Update of the Metro Vancouver Sensitive Ecosystem Inventory (2009-2014)

Technical Report

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Executive Summary

In 2014 Metro Vancouver produced the region's first Sensitive Ecosystem Inventory (SEI) in response to the need for up-to-date, standardized ecological information to support decision making. Polygon delineation relied primarily on 2009 orthophoto imagery. An update to that inventory was conducted in 2015-2018 using 2014 imagery. The purpose of the update was primarily to document ecosystem losses over the five-year period (2009-2014). Additionally, the update incorporated new mapping and fieldwork, and made corrections where necessary. Updating the SEI will ensure it continues to be an effective and relevant land use and conservation planning tool for the region.

In the update project, one Modified Ecosystem class was removed from the inventory—Seasonally flooded agricultural fields (FS) – because they were considered too ephemeral to be mapped consistently using only one set of imagery.

Spatial information and associated attributes are stored in an ArcGIS 10 geodatabase, including attributes to track changes from the 2009 inventory.

Analyses of the dataset shows that between 2009 and 2014 the region lost almost 1% (1,637 ha) of its 'Sensitive' and 'Modified' ecosystems (Table 1). Much of this loss (1,190 ha) was focused within the 'regional core' – the more urbanized southern part of the region that excludes the large parks and estuaries under Provincial management, watersheds and other higher elevation areas. This equals a loss of 3.4% of sensitive and modified ecosystems within the regional core in a 5-year period. A decrease in ecosystem quality of less than 1% was detected at both the region and regional core levels.

	Sensitive Ecosystems (SE)			**Modified Ecosystems (ME)**			**Totals – SE and ME**		
	Original SEI (Ha)	Loss (Ha)	% Loss	Original SEI (Ha)	Loss (Ha)	% Loss	Original SEI (Ha)	Loss (Ha)	% Loss
Region	150,422	658	0.4%	28,254	979	3.5%	178,676	1,637	0.9%
Regional Core	25,028	421	1.7%	10,049	767	7.6%	35,077	1,189	3.4%

Table 1 – Sensitive and Modified Ecosystem Loss for the Region and Regional Core

This report is focused on the update methodology and any changes from the original SEI methodology. Users should refer to the 2014 SEI Technical report (Meidinger, Clark, and Adamoski, 2014) for further details about how the inventory was created.

Contents

Introduction

The Metro Vancouver SEI was initiated in response to the need for up-to-date, standardized ecological information for the region to facilitate conservation of important ecological areas through informed land use and conservation planning, and increased awareness of ecosystem presence and declines. The initial SEI was completed in 2013 based on imagery from 2009 and other available map data. The initial SEI was recently updated using imagery from 2014 in order to incorporate changes to mapped ecosystems after 5 years, i.e., to document the amount, rate and type of ecosystem loss. This report describes the update process and summarizes the results.

To ensure the Metro Vancouver SEI continues to be an effective and relevant land use and conservation planning tool, it must be kept up to date. The overall goal of the update project was just that—to update the inventory, primarily to detect removals from sensitive ecosystem categories over the five years. Using 2014 regional orthophotos, ecosystem polygons were reviewed, and any loss or disturbance was documented. Improvements to the original mapping were also made through incorporation of new and more detailed mapping from other organizations, error correction, and additional field work to confirm and inform mapping decisions.

The objectives of the update were as follows:

1. Identify areas of disturbance or other land use change using 2014 regional orthophotos and update the SEI polygon boundaries;
2. Update the SEI classification attributes based on new imagery;
3. Modify the SEI data structure to allow changes to be tracked;
4. Identify, update and document polygons with classification errors in original mapping;
5. Summarize the changes, particularly the amount and rate of loss of sensitive ecosystems over time.

This report is focused on the update methodology and any changes from the original SEI methodology. Users should refer to the 2014 SEI Technical report (Meidinger, Clark, and Adamoski, 2014) for further details about how the inventory was created.

Change in Project Area

Abbotsford has returned to the Fraser Valley Regional District for its Parks function so Metro Vancouver no longer has responsibilities for conservation planning related to parks. For this reason, Abbotsford has been largely removed from the Metro Vancouver SEI. Some buffer areas around Regional Parks that fall on the Langley/Abbotsford border are still included.

Changes to Classification System

The initial SEI was conducted according to Provincial standards for mapping ecologically significant and relatively unmodified 'Sensitive Ecosystems', including wetlands, older forests and woodlands. In addition, important 'Modified Ecosystems' such as old fields and young forest were mapped[1]. Modified Ecosystems are younger and more human modified but still have ecological value and importance to biodiversity.

[1] See the SEI Technical Report (Meidinger, Clark, and Adamoski, 2014) for more detail on the classification system

However, at the start of the update, it became apparent that the Modified Ecosystem class: ***Seasonally Flooded Agricultural Fields*** (code: **FS**) was going to be problematic. There was not a good match in what appeared to be wet areas of agricultural fields in comparing the 2014 imagery to the 2009 imagery and the fieldwork that was conducted. There were several sites that were initially mapped as 'FS' that appeared completely dry in the 2014 and other Google Earth imagery. Many other areas looked wet in 2014 imagery but did not appear so last time (or not enough to digitize). There are other instances where the areas appear wet in both images, but the boundaries do not match up well. Due to concerns that this class would change too much between iterations or would require considerable additional imagery and field work to map accurately, the decision was made to remove the class from the inventory. It is an extremely modified ecosystem and was included as an "Other Important Ecosystem" by Ministry of Environment (2006) as the areas may, at one time, have supported moist forested and non-forested ecosystems, including wetlands, and in their present form are important to waterfowl in the winter months. However, the area of flooded field varies with winter rainfall and agricultural field modification and their ephemeral nature makes them challenging to map accurately.

SEI Update Procedures

The SEI Update incorporated four sources of information:

1. 2014 orthophoto image
2. Field checking
3. New ecosystem mapping from other organizations
4. New land cover mapping (2014)

A discussion of each of these follows. The update methodology detailed in this document was based initially on Axys (2005) and adjusted as required.

2014 Orthophoto Image Update Methodology

As the primary goal of the update was to detect change, the 2009 SEI polygons were overlaid on the 2014 image and each was inspected to see if change had occurred. Figure 1 outlines the workflow associated with decisions about change or no change to a mapped area and Figure 2 provides an example of spatial modification. The SEI database structure, including new fields added during the update, is provided in Appendix I.

During the update, various kinds of change were detected, including:

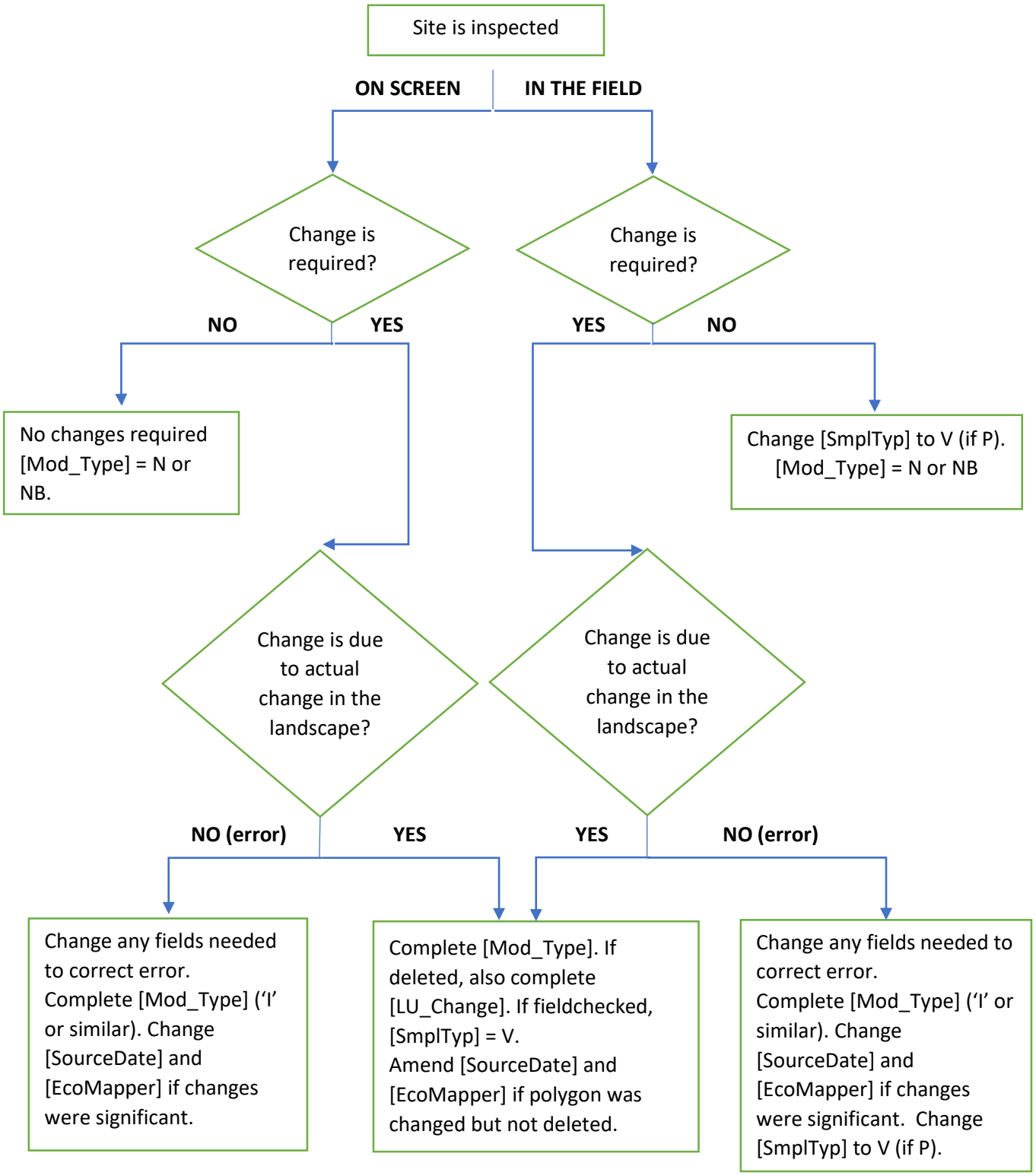
- Deletions: polygons that were disturbed to the point where they were no longer a Sensitive or Modified ecosystem. Polygons were attributed as to reasons for change and attributes modified accordingly. Deleted polygons remain in the database to allow for calculation of change.
- Reductions in size: polygons where a portion of the 2009 polygon was disturbed. Required digitizing change in polygons and attributing reasons for change.
- Reductions in condition: polygons where some disturbance reduced the condition, but the polygon still meets the minimum requirements for inclusion as a Sensitive or Modified ecosystem. Required modifying Condition field and attributing reasons for change.
- Correcting errors and making improvements in 2009 mapping: some errors were observed during the update process; new, improved ecosystem mapping datasets were occasionally made available from other organizations and were reviewed and incorporated; and some issues raised

in the 2012 quality assurance process required correction. Polygons deleted due to error correction (i.e. they should not have been included originally) have been removed from the inventory as they are not needed for calculations.

- Addition, deletion or condition change due to natural factors: addition due to restoration work or natural aging; deletion due to aging or change that could not be attributed directly to human disturbance (e.g. water level change affecting a wetland). Deleted polygons remain in the database to allow for calculation of change. Condition fields were modified where required.

The level of polygon updating was much less in the mountainous northern region—it is largely made up of protected areas (the watersheds, Provincial Parks and Regional Parks), with limited public access. In this area, the update was focused on fixing issues noted in the 2012 quality assurance assessment and scanning for obvious evidence of change (e.g. avalanche, blow downs, any park or watershed infrastructure development).

Figure 1- General Workflow



The following bullets outline how observed changes (actual and mapping error) were reflected in the database:

- The field [Mod_Type] was used to document type of modification conducted on the polygon. Codes and descriptions are provided in Appendix I. Multiple modification types were sometimes recorded for one polygon, e.g. actual disturbance plus correction of a mapping error.
- The field [Change] is a summary of actual change between 2009 and 2014, populated using the field [Mod_Type]. It records if a polygon was added due to natural change, deleted due to natural change, or deleted due to human disturbance.
- For polygons deleted due to disturbance, a new field named [LU_Change] was used to record the cause of ecosystem loss. If only a portion of the polygon was deleted, [LU_Change] was only completed for the deleted portion, not the remaining portion even if it was deleted due to a remnant assessment (i.e. deleted because the remaining portion falls below the minimum polygon size). [LU_Change] codes are provided in Appendix I. The associated field [LU_Change_Desc] – is used to provide a few words of description of the land use change observed, if needed.
    - For areas where multiple land use types caused the ecosystem loss, these were only separately digitized if it was relatively easy to do so and they were of a significant size. In instances where it was not practical to do so (e.g. a residential development with associated roads and lawns), the land use change type documented was the most dominant one.
- Field-checking:
    - If a polygon is field checked and nothing is changed, only the Amend fields – [AmendDate], [AmendMapper] and [AmendComment] - are completed, so as to record when the field check occurred (i.e. it wasn't when the polygon was first mapped)
    - If a polygon is field checked and the polygon is deleted as a result, only the Amend fields are completed, so as to record when the field check and deletion occurred
    - If a polygon is field checked and the classification is amended as a result, the Amend fields are completed to document the field checking, any changes are made to the classification fields, and the [SourceDate] and [EcoMapper] fields are changed to new date and mapper.
- If a polygon is checked and classification or disturbance fields are changed, [EcoMapper] and [SourceDate] are amended to the new mapper and date
- If a polygon is checked and deleted (due to actual disturbance or mapping error), [EcoMapper] and [SourceDate] remain with the original info. [AmendDate] and [AmendMapper] are completed so that there is a record of when the polygon dropped out of the inventory

Additional points to note:

- Before the update, a new field named [SEI_PolyNbr2009] was created to store the original SEI Polygon Number and provide a link to the previous version of the database. [SEI_PolyNbr] will only differ from [SEI_PolyNbr2009] in instances where amendments have split polygons and a new ID number is required to ensure each polygon has a unique ID.
- Polygons that were reassessed and found to be too disturbed to be included in the inventory (i.e. a mapping error) were removed from the inventory entirely.
- Calculations of loss can be made by selecting polygons with 'DD' in [Mod_Type] (alone or in combination with another code).

- As with the original SEI, if calculations are being made based on particular component, the fields [WSize_SE1_BASIC], [WSize_SE2_BASIC] and [WSize_SE3_BASIC], provided the area of the polygon covered by each ecosystem component.
- Two fields were added to aid calculation of change in Quality between 2009 and 2014. [Adj09Qual] holds 2009 quality scores, if they were adjusted due to a reassessment in 2014. [Qual0914] indicates whether the polygon was assessed for quality in 2009 and/or 2014.

Field Checking

Four days of field checking was conducted in September 2016. One hundred and two polygons were checked. If errors were found in mapped polygons, they were corrected. The experience gained was also used to update other map polygons. For example, some areas of Estuarine marsh vs. meadow were checked in Richmond. Areas on the imagery that appeared to be slightly drier and potentially meadow were not found to be such in the field. It is likely that upper estuarine areas that historically may have been meadows are now behind the dykes.

New Mapping Incorporated into SEI

Several new ecosystem mapping projects were incorporated into the SEI during the update.

2013 Islands Trust Area Eelgrass Inventory – Mapping was mostly used 'as is', with a few exceptions:

- Some polygons were merged with adjacent polygons if they were very close together.
- Some extremely small polygons were left out.

Although the minimum size of some resulting polygons falls below our official minimum (0.5 ha), the same approach was taken as with small TEM polygons – it has already been mapped so include, unless it's extremely small (Rao et al., 2013)

Widgeon Marsh Regional Park – new TEM mapping of the wetlands at Widgeon Marsh (Schaefer and Page, 2015).

Iona Island – new TEM mapping for park (Page, 2011).

Grauer – new mapping provided by Ducks Unlimited Canada (with permission from City of Richmond).

Pitt Polder – new TEM wetlands mapping provided by Nick Page (with permission from Ducks Unlimited Canada).

New Land Cover Mapping

Land Cover mapping is used to determine the Landscape Context attribute which is one of three values used to determine Quality (see Meidinger et al., 2014). New high-resolution Land Cover mapping for Metro Vancouver (2014) was obtained to update the landscape context values in the SEI. The 2014 Land Cover classification was created with a slightly different methodology and an improved resolution (Ruan et al., 2017), as compared to the 2009 land cover classification used when creating the SEI initially.

To enable an assessment of change in landscape context between 2009 and 2014, it was necessary to compare the two land cover classifications to determine how significant differences between the two were, and whether differences could be attributed to actual change or methodological change.

Sources of major difference between the 2010 and 2014 land cover classifications were:

- Increased image resolution. 2010 was 10m and 2014 was 5m.
- Incorporation of LiDAR data, where it was available in the region. This further enhanced the ability to detect small features.
- Only 'pure' land cover classes. The 2010 land cover used some 'mixed' classes, e.g. Urban Mixed was used when buildings, paved areas, trees, grass and shrub occur in close proximity to each other and are not well defined. The increased resolution in 2014 meant these mixed classes could be removed.

Appendix II outlines the method used to compare the two land cover datasets and assess whether changes were likely due to the methodology, or actual change. The assessment exercise showed that actual change of vegetated to non-vegetated land covers was picked up well which was the primary concern for use in the SEI. It is likely that some change, positive and negative, was not captured due to the change in methodology. However, for use in the landscape context, land cover classes are generalized and similar classes (e.g. Buildings and Roads) are given the same landscape context 'score' within the analysis – this means that differences between similar classes between 2009 and 2014 will not affect the landscape context assessment. Given this, and the steps taken to refine detected change and only classify a subset as actual change, any errors or omissions are unlikely to be very significant.

This is likely to be somewhat of an ongoing issue, i.e., different imagery quality and methods of analysis will change the result of future updates.

Estuarine and Intertidal Mapping

Mapping of Intertidal mudflats and eelgrass, and Estuarine marsh and tidal flats, which are often partially or wholly submerged in orthophotos, are challenging to update without focused effort in the field. Mapping of these classes in the SEI has relied largely on the 2006 FREMP (Fraser River Estuary Management Program) Habitat Inventory work. For this update, changes were made when they were visible in the orthos but **the SEI should not be used to assess or calculate change over time in these ecosystems**. Recession in the brackish marshes of the Fraser River estuary is being studied by the Provincial and Federal governments, in-conjunction with others, and these sources should be referred to for this information. For more information, please contact the Coordinator of the South Coast Conservation Land Management Program, Eric Balke (Eric.Balke@gov.bc.ca).

Quality Assurance - Overall

In this update, Josephine Clark conducted the update mapping and flagged some polygons for additional evaluation. Del Meidinger checked these polygons and scanned others to check the mapping – 820 polygons were given this additional review, which is 5% of the polygons reviewed (~11,500 polygons fall within the protected watersheds and provincial parks and were only scanned for change). The QA was used to update the mapping and was not a separate procedure post-mapping.

Quality Assurance - Old Field

The intention with the Old Field class is to capture a particular ecological state. Sites with well-developed herbaceous vegetation but with some shrubs and potentially a few young trees. This range in

vegetation types and heights provides a range of habitats for biodiversity and this importance for biodiversity is why Old Fields are included within the SEI. Old Field sites usually, but not always, have a history of being cleared for agricultural production but later abandoned. Areas under powerlines are an example of areas managed in a way that produces old field-like conditions and so these sites are also included within the class. Old Field is the second smallest class in the inventory, making up less than 1% of the inventory by area.

Old Fields represent an intermediate stage in succession, and without management will generally become forest eventually. Capturing a particular state in time with the right characteristics – old enough but not too old – is a challenge to map. For this reason, a more comprehensive and in-depth review of old field sites was undertaken in this review to ensure that 'old enough' sites were captured. Any sites identified as seeming to be too young or having insufficient old field characteristics were deleted from the inventory.

Additionally, a sub-set of Old Field polygons were imported to Google Earth and their actual age was assessed using historic imagery. The results of this exercise are as follows:

34 polygons (20%) of active Old Field sites, i.e. still present in 2014, were assessed. 33 sites (97%) are at least 15 years old. 14 sites are at least 20 years old (41%). It isn't possible to tell the exact age because historic imagery did not go back far enough. The youngest site was 13 years old.

An additional 9 sites were reviewed of Old Field polygons that were deleted in the 2014 update due to disturbance. This means that 12% of deleted sites were checked. 4 sites (44%) were between 6 and 12 years old at the time of disturbance. 5 sites (55%) were between 11 and 14 years old at the time of disturbance. It often was not possible to tell the exact year of disturbance due to gaps of several years in imagery.

Finally, to ensure the Old Field class was not inadvertently picking up grassland set-aside fields, the Delta Farmland and Wildlife Trust – responsible for a grassland set-aside stewardship program – reviewed the SEI Old Field polygons and compared them with their inventory of grassland set-aside locations. They found there was only 1 site that appeared in both inventories.

As a result of these additional quality assurance steps, we can have high confidence that the SEI is accurately capturing Old Field sites.

Results

Upon completion of the update to the SEI, the following attributes were re-calculated:

- 'Size' values were recalculated on changed polygons.
- 'Landscape context' values were recalculated for ALL polygons based on new land cover data.
- 'Quality' values were recalculated for ALL polygons.

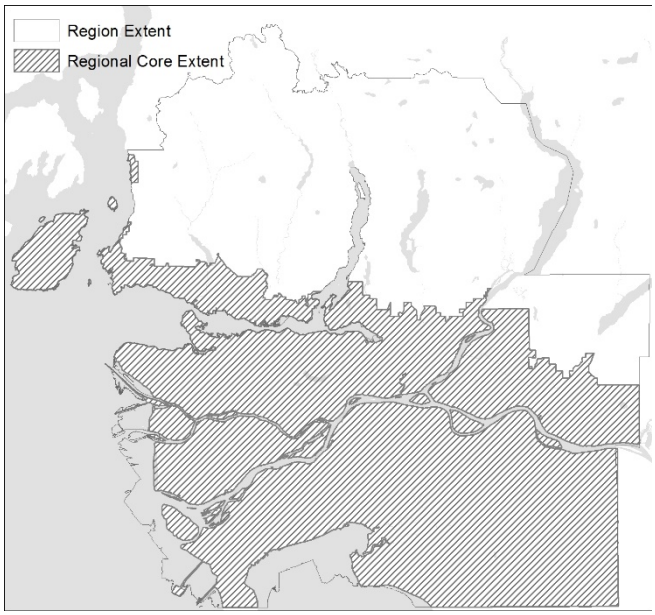
Changes in ecosystem extent and quality were calculated and summarized at the regional and regional core levels. They are summarized below.

To calculate loss correctly, users should use fields within the 2014 updated SEI rather than comparing the 2009 dataset with the 2014 dataset. This is because errors were corrected from the 2009 version which 'reset the baseline'.

Region and Regional Core

Tables 2 and 3 below depict ecosystem losses summarized for the region and the regional core. The regional core (see Map 1) is the more urbanized southern part of the region and excludes the large parks and estuaries under Provincial management, watersheds and other higher elevation areas. The regional core is most relevant to policy and planning and is where municipal decisions and actions will have the most impact.

Total loss of sensitive and modified ecosystems over 5 years was 1,640 ha (0.9%) for the region, and 1,190 ha (3.4%) at the regional core level. Losses of modified ecosystems are several times higher than that of sensitive ecosystems for the region and regional core.



Map 1 – Region and Regional Core Extents for the SEI

	Sensitive Ecosystems (SE)			Modified Ecosystems (ME)			Totals – SE and ME		
	Original SEI (Ha)	Loss (Ha)	% Loss	Original SEI (Ha)	Loss (Ha)	% Loss	Original SEI (Ha)	Loss (Ha)	% Loss
Region	150,422	658	0.4%	28,254	979	3.5%	178,676	1,637	0.9%
Regional Core	25,028	421	1.7%	10,049	767	7.6%	35,077	1,189	3.4%

Table 2 – Sensitive and Modified Ecosystem Loss for the Region and Regional Core

Table 2 presents only losses attributed to human causes. 30 hectares of loss was also mapped and attributed to natural causes. The large majority (29 ha) was aging Old Fields that no longer met the classification standard. The remaining 1 ha was an area of Mature Forest flooded due to beaver activity, resulting in tree death.

This natural loss was balanced by some gains to the inventory due to fields now old enough to be considered Old Field (36 ha), and restoration actions (~3 ha).

Table 3 presents ecosystem loss due to human causes for the Region and Regional Core, broken down by SEI class.

Ecosystem Type	Region			Regional Core		
	Original SEI (Ha)	Loss (Ha)	% Loss	Original SEI (Ha)	Loss (Ha)	% Loss
Alpine	14,536	0	0.0%	0	0	0%
Estuarine	8,636	1	0.0%	1,246	1	0.1%
Freshwater (SE)[2]	7,119	1	0.0%	425	1	0.3%
Herbaceous	114	0.2	0.2%	89	0	0.3%
Intertidal	8,129	1	0.0%	218	0	0.2%
Mature Forest (SE)[3]	22,014	425	1.9%	7,647	223	2.9%
Old Forest	34,343	10	0.0%	118	0	0.1%
Riparian	30,706	96	0.3%	7,973	72	0.9%
Sparsely Vegetated	9,187	1	0.0%	96	0	0.0%
Wetland	9,975	120	1.2%	6,900	122	1.8%
Woodland	5,663	4	0.1%	316	4	1.1%
Total - Sensitive Ecosystems (SE)	**150,422**	**658**	**0.4%**	**25,028**	**421**	**1.7%**
Mature Forest (ME)[1]	4,594	93	2.0%	2,272	80	3.5%
Freshwater (ME)[2]	142	0	0.0%	140	0	0.0%
Young Forest	21,384	459	2.1%	5,503	261	4.7%
Old Field	2,134	426	20.0%	2,134	426	20%
Total – Modified Ecosystem (ME)	**28,254**	**979**	**3.5%**	**10,038**	**767**	**7.6%**
Total – SE and ME	**178,676**	**1,637**	**0.9%**	**34,996**	**1,189**	**3.4%**

Table 3 – Loss by Ecosystem Type for the Region and Regional Core

At both the region and regional core, losses for the 5-year period were highest for Old Field, Mature Forest and Young Forest. Levels of forest loss are explored in more detail below. Wetland ecosystems saw losses of 120 ha (1.2%) for the region.

Loss of Forest Ecosystems

The large Provincial parks and protected watersheds in the northern part of the region are home to large amounts of Old Forest (>250 years old), but outside of these areas, remaining forests are Mature Forest (80-250 years old) and Young Forest (30-80 years old). Between 2009 and 2014, Mature and Young Forests mapped in the SEI saw the greatest declines aside from Old Field ecosystems. Table 4 summarizes these losses. Actual loss of young forest will be larger than reported here because the SEI only includes patches of young forest greater than 5 hectares in size. Therefore, loss of smaller patches of young forest will not be included in these figures. However, because smaller patches of young forest are still important, particularly given the rate and extent of forest loss across the region, smaller patches of young forest

were mapped as part of the SEI process (class Small Young Forest, 'YS') and are included in Table 4 below to provide a more complete picture of regional forest loss.

As summarized in Table 4, 1,162 ha (2.2%), of the region's mature and young forests were converted to other land uses over the 5-year period. For the regional core, these losses were 734 ha (3.9%).

	Region			Regional Core		
	Original SEI (Ha)	Loss (Ha)	% Loss	Original SEI (Ha)	Loss (Ha)	% Loss
Mature Forest (SE and ME)	26,608	518	1.9%	9,918	303	3.1%
Young Forest (ME)	21,384	459	2.1%	5,503	261	4.7%
Small Young Forest (non SE or ME)	5,413	185	3.4%	3,184	169	5.3%
Total	**53,404**	**1,162**	**2.2%**	**18,606**	**734**	**3.9%**

Table 4 – Loss of Mature and Young Forests

Changes in Ecosystem Quality

Ecosystems in the Sensitive Ecosystem Inventory are assessed for 'ecosystem quality', which is determined through an evaluation of their condition, visible disturbances, context within the landscape, and size. As shown in Table 5 below, at the regional level, a high percentage of ecosystems in the Sensitive Ecosystem Inventory are rated higher quality (84.7%), but this number drops considerably when looking at the regional core (39.1%). This difference is due to the dominating effect of the watersheds and large provincial parks in the north which contain very large areas of undisturbed ecosystems.

Changes in ecosystem quality were assessed during the recent Sensitive Ecosystem Inventory update. A decrease of less than 1% was detected at both the region and regional core level.

	% Ecosystems rated Higher Quality	**Change over 5-years**
Region	85%	-0.3%
Regional Core	39%	-0.7%

Table 5 – Ecosystem quality for the region and regional core

Further analysis of the SEI is provided in a report to Metro Vancouver's Climate Action Committee, titled 'Sensitive Ecosystem Inventory – Sub-Regional Profiles and Assessment of Ecosystem Loss'.

Improvements and Future Work

1) In 2013 we proposed eliminating the Herbaceous Class and instead having a new 'Beachland Class' which will include the two coastal subclasses (currently in Herbaceous), dunes and spits (currently in Sparsely Vegetated), and Intertidal Beaches and Shoreline (as they are often mixed with these others) as follows:

   Beachland Class (BL): Beachland: dunes, spits, and Headlands: coastal headlands
   - BL:sd - sand dunes (currently SV:sd)
   - BL:sp - spits (currently SV:sp)
   - BL:cs - coastal herbaceous (currently HB:cs)
   - BL:vs - vegetated shoreline (currently HB:vs)
   - BL:bs – beaches and shorelines (currently IT:bs)

   This leaves 3 subclasses from the Sparsely Vegetated class that could be better described as a **new Rock Class** (RO):
   - RO:ro - Rock outcrop (currently SV:ro)
   - RO:ta - Talus (currently SV:ta)
   - RO:cl - Cliff (currently SV:cl)

2) As noted in the section Intertidal and Estuarine Mapping, these classes are challenging to update without focused effort using specialist methods. Attempts should be made to find additional sources of data from agencies and organizations conducting research on coastal ecosystems that can be used to conduct a more comprehensive update of these classes in the SEI.
3) Mapping of the watersheds (Capilano, Seymour and Coquitlam) dates from a series of TEM mapping projects in the 1990's. In a future update of the Metro Vancouver SEI it would be beneficial to assess areas within the watersheds that were excluded from the inventory as the original mapping indicated they were younger than 30 years old. These areas are typically recovering from earlier logging activities and may now be old enough for inclusion within the Young Forest SEI class (30-80 years). There may also be areas currently classified as Young Forest that should be reclassed as Mature Forest (80-250 years).
4) Municipal ecosystem or Environmentally Sensitive Area (ESAs) mapping exercises can produce information that is a useful input or 'check' for the SEI. Recent municipal mapping should be reviewed to ensure any areas that meet the SEI classification system and mapping requirements have been captured.

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Appendices

Appendix I: SEI Data Model[4]

The SEI Data Model, as updated, is presented here.

Field Name	Alias	Description	Type	Length
SourceName	Source Name	Field to identify the agency or organization where the data originates	Text	12
SourceDate	Source Date	Date the data was sourced or created	Date	12
Jursidiction	Jurisdiction	Internal MV field. MV department the data is associated with	Text	20
Location	Location	Used only when polygon originates from MV TEM. Internal MV field. Specific name of park or watershed	Text	40
Classification	Classification	Used only when polygon originates from MV TEM. Internal MV field. Type of ecological or administrative unit	Text	30
TEM_PolyNbr	TEM Poly No.	Used only when polygon originates from TEM. Identifying number for the related polygon in the TEM dataset	Long Int	
SEI_PolyNbr	SEI Poly No.	Polygon Number - An identifying number for polygon being mapped	Long Int	
SmplType	Sample Type	Field check of polygon - describes the level of field checking done on the current polygon	Text	2
PlotNo	Plot No.	Field Plot number	Text	10
ProjType	Project Type	Project Type - Indicates the type of mapping project	Text	9
Proj_ID	Project ID	Project Identification - A unique identifier for each project	Text	5
EcoMap	Eco Mapper	First initial and surname of mapper	Text	15
EcoSec	Ecosection	Ecosection Label - Component of the hierarchical Ecoregion Classification system	Text	3
BGC_Unit	BGC Unit	Combination of BGC Zone/subzone/variant	Text	7
SEDec_1	Ecosystem 1 Decile	Ecosystem Decile of Ecosystem Component 1 - Proportion of the polygon covered by ecosystem component 1, in deciles.	Short Int	
SECl_1	Ecosystem 1 Class	Sensitive Ecosystem Class of Ecosystem Component 1	Text	2
SEsubcl_1	Ecosystem 1 Subclass	Sensitive Ecosystem Subclass of Ecosystem Component 1	Text	2
Strct_S1	Stuc Stg, Ecosystem 1	Structural Stage of Ecosystem Component 1	Text	2
StrctMod_1	Struc Stg Mod, Ecosystem 1	Structural Stage Substage or Modifier of Ecosystem Component 1	Text	2

[4] Administrative GIS fields are not included

Field Name	Alias	Description	Type	Length
Stand_A1	Stand Comp, Ecosystem 1	Stand Composition Modifier of Ecosystem Component 1 - Differentiates forest stands based on coniferous, broadleaf and mixed stand composition	Text	1
SEDec_2	Ecosystem 2 Decile	Ecosystem Decile of Ecosystem Component 2 - Proportion of the polygon covered by ecosystem component 2, in deciles.	Short Int	
SECl_2	Ecosystem 2 Class	Sensitive Ecosystem Class of Ecosystem Component 2	Text	2
SEsubcl_2	Ecosystem 2 Subclass	Sensitive Ecosystem Subclass of Ecosystem Component 2	Text	2
Strct_S2	Struc Stg, Ecosystem 2	Structural Stage of Ecosystem Component 2	Text	2
StrctMod_2	Struc Stg, Ecosystem 2	Structural Stage Substage or Modifier of Ecosystem Component 2	Text	2
Stand_A2	Stand Comp, Ecosystem 2	Stand Composition Modifier of Ecosystem Component 2 - Differentiates forest stands based on coniferous, broadleaf and mixed stand composition	Text	1
SEDec_3	Ecosystem 3 Decile	Ecosystem Decile of Ecosystem Component 3 - Proportion of the polygon covered by ecosystem component 3, in deciles.	Short Int	
SECl_3	Ecosystem 3 Class	Sensitive Ecosystem Class of Ecosystem Component 3	Text	2
SEsubcl_3	Ecosystem 3 Subclass	Sensitive Ecosystem Subclass of Ecosystem Component 3	Text	2
Strct_S3	Struc Stg, Ecosystem 3	Structural Stage of Ecosystem Component 3	Text	2
StrctMod_3	Struc Stg, Ecosystem 3	Structural Stage Substage or Modifier of Ecosystem Component 3	Text	2
Stand_A3	Stand Comp, Ecosystem 3	Stand Composition Modifier of Ecosystem Component 3 - Differentiates forest stands based on coniferous, broadleaf and mixed stand composition	Text	1
Microsite	Microsite	Microsite - ecosystem representing < 10% of the polygon	Text	4
Condition_SE1	Condition, Ecosystem 1	Condition assessment of the first component present in the polygon. A (best) to E (worst)	Text	1
ConditionNo_SE1	Condition (Num), Ecosystem 1	Condition assessment for component 1 expressed as a number. 5 (best) to 1 (worst)	Short Int	
Condition_SE2	Condition, Ecosystem 2	Condition assessment of the second component present in the polygon. A (best) to E (worst)	Text	1
ConditionNo_SE2	Condition (Num), Ecosystem 2	Condition assessment for component 2 expressed as a number. 5 (best) to 1 (worst)	Short Int	
Condition_SE3	Condition, Ecosystem 3	Condition assessment of the third component present in the polygon. A (best) to E (worst)	Text	1

Field Name	Alias	Description	Type	Length
ConditionNo_SE3	Condition (Num), Ecosystem 3	Condition assessment for component 3 expressed as a number. 5 (best) to 1 (worst)	Short Int	
Disturb_1	Disturbance (1st)	Disturbance (of greatest importance)	Text	7
Disturb_2	Disturbance (2nd)	Disturbance	Text	7
Disturb_3	Disturbance (3rd)	Disturbance	Text	7
Disturb_4	Disturbance (4th)	Disturbance (of least importance)	Text	7
Context	Context	Landscape context assessment for the entire polygon. A (best) to E (worst)	Text	1
ContextNo	Context (Num)	Landscape context assessment for the polygon expressed as a number. 5 (best) to 1 (worst)	Short Int	
WSize_SE1	Weighted Size, Ecosystem 1	Area of polygon covered by ecosystem component 1. Only completed for components > 2 deciles. This is an intermediate field used to calculate the Size grade only.	Double	
Size_SE1	Size, Ecosystem 1	Size grade for component 1. A (best) to E (worst). Based on SumWSize_SE1	Text	1
SizeNo_SE1	Size (Num), Ecosystem 1	Size grade for component 1 expressed as a number. Based on SumWSize_SE1	Short Int	
WSize_SE2	Weighted Size, Ecosystem 2	Area of polygon covered by ecosystem component 2. Only completed for components > 2 deciles. This is an intermediate field used to calculate the Size grade only..	Double	
Size_SE2	Size, Ecosystem 2	Size grade for component 2. A (best) to E (worst). Based on SumWSize_SE2	Text	1
SizeNo_SE2	Size (Num), Ecosystem 2	Size grade for component 2 expressed as a number. Based on SumWSize_SE2	Short Int	
WSize_SE3	Weighted Size, Ecosystem 3	Area of polygon covered by ecosystem component 3. Only completed for components > 2 deciles. This is an intermediate field used to calculate the Size grade only.	Double	
Size_SE3	Size, Ecosystem 3	Size grade for component 3. A (best) to E (worst). Based on SumWSize_SE3	Text	1
SizeNo_SE3	Size (Num), Ecosystem 3	Size grade for component 3 expressed as a number. Based on SumWSize_SE3	Short Int	
QualityNo_SE1	Quality (Num), Ecosystem 1	Quality assessment for component 1, combination of condition, landscape context and size ratings	Double	
WQuality_SE1	Weighted Quality (Num), Ecosystem 1	Quality rating (QualityNo_SE1) weighted by the proportion of the polygon covered by component 1	Double	
QualityNo_SE2	Quality (Num), Ecosystem 2	Quality assessment for component 2, combination of condition, landscape context and size ratings	Double	

Field Name	Alias	Description	Type	Length
WQuality_SE2	Weighted Quality (Num), Ecosystem 2	Quality rating (QualityNo_SE2) weighted by the proportion of the polygon covered by component 2	Double	
QualityNo_SE3	Quality (Num), Ecosystem 3	Quality assessment for component 3, combination of condition, landscape context and size ratings	Double	
WQuality_SE3	Weighted Quality (Num), Ecosystem 3	Quality rating (QualityNo_SE3) weighted by the proportion of the polygon covered by component 3	Double	
WCombQuality	Weighted Quality (Num), all	Total quality rating for the polygon, combining the weighted quality ratings for each component (WQuality_SE1, WQuality_SE2, WQuality_SE3)	Double	
Quality	Quality	Final quality grade for the polygon (based on WCombQuality) expressed as A (best) to E (worst)	Text	1
QualityNo	Quality (Num)	Final quality grade for the polygon (based on WCombQuality) expressed as a number – 5 (best) to 1 (worst)	Short Int	
SE_ME_1	SE/ME, Ecosystem 1	Status of component 1 as a sensitive, modified or non-sensitive ecosystem	Text	3
SE_ME_2	SE/ME, Ecosystem 2	Status of component 2 as a sensitive, modified or non-sensitive ecosystem	Text	3
SE_ME_3	SE/ME, Ecosystem 3	Status of component 3 as a sensitive, modified or non-sensitive ecosystem	Text	3
WSize_SE1_BASIC	Area, Ecosystem 1	Area of polygon covered by ecosystem component 1	Double	
WSize_SE2_BASIC	Area, Ecosystem 2	Area of polygon covered by ecosystem component 2	Double	
WSize_SE3_BASIC	Area, Ecosystem 3	Area of polygon covered by ecosystem component 3	Double	
PolyCom	Polygon Comment	Polygon comments	Text	250
Comp1Lgnd	Comp 1 Legend	Class and type (sensitive, modified or non-sensitive) of Ecosystem Component 1. Labeling field.	Text	50
Comp2Lgnd	Comp 2 Legend	Class and type (sensitive, modified or non-sensitive) of Ecosystem Component 2. Labeling field.	Text	50
Comp3Lgnd	Comp 3 Legend	Class and type (sensitive, modified or non-sensitive) of Ecosystem Component 3. Labeling field.	Text	50
Mod_Type	Modification Type	Type of modification observed	Text	10
LU_Change	LU Change	Land use change observed (i.e. from Sensitive/Modified Ecosystem to a different land use)	Text	35
LU_Change_Desc	LU Change Description	Additional information about land use change	Text	250

Field Name	Alias	Description	Type	Length
SEI_PolyNbr2009	SEI Poly No.2009	Holds the original SEI Polygon Number. Provides a link between the update and the original 2009 SEI	Long	
AmendDate	Amend Date	Records the date a polygon was fieldchecked (if it was different to the polygon creation date), or the date a polygon was deleted	Date	
AmendComment	Amend Comment	Notes if the date refers to deletion or fieldcheck	Text	50
AmendMapper	Amend Mapper	Name of mapper who fieldchecked or deleted	Text	15
Change	Change	Notes if this polygon was added or deleted between 2009 and 2014. This field summarizes the Mod_Type field	Text	3
Adj09Qual	Adjusted 2009 Quality	An adjusted Quality score for 2009, to account for errors identified in the original data. This field is used to calculate changes in Quality between 2009 and 2014.	Text	5
Q0914	Quality Assess 0914	Indicates whether the polygon was assessed for Quality in 2009 and/or 2014	Text	5
Comp1Lgnd_Full	Comp 1 Legend – Full	%, Class and type (sensitive, modified or non-sensitive) of Ecosystem Component 1. Labeling field.	Text	125
Comp2Lgnd_Full	Comp 2 Legend – Full	%, Class and type (sensitive, modified or non-sensitive) of Ecosystem Component 2. Labeling field.	Text	125
Comp3Lgnd_Full	Comp 3 Legend - Full	%, Class and type (sensitive, modified or non-sensitive) of Ecosystem Component 3. Labeling field.	Text	125

Field Descriptions[5]

SourceName

Code	Description
Acres Int.	Acres International Consortium (GVRD Ecological Inventory)
Blackwell	B.A. Blackwell and Associates Ltd.
Diamondhead	Diamond Head Consulting Ltd.
FIS	FIS (GVRD Ecological Inventory)
Hemmera	Hemmera
MV	Metro Vancouver
Madrone	Madrone Environmental Services
Raincoast	Raincoast Applied Ecology
Timberline	Timberline Natural Resource Group

Jurisdiction

Code	Description
O&M	Metro Vancouver Operations and Maintenance Dept.
Parks	Metro Vancouver Regional Parks Dept.
Non MV	Non Metro Vancouver lands

SmplType[6]

Code	Description
A	Aircall – data recorded from low-flying helicopter
D	Desktop verified - photo interpretation checked using another imagery source
E	Full plot – data recorded on FS882 forms from the ground
G	Ground inspection plot – data recorded on GIF cards from the ground
P	Photo interpretation – data interpreted from ortho/air photo
Code	**Description**
V	Visual inspection – abridged data recorded on plot card
VF	Visually inspected by FREMP

ProjType

Code	Description
NEM	Terrestrial ecosystem mapping without terrain
NEMNSS	Terrestrial ecosystem mapping with no bioterrain or structural stage
NEMSEI	Terrestrial ecosystem mapping (without bioterrain) and sensitive ecosystem inventory
SEI	Sensitive ecosystem inventory
TEM	Terrestrial ecosystem mapping

[5] Self explanatory fields not included

[6] Not always available for records originating from TEM due to merging process (the Watersheds and Lynn Headwaters Regional Park). Refer to original TEM datasets for exact locations of field checked polygons

EcoSec

Code	Description
FRL	Fraser Lowlands
GEL	Georgia Lowland
NWC	Northwestern Cascade Ranges
SOG	Strait of Georgia
SPR	Southern Pacific Ranges

BGC_Unit

Code	Description
CDFmm	Moist Maritime Coastal Douglas Fir Subzone
CWHdm	Dry Maritime Coastal Western Hemlock Variant
CWHxm1	Eastern Very Dry Maritime Coastal Western Hemlock Variant
CWHvm1	Submontane Very Wet Maritime CWH Variant
CWHvm2	Montane Very Wet Maritime CWH Variant
MHmm1	Windward Moist Maritime MH Variant
MHmmp	Parkland Moist Maritime MH Variant
CMA	Coastal Mountain-heather Alpine

SECl_1-3

Code	Description
AP	Alpine
ES	Estuarine
FW	Freshwater
HB	Herbaceous
IT	Intertidal
MF	Mature Forest
OD	Old Field
OF	Old Forest
RI	Riparian
SV	Sparsely Vegetated
WD	Woodland
WN	Wetland
XX	Non SE or ME
YF	Young Forest
YS	Young Forest (small)[7]
x	An x in front of any of the above code means the ecosystem has been recorded as lost, either to natural or human causes, e.g. xMF or xMature Forest

[7] Young Forest patches of < 5 ha are not considered an SE or ME

SEsubcl_1-3

Code	Description
av	avalanche tracks
bd	broadleaf
bg	bog
bs	beaches and rocky shorelines
ca	canyon
cl	cliff
co	coniferous
cs	coastal herbaceous
ds	dwarf shrub
el	eelgrass
ff	fringe
fh	high bench floodplain
fl	low bench floodplain
fm	medium bench floodplain
fn	fen
gu	gully
hb	herbaceous
kr	krummholz
la	lake
md	meadow
mf	mudflat
ms	marsh
mx	mixed
pd	pond
pf	parkland forest
ri	river
ro	rocky outcrop
rs	reservoir
sd	sand dune
sh	shrub
sp	swamp
st	spit
sw	shallow water
ta	talus
tf	tidal flat
ts	tall shrub
vo	very old
vs	vegetated shoreline
wm	wet meadow
xx	non SE or ME

Strct_S1-3 and **StrctMod_1-3** (see below for further details on structural stage definitions)

Code - Strct	Code - StrctMod	Description
1	a	Sparse/cryptogam: Sparse
1	b	Sparse/cryptogam: Bryoid
1	c	Sparse/cryptogam: Lichen
2	a	Herb: Forb-dominated
2	b	Herb: Graminoid-dominated
2	c	Herb: Aquatic
2	d	Herb: Dwarf shrub
3	a	Shrub/Herb: Low shrub
3	b	Shrub/Herb: Tall shrub
4		Pole/Sapling
5		Young Forest
6		Mature Forest
7	a	Old Forest: old
7	b	Old Forest: Very old
	99	Attribute not assessed (from original TEM)

Stand_A1-3

Code	Description
B	Broadleaf - > 75% of total tree cover is broadleaf
C	Coniferous - > 75% of total tree cover is coniferous
M	Mixed - Neither coniferous or broadleaf is > 75% of total tree cover

Disturb_1-4

(see *Field Manual for Describing Terrestrial Ecosystems* for additional codes).
Adjacent disturbance assessed within 15m of polygon

Code	Description
A	Atmospheric related effects
Aesn	Heavy snow
Aw	Windthrow
B	Biotic (plant and animal) effects
Bb	Beaver tree cutting
Bd	Grazing
Bv	Aggressive vegetation
Bvbk	Aggressive vegetation - blackberry
Bvbs	Aggressive vegetation – Birch salal woodland
Bvrcg	Aggressive vegetation – reed canary grass
Dc	Disposal – chemical spill or disposal
Dg	Domestic garbage disposal
Fc	Overstorey crown fire
Fh	Fire - harvest related
Fn	Fire confirmed - natural
Fs	Fire suspected
G	Gap replacement

Code	Description
H	Harvesting
Hbad	Buildings or structures (adjacent)
Hbw	Buildings or structures (within)
Hla	Human log accumulation
Hmh	Modified hydrology, e.g. dikes, man-modified lake/pond
Hmv	Modified vegetation, e.g. agriculture, recreation fields (adjacent)
Ho	Harvesting - old
Hr	Harvesting - recent
Hrad	Roads (adjacent)
Hrw	Roads (within)
Hs	Harvesting - recent, selective
Htad	Trails (adjacent)
Htr	Tree removal – recent
Htw	Trails (within polygon)
Huad	Utility right-of-way (adjacent)
Huw	Utility right-of-way (within)
I	Inundation
L	Landslide
Lc	Forest harvesting – clearcut system
Le	Forest harvesting – selective system
Ll	Land clearing
Ls	Selective logging
Lt	Active talus
M	Plant or site modification effects
Mc	Herbicide (chemical) use
Mg	Planted or seeded to grasses
Mh	Planted or seeded to herbs
Ms	Planted or seeded to shrubs
Mt	Planted or seeded to trees
Mw	Mowed
P	Unknown (watersheds only)
S	Soil disturbances
Sa	Cultivation (agriculture)
Sc	Snow creep
Se	Excavation
Sf	Sidecast Fill
Shp	Soil disturbance – harvesting of peat
Sr	Road bed, abandoned
T	Terrain related effects
Ta	Avalanching
Tq	Rock quarrying (incl. open pit mines)
Ts	Terrain failures
V	Vehicle tracks
W	Water related effects
Wb	Windthrow by cutblock boundaries
Wd	Water table control (diking, damming)
We	Water table depression
Wi	Inundation

SE_ME_1-3

Code	Description
ME	Modified Ecosystem
SE	Sensitive Ecosystem
XX	Non SE, ME or YS ecosystem type
YS	Small patches of young forest (< 5 ha) (not an SE or ME)
x	An x in front of any of the above code means the ecosystem has been recorded as lost, either to natural or human causes (e.g. xME or xModified Ecosystem)

Condition_SE1-3 and **Context** and **Size_SE1-3** and **Quality**

Code	Description
A	Excellent
B	Good
C	Moderate
D	Poor
E	Very Poor

ConditionNo_SE1-3 and **ContextNo** and **SizeNo_SE1-3** and **QualityNo**

Code	Description
5	Excellent
4	Good
3	Moderate
2	Poor
1	Very Poor

Mod_Type

Code	Description	Additional Information
A	Addition	New to the inventory (completely new polygon), e.g. newly created reservoir; restored habitat
AC	Extension	Extension of existing polygon as adjacent area should now be included (used for significant extensions only), e.g. adjacent area to an Old Field now old enough to be included
C	Change	Change in classification (from one SEI class to another), usually due to natural change. Possible that changes are human-caused (e.g. drainage in an nearby area) but not obvious. e.g. changes in water levels have resulted in shifts of different wetland types; beaver activity
CD	Change due to disturbance	Disturbance resulted in a change to a different class, e.g. wetland converted to a freshwater reservoir

Code	Description	Additional Information
CR	Reduced due to change	Change (as described in C above) resulted in a reduction in the size of a polygon. Change appears to be due to natural factors. e.g. changes in water levels have shrunk a wetland
D	Disturbed	Condition rating has been reduced due to disturbance
DC	Deleted due to Change	Natural change has resulted in the site no longer meeting the classification requirements for any classes, e.g. Old Field that has become too overgrown; beaver activity has flooded an area and killed the trees;
DD	Deleted due to disturbance	Area deleted from the SEI due to disturbance which resulted in complete or reduction in condition below the level of 'E'. Polygons retained as a separate layer.
DR	Deleted due to remnant assessment	Part of the polygon deleted due to disturbance. The remaining intact ecosystem is now so small as to not meet the size criteria for inclusion
I	Reinterpretation	Classification, components, or linework has been reassessed and amended. Usually due to an error in original data or improved imagery
IA	Reinterpreation - Addition	Polygon was reassessed and found to meet the standard required to be included in the inventory so was added (may be a fully new polygon or an extension to an existing one).
ID	Reinterpretation - Disturbance	The polygon was reinterpreted which led to a change in the disturbance coding.
IDD	Reinterpretation - Deleted due to disturbance	Polygon was reinterpreted and found to be too disturbed to be included and so deleted from the inventory. *Polygons with this coding were removed from the inventory.*
IDR	Reinterpretation - deleted due to remnant assessment	Polygon was reinterpreted and part of it was found to be too disturbed and deleted from the inventory. The remainder of the polygon is now too small so does not meet the size criteria for inclusion. *Polygons with this coding were removed from the inventory.*
IR	Reinterpreted - Reduced	The polygon was reinterpreted which led to a reduction in size
IRD	Reinterpretation - Reduced and Disturbed	The polygon was reinterpreted which led to a reduction in size and a change in the disturbance coding
N	No Change	No change observed since the last assessment

Code	Description	Additional Information
NB	No Change (Brief)	Brief scan of area rather than in-depth look (only for watersheds and large provincial parks in the north)
ND	Change in disturbance due to natural factors	Used for Old Field where condition has been reduced or improved due to natural succession
R	Reduced	Reduced in size due to disturbance
RD	Reduced and Disturbed	The polygon was both reduced in size and disturbed.
Any codes with an underscore between them, e.g. R_C	Indicates two separate issues that apply to the same polygon. E.g. Reduced and Changed	EXAMPLES ONLY PROVIDED HERE. MORE EXIST IN THE DATABASE AND CAN BE UNDERSTOOD BY LOOKING AT THE INDIVIDUAL CODES
I_R	Reinterpreted and reduction due to new disturbance	Reinterpretation of initial classification or linework. Plus reduction in size due to new disturbance
I_DD	Reinterpreted and deleted due to disturbance	Reinterpretation of initial classification or linework. Since the original call, it was disturbed and so will be deleted from the inventory
I_D	Reinterpreted and new disturbance	Reinterpretation of initial classification or linework. Plus reduction in condition rating due to new disturbance
I_IR	Reinterpreted, and reinterpreted and reduced	Reinterpretation led to a change in classification or other attribute, plus the polygon has been reduced due to reinterpretation
I_RD	Reinterpreted plus reduced and disturbed	Reinterpreation of initial classification or linework. Plus a reduction in size and condition due to new disturbance
IR_R	Reinterpreted and Reduced, and reduced	The polygon was reinterpreted which led to a reduction in size (and potentially other changes e.g. classification). Plus the polygon was reduced due to new disturbance

LU_Change

Code	Description
Agriculture	Land used for agricultural production. Includes cultivated field crops, farm infrastructure, crop cover structures, equestrian.
Cleared/Mowed	The area was cleared of vegetation or mowed and no further development has occurred or looks like it will occur. 2016 orthos were used to confirm that development had not occurred two years later.
Commercial & Services	Retail services, cultural and entertainment
Drainage	The area was cleared in order to install drainage features (ponds, culverts, etc.)
Extraction	Mineral, petroleum
Golf Course	
In Transition	The area was cleared and development is in process but the land use is unclear
Industry	Includes work yards and buildings associated with industrial activities
Institutional & Community	Government, religious, medical, educational, correctional
Logged	Trees logged as part of forestry operations (includes the academic research forests)
Outdoor Storage	Areas cleared and now used to store equipment, vehicles, etc. Not clearly associated with another land use type.
Recreation	Playing fields, trails
Residential	Housing and associated driveways, lawns (immediately adjacent to the property) and small streets leading to the house. In cases where an area has been cleared and a residential development with roads etc. was added, the individual local roads were not separated and classified as Transportation & Communication, they are included within Residential. Larger roads were separated out. Larger areas of clearing that appear associated to a residence but are not clearly lawn are classified as 'Cleared/Mowed'
Restoration	Occasionally, restoration activities result in clearing of vegetation (usually to remove invasives). These areas will likely return to the inventory in a few years
Transportation & Communication	Roads, rail, airports, telecommunications
Unknown	Used to the minimum extent possible where the purpose of a development cannot be determined
Utilities	Energy transmission, water

Change

Code	Description
AN	Added due to natural change (an ecosystem now meets the classification requirements)
DN	Deleted due to natural change (e.g. an aged old field that no longer meets the classification requirements)
DM	Deleted due to mapping change (e.g. fixing error)[8]
DH	Deleted due to human activities (an ecosystem lost due to human activities)

Adj09Qual

Code	Description
A	Excellent
B	Good
C	Moderate
D	Poor
E	Very Poor
N/A	For polygons with no quality score in 2009

Q0914

Code	Description
QAll	Assessed for quality in both 2009 and 2014
Q14	Assessed for quality in 14 but not 09
NQ	Not assessed for quality

[8] These polygons have been removed in the final version of the database

Appendix II: Comparing 2009 and 2014 Land Cover Mapping

The 2009 Land Cover was created using 10m resolution SPOT multi-spectral satellite imagery. Due to the moderate resolution, some classes were 'mixed', i.e. not a pure land cover class. For example, the Urban Mixed class is used when buildings, paved areas, trees, grass and shrub occur in close proximity to each other and were not well defined. The 2014 Land Cover was created using 5m RapidEye imagery and LiDAR, where available. The use of LiDAR further increased the resolution of the output and greatly improved distinction between spectrally similar classes (e.g. shrub and grass/herb; paved and buildings). Due to the improved resolution, no mixed classes were used in the 2014 Land Cover classification.

Given the change in methodology and imagery resolution between the 2009 and 2014 Land Cover datasets, it could be difficult to tell what is actual change and what is due to methodology/image change. In order to assess this, a subset of data from the region was reviewed in detail with the objective of comparing the two and understanding where are the problems and how should we go about using the 2014 land cover to look at change.

A subset of the region was reviewed—a reasonably large area covering most of Maple Ridge and Surrey, where there has been quite a bit of actual change and also a range of types of land use (urban, agricultural, forested, etc.). The polygonised Land Covers from 2009 and 2014 were "unioned" in order to have classes from both years in the same dataset. Then the polygons were classified as to whether there was a change between 2009 and 2014, and what that change was. The following table presents how change was classified. An explanation of the 'Change Categorization' is provided below the table. It is worth noting that for the purposes of assessing landscape context, the land cover values are further generalized and similar classes are given the same landscape context 'score'. For example, buildings and paved both are rated 0. Differences between similar classes in 2009 vs 2014 will therefore not make a difference in the landscape context assessment. It's also important to note that the land cover is only used to fill in around the SEI polygons for assessing landscape context, i.e. the SEI takes precedence.

2009 Class	**2014 Class**	**Change Categorization**
Bare Soil	Soil	Match
Grass-herb	Natural grass-herb; Modified grass-herb	Match
Shrub	Shrub	Match
Mixed Tree; Deciduous; Coniferous	Coniferous; Deciduous; Mixed Tree	Match
Built Environment	Buildings; Paved; Other Built	Match
Barren – All; Barren-Modified	Barren	Match
Shadow	Any class	Match
Water	Water	Match
Roads	Paved; Buildings; Other Built	Match

Bare Soil	Buildings; Paved; Other Built; Barren; Non-photosynthetic vegetation; Shadow; Clouds/Ice; Modified grass-herb; Natural grass-herb	Partial Match
Grass-herb	Shrub; Non-photosynthetic vegetation; Shadow; Clouds/Ice; Soil; Barren	Partial Match
Shrub	Non-photosynthetic vegetation; Shadow; Clouds/Ice; Modified grass-herb; Natural grass-herb; Coniferous; Deciduous	Partial Match
Mixed Tree; Deciduous; Coniferous	Shadow; Clouds/Ice; Shrub	Partial Match
Built Environment	Soil; Barren; Shadow; Clouds/Ice	Partial Match
Urban Mix	Shadow; Clouds/Ice	Partial Match
Barren-All; Barren-Modified	Soil; Shadow; Clouds/Ice; Non-photosynthetic vegetation; Buildings; Paved; Modified Grass-herb; Natural Grass-herb	Partial Match
Roads	Soil; Barren; Shadow; Clouds/Ice	Partial Match
Water	Shadow; Clouds/Ice	Partial Match
Bare Soil	Shrub; Deciduous; Coniferous	No Match +
Grass-herb	Buildings; Paved; Other Built	No Match -
Grass-herb	Coniferous; Deciduous	No Match +
Shrub	Soil; Buildings; Paved; Other Built; Barren	No Match -
Mixed Tree; Deciduous; Coniferous	Soil; Buildings; Paved; Other Built; Barren; Modified Grass-herb; Natural grass-herb; Non-photosynthetic vegetation	No Match -
Built Environment	Modified Grass-herb; Natural grass-herb; Non-photosynthetic vegetation; Coniferous; Deciduous; Shrub	No Match +
Barren-All; Barren-Modified	Coniferous; Deciduous; Shrub	No Match +
Roads	Modified Grass-herb; Natural grass-herb; Non-photosynthetic vegetation; Coniferous; Deciduous; Shrub	No Match +
Urban Mix	All classes except Shadow, Clouds/Ice	No Match
Water	All classes except Water, Shadow, Clouds/Ice	No Match

Table 6: Comparing 2009 and 2014 Land Cover values

Change Categorization values:

'**Partial Match'** means the classes are similar and likely to have some misclassification between them. This misclassification would not result in significant impacts to landscape context values.

'No Match +' means the classes don't match and the change is positive (i.e., non-vegetated to vegetated).

'No Match –' means the classes don't match and the change is negative (i.e., vegetated to non-vegetated, or treed to shrub/grass-herb).

'No Match' means the classes don't match and the change is neither negative nor positive. For example, the Urban Mix class in 2009 is a mixed class used when buildings, grass, trees etc. are close together and pixels are a mix of classes. The class was not used in 2014. It is not possible to say whether there has been a change for this class between 2009 and 2014.

Then, the areas of each of these different types of changes were calculated to see how significant they could be. The following provides some observations on what was found.

1. Classes that MATCH:
    a. 66% of area matches between 2009 and 2014
    b. No change in landscape context is required for these areas
2. Classes that are a PARTIAL MATCH:
    a. 'Partial Match' means the classes are similar and likely to have some misclassification between them. Due to this, we would not feel confident about ascribing any change in class to actual change. But due to the similarity in classes between 2009 and 2014, this misclassification would not result in significant changes to landscape context values anyway. Shadow and Clouds/Ice are included here because Shadow and Cloud could be obscuring any class.
    b. 15% by area is a Partial Match between 2009 and 2014. The most significant classes with a Partial Match are Shrub (2009) to Grass-Herb and Coniferous or Deciduous (2014).
    c. No adjustment to landscape context values were made.
3. Classes that are a NO MATCH – NEGATIVE CHANGE:
    a. 4.7% by area is a No Match – Negative change between 2009 and 2014. This means either in 2009 it was classified as a vegetated class and in 2014 as a non-vegetated class, or in 2009 it was treed and in 2014 was classified as shrub or grass-herb.
    b. Example areas were reviewed in the north of Maple Ridge that have had areas of trees harvested – these have been well classified for change. Also, the powerline was expanded and this loss of trees is mostly picked up correctly. New residential developments have been well captured as change.
    c. There are some areas classed as a type of vegetation in 2009 and now classed as Buildings or Paved in 2014. This looks like change but actually the 2009 land cover was incorrect. These are frequent but small (1 or 2 pixels). They tend to happen in residential areas with very mixed land covers. Also happens in the other direction though – i.e. it was in as vegetated area in 2009 correctly, and now classed as Buildings/Paved incorrectly. This occurs infrequently.

    d. Overall, changes from vegetated to non-vegetated are well captured. Changes between vegetation types in forested areas (i.e. forested to not) are mostly good.
    e. These areas are counted as an actual change in landscape context between 2009 and 2014.
4. Classes that are a NO MATCH – POSITIVE CHANGE:
    a. 7.6% by area is a No Match – Positive change between 2009 and 2014
    b. These areas were classified as Roads in 2009, and Coniferous/Deciduous or other vegetation in 2014. This seems to have occurred largely because the roads were burned into the land cover in 2009, using a roads vector file. They aren't picked up as road in 2014 because this approach was not taken and they are quite small (and often not paved) so not captured in the classification process. Sometimes they are actually a path rather than a road. These are not significant in area though so shouldn't have an impact on the final landscape context value of an area. This is not real change – but the 2009 is technically correct. However, as per the next point, there are often areas alongside roads that are now better defined and were in as road but now are in (correctly) as a veg class – so some balance here perhaps?
    c. Looking at areas that were classed as Built Environment in 2009 and are now classed as some type of vegetation in 2014. These all seem to come about as a result of better definition of buildings, roads etc., or are just a result of error (usually in the 2009, but not always). These are not actual change.
    d. Areas in as Grass-Herb in 2009, now classed as Coniferous or Deciduous in 2014 – these are very largely due to misclassification in 2009 and were always treed. Tend to be small (1-5 pixels) and very scattered. Could result in a significant change on landscape context if enough were in an area.
    e. No adjustment to landscape context values were made.
5. Classes that are a NO MATCH – NEUTRAL CHANGE:
    a. 7% by area is a No Match – Neutral change between 2009 and 2014.
    b. This is mostly because of Urban Mix which was included in 2009 and is a mixed class, used when buildings, grass, trees etc. are close together and pixels/areas are a mix of classes. The class was not used in 2014. It is not possible to say whether there has been a change for areas classified as Urban Mix in 2009. Given that Urban Mix got a middling to low context score in 2009, and these will now be a mix of vegetated and non-vegetated (and don't tend to be in natural areas), the effect on context shouldn't be great.
    c. No adjustment to landscape context values were made.

For purposes of this analysis, the primary concern is capturing vegetated areas that have become non-vegetated, and for the most part this is captured well between 2009 and 2014. Consideration was given to resetting the 2009 baseline with the modified methodology. This was not enacted because there is a good match overall and there would be little to gain in trying to refine 2009 values. The impact on final landscape context values would be slight. Landscape context is then combined with scores for Condition and Size to give an overall Quality value so any impact would be even less. This is likely to be somewhat of an ongoing issue, i.e., different imagery quality and methods of analysis will change the result of future updates.