100.0%**		

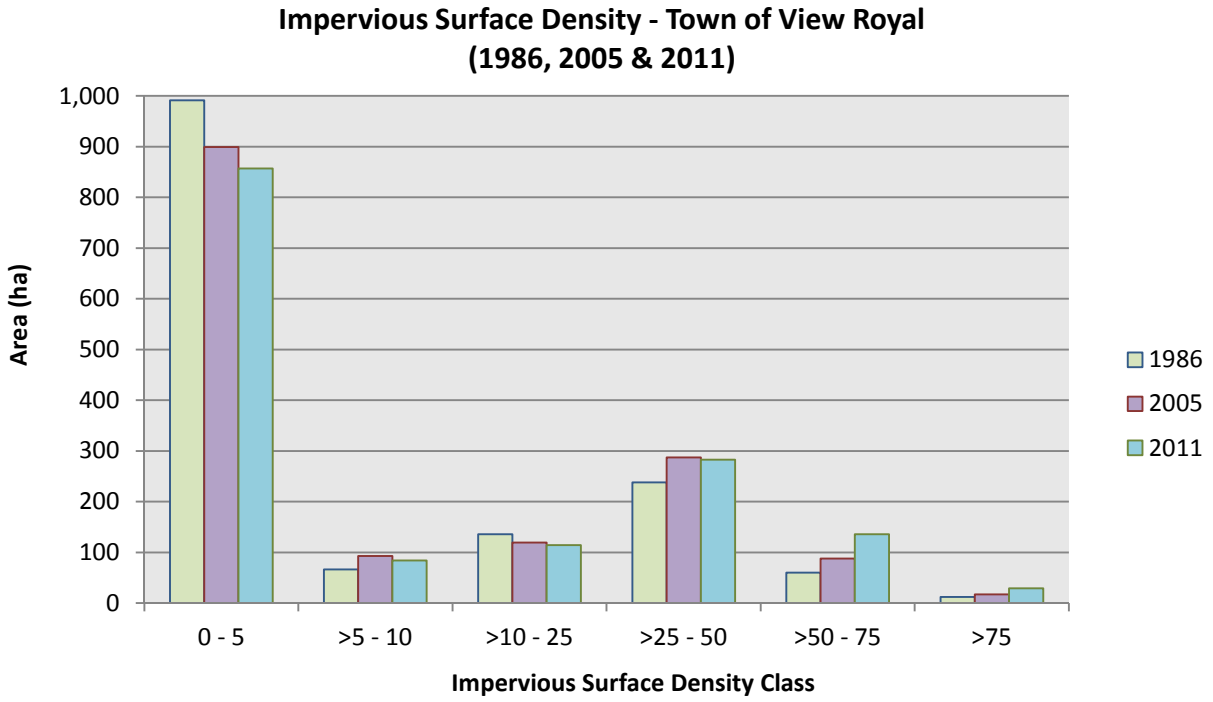
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – Town of View Royal

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Municipality	Hectares	Percent of Municipality			Hectares	Percent of Municipality		
0 - 5	991	65.9%	899	59.8%	-92	-9.3%	857	57.0%	-42	-4.7%
>5 - 10	66	4.4%	93	6.2%	27	40.9%	84	5.6%	-9	-9.7%
>10 - 25	136	9.0%	119	7.9%	-17	-12.5%	114	7.6%	-5	-4.2%
>25 - 50	238	15.8%	287	19.1%	49	20.6%	283	18.8%	-4	-1.4%
>50 - 75	60	4.0%	88	5.9%	28	46.7%	136	9.0%	48	54.5%
>75	12	0.8%	17	1.1%	5	41.7%	29	1.9%	12	70.6%
Total	**1,503**	**100.0%**	**1,503**	**100.0%**			**1,503**	**100.0%**		

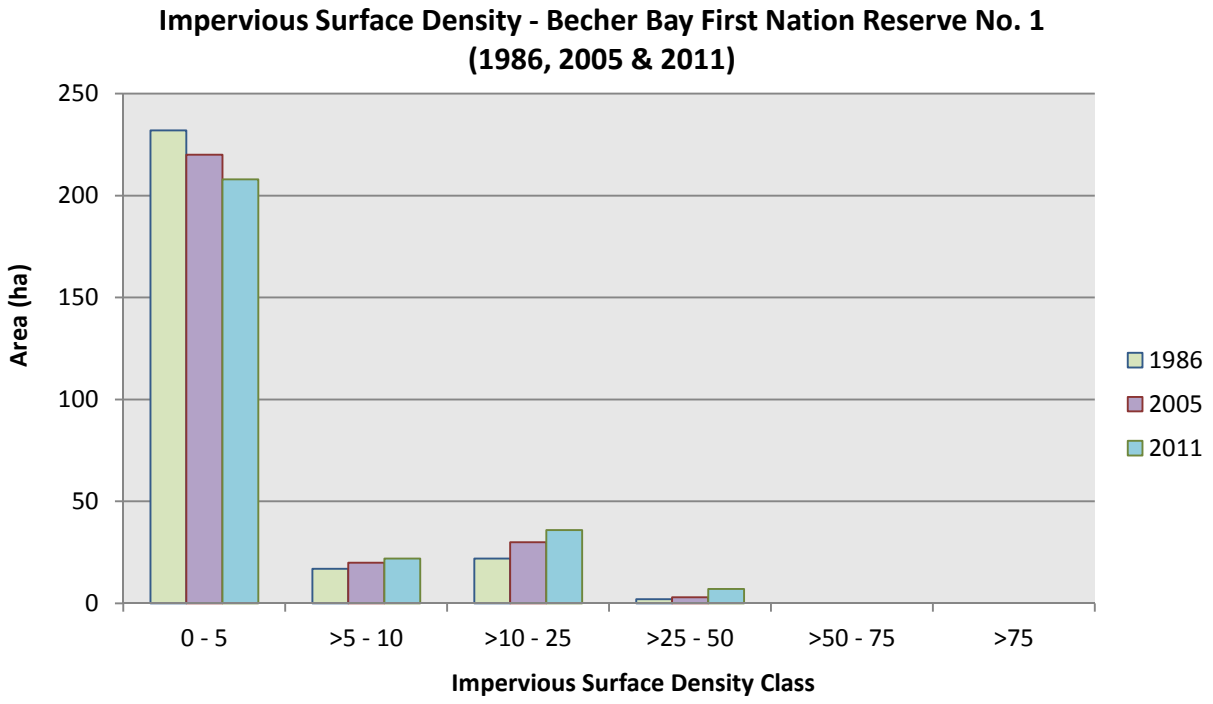
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density - Becher Bay First Nation Reserve No. 1

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	232	85.0%	220	80.6%	-12	-5.2%	208	76.2%	-12	-5.5%
>5 - 10	17	6.2%	20	7.3%	3	17.6%	22	8.1%	2	10.0%
>10 - 25	22	8.1%	30	11.0%	8	36.4%	36	13.2%	6	20.0%
>25 - 50	2	0.7%	3	1.1%	1	50.0%	7	2.6%	4	133.3%
>50 - 75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
Total	**273**	**100.0%**	**273**	**100.0%**			**273**	**100.0%**		

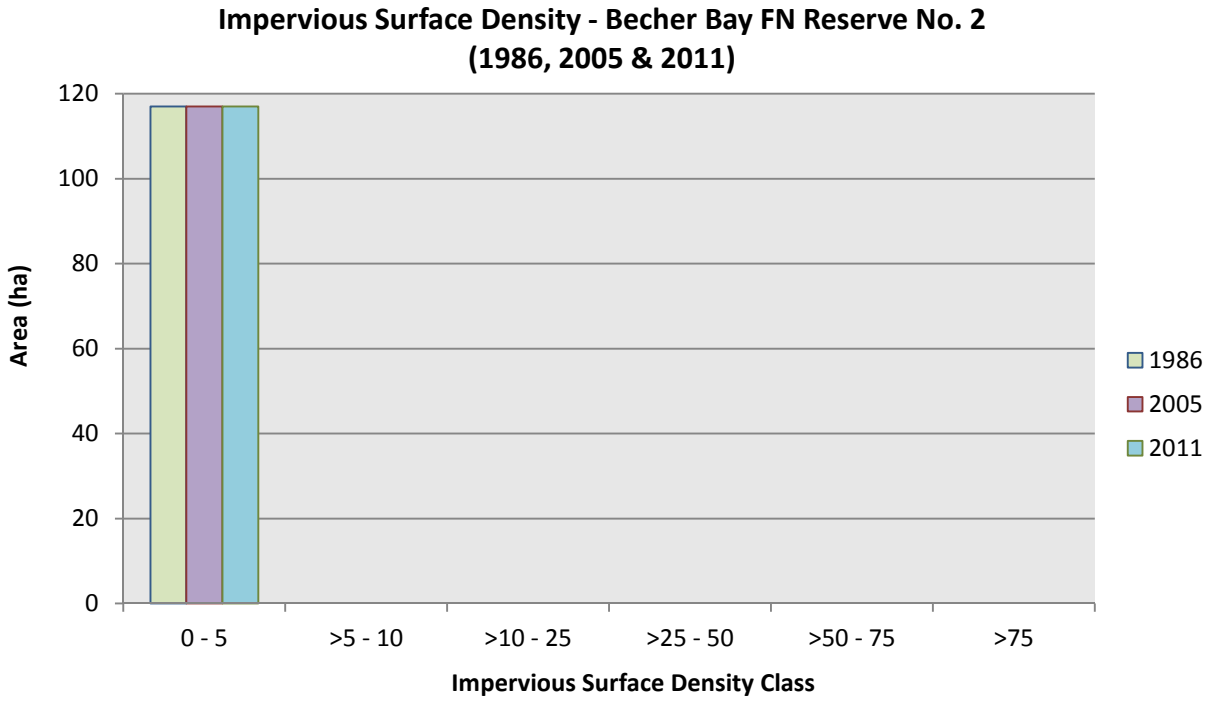
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density - Becher Bay First Nation Reserve No. 2

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	117	100.0%	117	100.0%	0	0.0%	117	100.0%	0	0.0%
>5 - 10	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>10 - 25	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>25 - 50	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>50 - 75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
Total	**117**	**100.0%**	**117**	**100.0%**			**117**	**100.0%**		

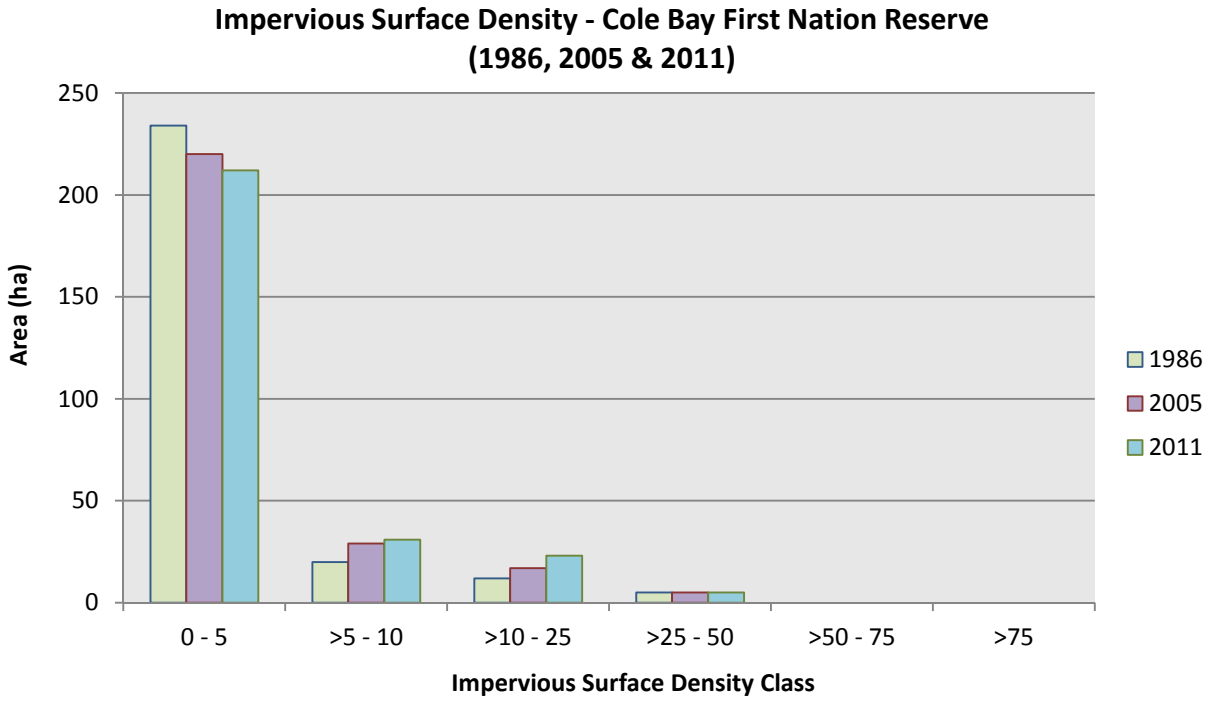
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – Cole Bay First Nation Reserve

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	234	86.3%	220	81.2%	-14	-6.0%	212	78.2%	-8	-3.6%
>5 - 10	20	7.4%	29	10.7%	9	45.0%	31	11.4%	2	6.9%
>10 - 25	12	4.4%	17	6.3%	5	41.7%	23	8.5%	6	35.3%
>25 - 50	5	1.8%	5	1.8%	0	0.0%	5	1.8%	0	0.0%
>50 - 75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
Total	**271**	**100.0%**	**271**	**100.0%**			**271**	**100.0%**		

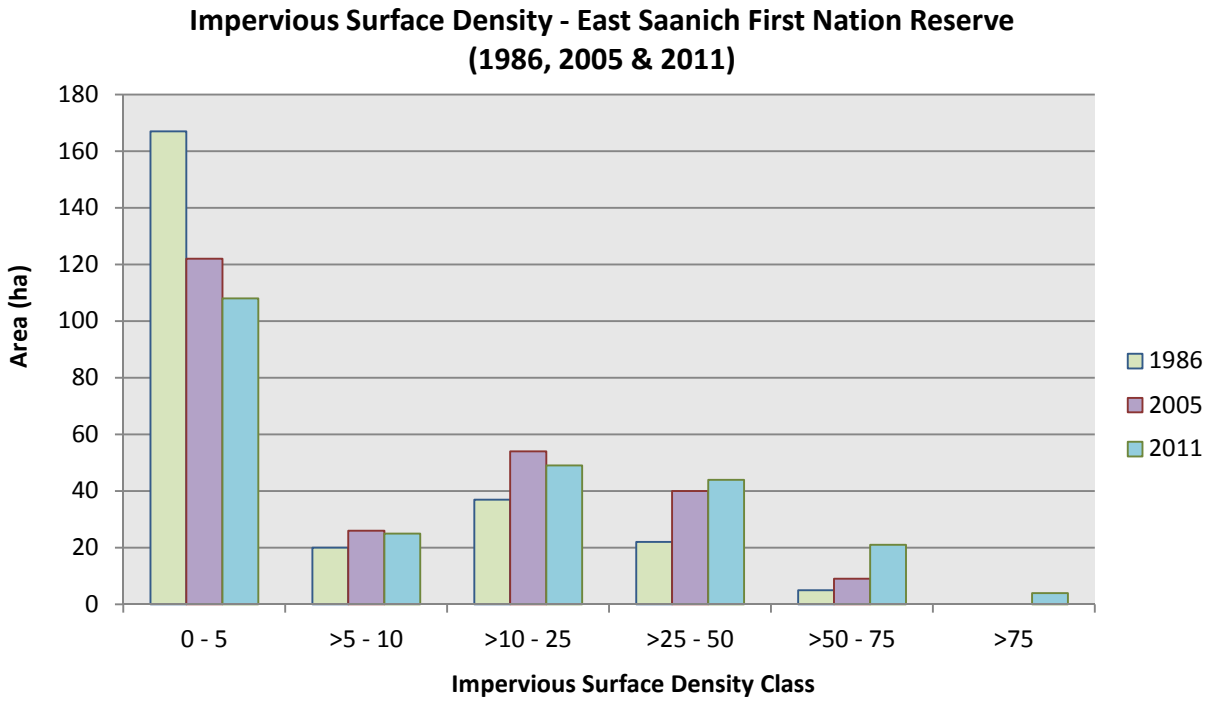
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – East Saanich First Nation Reserve

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	167	66.5%	122	48.6%	-45	-26.9%	108	43.0%	-14	-11.5%
>5 - 10	20	8.0%	26	10.4%	6	30.0%	25	10.0%	-1	-3.8%
>10 - 25	37	14.7%	54	21.5%	17	45.9%	49	19.5%	-5	-9.3%
>25 - 50	22	8.8%	40	15.9%	18	81.8%	44	17.5%	4	10.0%
>50 - 75	5	2.0%	9	3.6%	4	80.0%	21	8.4%	12	133.3%
>75	0	0.0%	0	0.0%	0	-	4	1.6%	4	-
Total	**251**	**100.0%**	**251**	**100.0%**			**251**	**100.0%**		

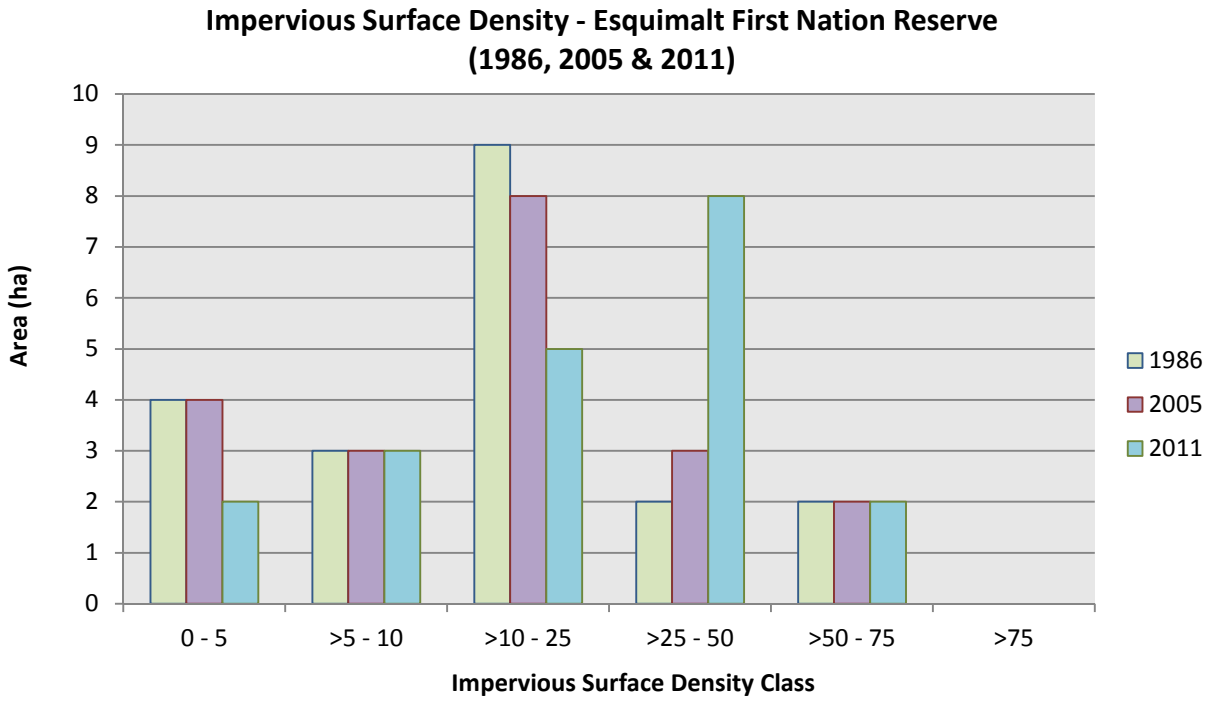
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density - Esquimalt First Nation Reserve

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	4	20.0%	4	20.0%	0	0.0%	2	10.0%	-2	-50.0%
>5 - 10	3	15.0%	3	15.0%	0	0.0%	3	15.0%	0	0.0%
>10 - 25	9	45.0%	8	40.0%	-1	-11.1%	5	25.0%	-3	-37.5%
>25 - 50	2	10.0%	3	15.0%	1	50.0%	8	40.0%	5	166.7%
>50 - 75	2	10.0%	2	10.0%	0	0.0%	2	10.0%	0	0.0%
>75		0.0%		0.0%	0	-		0.0%	0	-
Total	**20**	**100.0%**	**20**	**100.0%**			**20**	**100.0%**		

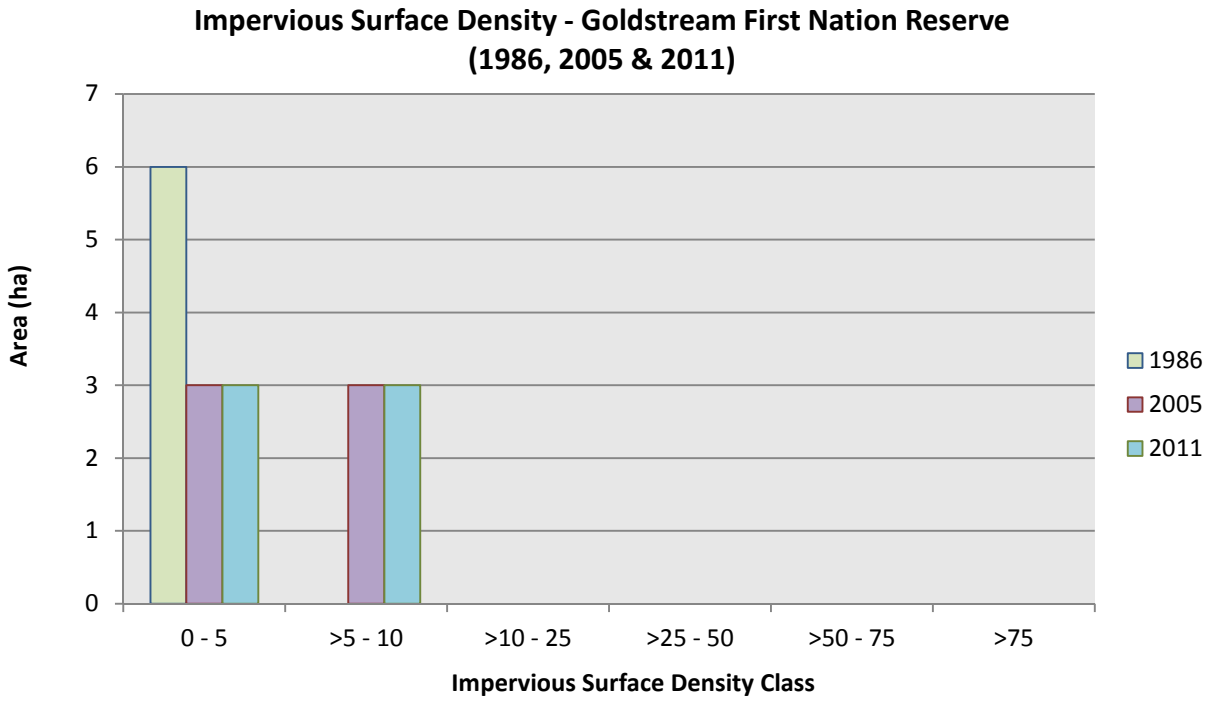
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density - Goldstream First Nation Reserve

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	6	100.0%	3	50.0%	-3	-50.0%	3	50.0%	0	0.0%
>5 - 10	0	0.0%	3	50.0%	3	-	3	50.0%	0	0.0%
>10 - 25	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>25 - 50	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>50 - 75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
Total	**6**	**100.0%**	**6**	**100.0%**			**6**	**100.0%**		

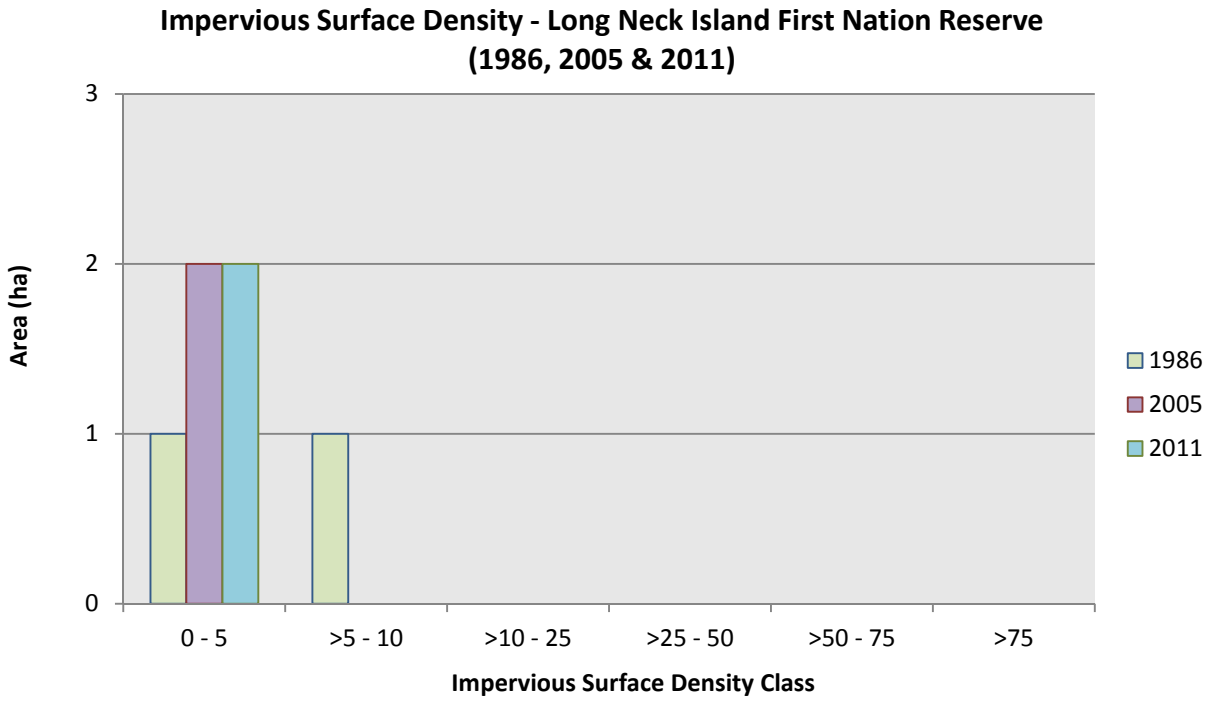
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – Long Neck Island First Nation Reserve

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	1	50.0%	2	100.0%	1	100.0%	2	100.0%	0	0.0%
>5 - 10	1	50.0%	0	0.0%	-1	-100.0%	0	0.0%	0	-
>10 - 25	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>25 - 50	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>50 - 75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
Total	**2**	**100.0%**	**2**	**100.0%**			**2**	**100.0%**		

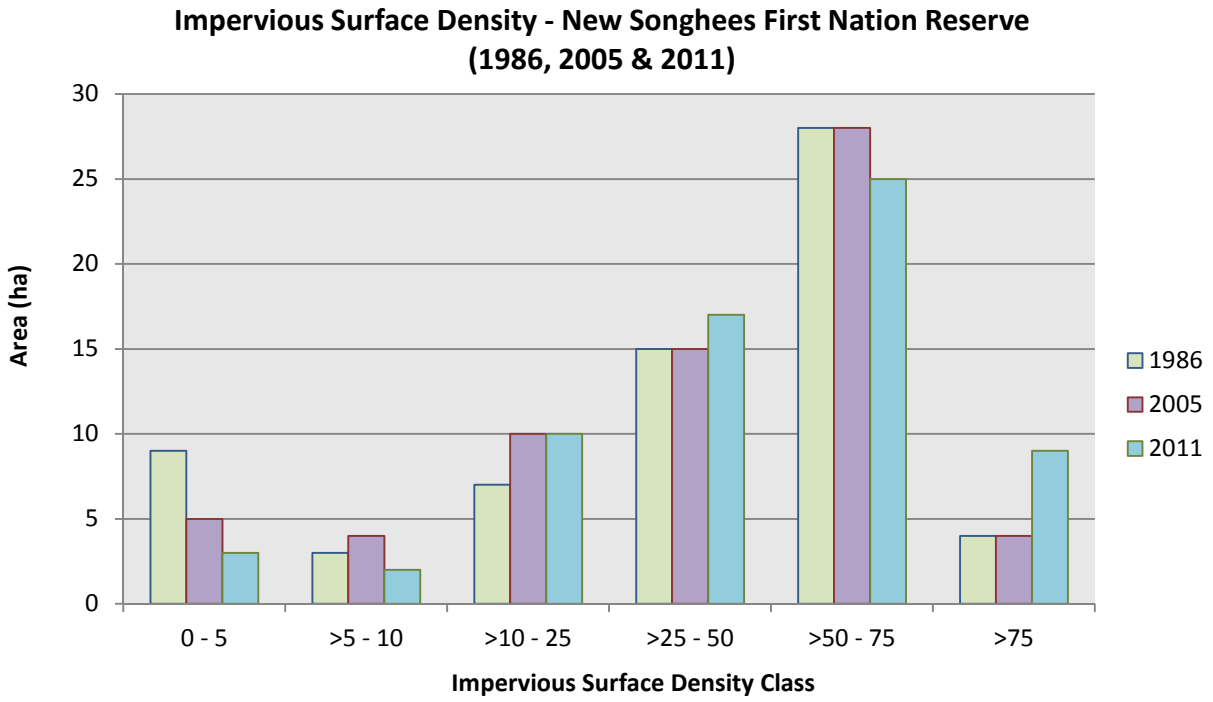
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – New Songhees First Nation Reserve

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	9	13.6%	5	7.6%	-4	-44.4%	3	4.5%	-2	-40.0%
>5 - 10	3	4.5%	4	6.1%	1	33.3%	2	3.0%	-2	-50.0%
>10 - 25	7	10.6%	10	15.2%	3	42.9%	10	15.2%	0	0.0%
>25 - 50	15	22.7%	15	22.7%	0	0.0%	17	25.8%	2	13.3%
>50 - 75	28	42.4%	28	42.4%	0	0.0%	25	37.9%	-3	-10.7%
>75	4	6.1%	4	6.1%	0	0.0%	9	13.6%	5	125.0%
Total	**66**	**100.0%**	**66**	**100.0%**			**66**	**100.0%**		

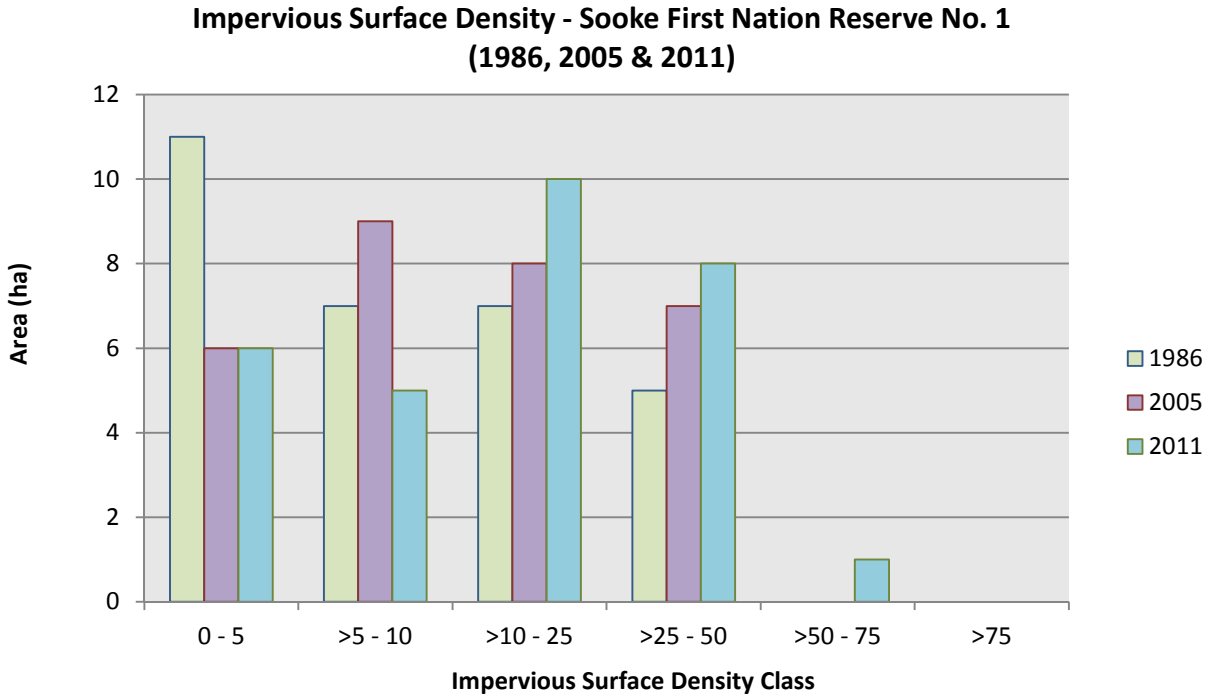
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – Sooke First Nation Reserve No. 1

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	11	36.7%	6	20.0%	-5	-45.5%	6	20.0%	0	0.0%
>5 - 10	7	23.3%	9	30.0%	2	28.6%	5	16.7%	-4	-44.4%
>10 - 25	7	23.3%	8	26.7%	1	14.3%	10	33.3%	2	25.0%
>25 - 50	5	16.7%	7	23.3%	2	40.0%	8	26.7%	1	14.3%
>50 - 75	0	0.0%	0	0.0%	0	-	1	3.3%	1	-
>75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
Total	**30**	**100.0%**	**30**	**100.0%**			**30**	**100.0%**		

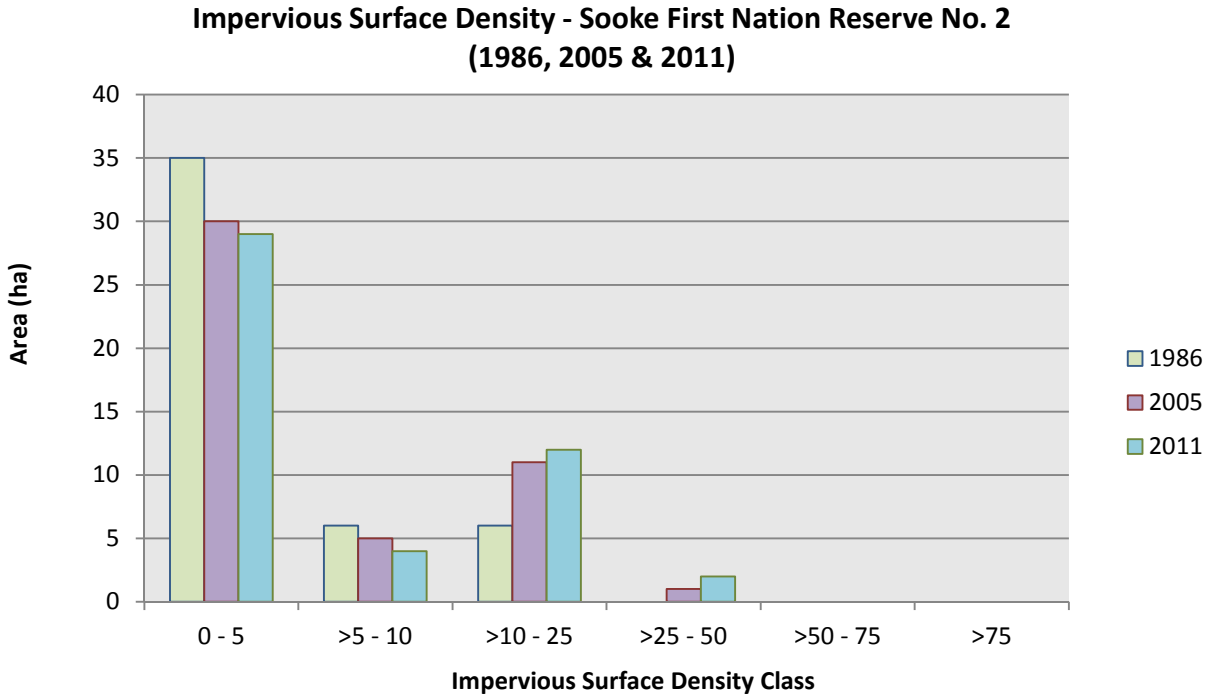
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – Sooke First Nation Reserve No. 2

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	35	74.5%	30	63.8%	-5	-14.3%	29	61.7%	-1	-3.3%
>5 - 10	6	12.8%	5	10.6%	-1	-16.7%	4	8.5%	-1	-20.0%
>10 - 25	6	12.8%	11	23.4%	5	83.3%	12	25.5%	1	9.1%
>25 - 50	0	0.0%	1	2.1%	1	-	2	4.3%	1	100.0%
>50 - 75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
Total	**47**	**100.0%**	**47**	**100.0%**			**47**	**100.0%**		

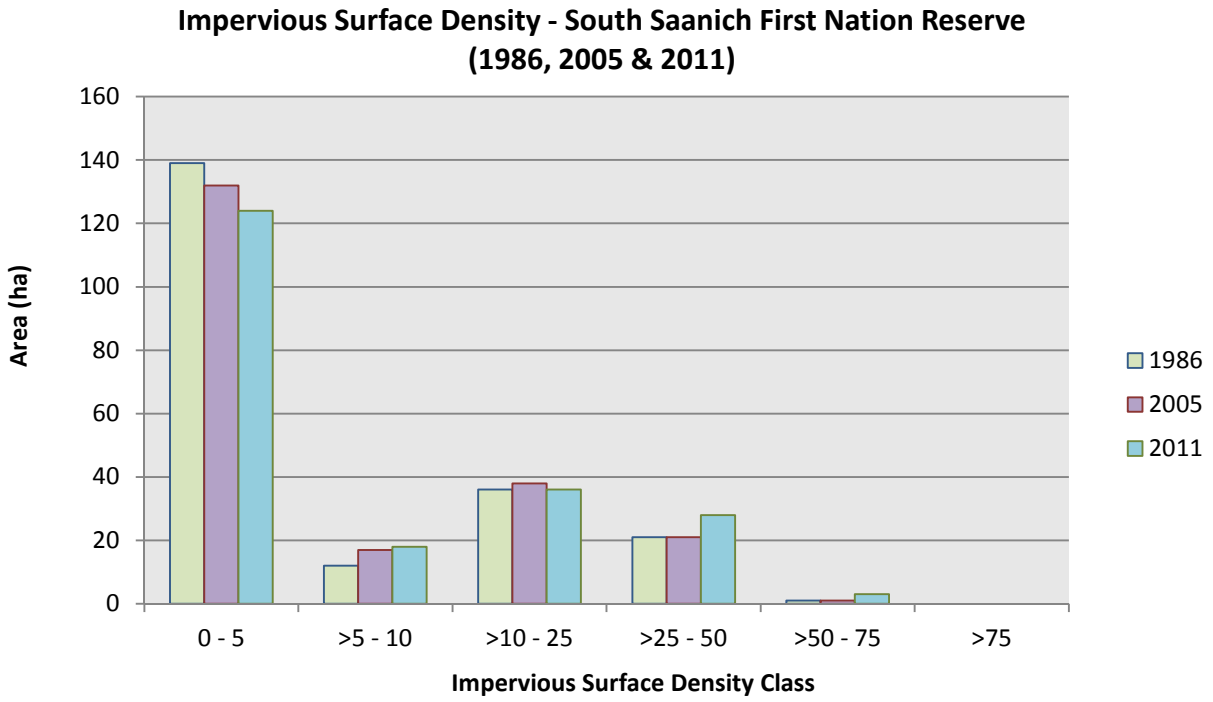
* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – South Saanich First Nation Reserve

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	139	66.5%	132	63.2%	-7	-5.0%	124	59.3%	-8	-6.1%
>5 - 10	12	5.7%	17	8.1%	5	41.7%	18	8.6%	1	5.9%
>10 - 25	36	17.2%	38	18.2%	2	5.6%	36	17.2%	-2	-5.3%
>25 - 50	21	10.0%	21	10.0%	0	0.0%	28	13.4%	7	33.3%
>50 - 75	1	0.5%	1	0.5%	0	0.0%	3	1.4%	2	200.0%
>75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
Total	**209**	**100.0%**	**209**	**100.0%**			**209**	**100.0%**		

* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.



Impervious Surface Density – Union Bay First Nation Reserve

Impervious Surface Density Class (%)	1986		2005		Change in Area 1986 to 2005 (ha)	% Change 1986 to 2005	2011		Change in Area 2005 to 2011 (ha)	% Change 2005 to 2011
	Hectares	Percent of Reserve	Hectares	Percent of Reserve			Hectares	Percent of Reserve		
0 - 5	18	58.1%	16	51.6%	-2	-11.1%	16	51.6%	0	0.0%
>5 - 10	3	9.7%	4	12.9%	1	33.3%	2	6.5%	-2	-50.0%
>10 - 25	7	22.6%	8	25.8%	1	14.3%	10	32.3%	2	25.0%
>25 - 50	3	9.7%	3	9.7%	0	0.0%	3	9.7%	0	0.0%
>50 - 75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
>75	0	0.0%	0	0.0%	0	-	0	0.0%	0	-
Total	**31**	**100.0%**	**31**	**100.0%**			**31**	**100.0%**		

* Negative numbers indicate a decrease and positive an increase in the number of hectares within each class.