Tracking Ecosystem Loss on East Vancouver Island and the Gulf Islands: Recent Research and Application

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Abstract: The Sensitive Ecosystems Inventory 2003–2004 disturbance mapping project for east Vancouver Island and the Gulf Islands, British Columbia, measured changes to the landscape over approximately a ten-year period. In 1993–1997, the Sensitive Ecosystems Inventory mapped seven different natural ecosystem types that were considered to be rare and sensitive on east Vancouver Island and the Gulf Islands, plus two other ecosystem types that were mapped for general biodiversity and wildlife habitat values. Based on interpretation of air photos, most of which were from 1992, less than 8% of the landscape was mapped as sensitive ecosystems that were in a relatively natural state. The recent disturbance mapping work evaluated the current (2002) condition of the original mapped polygons by underlaying the spatial data with 2002 orthophotographs. Changes to polygons were noted, and areas that were lost to disturbance or were heavily modified were digitized, allowing calculation of total hectares lost to disturbance throughout the study area since the original inventory.

The results of the disturbance mapping project show an alarming trend. Over 1460 ha (4.5%) of the area occupied by the seven sensitive ecosystem types in the early 1990s had been disturbed (and was considered to be no longer representative of the ecosystem types) by 2002. Over 8800 ha (11%) of the disturbed area had originally been occupied by the nine different mapped ecosystems. Older forests had the highest rate of loss at 8.6% (915 ha), followed by riparian (4.6%; 311 ha), woodland (2.6%; 66 ha), and wetland (2.0%; 142 ha) ecosystems. The largest area of loss was 7363 ha (16.4%) in the older second growth forest category. Losses due to fragmentation are currently being assessed and will add to these totals.

The losses raise concerns over the rate and extent at which rare and ecologically sensitive ecosystems continue to be altered or lost in the east Vancouver Island and Gulf Islands region. It is hoped that this project and its map products will not only raise awareness of escalating ecosystem loss in the region, but will also facilitate and encourage the development of comprehensive conservation strategies to ensure the protection of the remaining natural ecosystems through a more strategic landscape approach to land use planning.

Key Words: ecosystem loss, disturbance mapping, conservation planning, land use planning, Sensitive Ecosystems Inventory, British Columbia

Project Background

Sensitive Ecosystems Inventory Mapping 1993–1997

By the late 1980s, it had become clear that ecologically significant lands and important wildlife habitats were fast disappearing throughout the lowlands surrounding the Strait of Georgia. This loss was due to intense development pressure fueled by population and economic growth. To address this concern, the Sensitive Ecosystems Inventory (SEI) of east Vancouver Island and the Gulf Islands (British Columbia) was undertaken in 1993 as a joint pilot project of Environment Canada (Canadian Wildlife Service) and the British Columbia Ministries of Sustainable Resource Management and Water, Land and Air Protection. Funding support was provided by the Habitat Conservation Trust Fund and several local governments.

The purpose of the SEI was to identify, classify, and map terrestrial ecosystem polygons that existed in a relatively unmodified state within the region (Ward et al. 1998). Seven **sensitive ecosystem** types that once defined the ecological character of this region were identified: wetland, riparian, older forest, woodland, coastal bluff, sparsely vegetated (e.g., dunes, spits, and cliffs), and terrestrial herbaceous ecosystems (Ward et al. 1998). SEI results showed that by the early 1990s, sensitive ecosystems covered only 7.9% of the regional land base.

The SEI also mapped two **other important ecosystems**—seasonally flooded agricultural fields and older second growth forests—because of their contribution to the general biodiversity and wildlife habitat values of the region. These ecosystems were not considered to be sensitive ecosystems because of their widespread distribution and history of recent human disturbance. SEI results showed that these ecosystems covered an additional 11.6% of the regional land base.

The primary objective of the SEI was to conserve remaining examples of the seven sensitive ecosystems in a relatively natural state. The objective with regard to the two other important ecosystems was to maintain their resource use values while minimizing the loss of ecosystem function and to give conservation priority to those surrounding or adjacent to sensitive ecosystems (McPhee et al. 2000).

The seven sensitive ecosystem types used in the SEI are described below:

Coastal Bluff (CB)	vegetated rocky islets, shorelines, and coastal cliffs
Sparsely Vegetated (SV)	dunes, spits, and inland cliffs
Terrestrial Herbaceous (HT)	mosaics of coastal grassland meadows and moss-covered rock outcrops
Riparian (RI)	vegetated floodplains, stream and lake shores, and gullies
Wetland (WN)	marshes, fens, bogs, swamps, shallow water, and wet meadows
Woodland (WD)	open forests dominated by deciduous trees with canopy cover generally less than 50%
Older Forest (OF)	forests older than 100 years

The two other important ecosystem types that were mapped for their biodiversity and wildlife values were

Older Second Growth Forest (SG)	large forested stands that are 60–100 years old
Seasonally Flooded Agricultural Field (FS)	agricultural fields that are regularly flooded in winter months

Over 20% of the SEI polygons originally identified contained a mixture of primary and secondary ecosystem components that could not be delineated separately. Such polygons are referred to as 'complex' units and have two ecosystems associated with them.

Information generated by the SEI has proven to be a valuable tool in addressing some of the concerns about the loss of sensitive ecosystems. The intent of the program was to develop a scientific database that could be used to promote responsible land stewardship, support sound land use planning decisions, encourage wildlife conservation, and expand the suite of tools available for protecting and conserving valuable habitats and ecosystems (Ward et al. 1998; Environment Canada 2002). To this end, SEI information has been used to build the case for acquisition of sites such as Tumbo Island, the Galiano bluffs, and portions of the Sooke Hills for the purpose of conserving rare and sensitive ecosystems (AXYS 2003a). Additionally, SEI information has been used to establish buffers along park boundaries, delineate boundaries for conservation covenants, develop natural area plans, and evaluate development proposals (AXYS 2003a).

Preliminary SEI Audit 2001

A 1999–2001 Ministry of Water, Land and Air Protection audit (based on 1999 orthophotos) of the status of 27% of the original SEI polygons in the east Vancouver Island and Gulf Islands study area indicated that 11.2% of those polygons had been either lost or affected by disturbances with 1.3% of the sites classified as 'Severely Disturbed/Degraded'. This represents an average rate of change of 1.6% per year, and the audit noted that the level of disturbance had increased during the latter half of the 1990s (Caskey and Henigman 2002). Of particular concern was the level of disturbance in Older Second Growth Forest (24.9%) and Older Forest (17.6%) due to forestry activities and urban encroachment (Caskey and Henigman 2002). Not surprisingly, these results prompted valid concerns about the rate and extent to which rare and ecologically sensitive ecosystems continue to be altered or lost in the east Vancouver Island and Gulf Islands region.

SEI Disturbance Mapping 2003–2004

The air photos used for original polygon designation were taken from 1984 to 1992. It was acknowledged that if the SEI was to continue to be an effective and relevant conservation and land use planning tool, it must contain up-to-date information. In recognition of that need, AXYS

Environmental Consulting Ltd. (AXYS) was contracted to evaluate the present condition of all original SEI polygons using air photos taken in 2002, and to update the spatial coverage and associated attribute files with information such as disturbance type, percent of polygon disturbed, and extent of polygon fragmentation. This update of the SEI data increases the value of the SEI to both current and potential users, and allows the amount, rate, and type of ecosystem loss since the original inventory to be quantified and summarized. The following methodology and results sections were adapted from AXYS (2003b).

Methodology

The original SEI polygon designation was made using air photos taken from 1984 to 1992. New anthropogenic disturbance to those polygons was identified by examining each of the 7388 SEI polygons individually in conjunction with 1:10,000 digital orthophotos taken in July–August 2002. Most of the study area was rendered in black and white. Color images were available only for Lasqueti Island and its adjacent islets.

Seven types of disturbance were identified: cleared/logged, industrial use, rural use, agriculture, urban use, trails/recreation, and ‘other’. Disturbance was often obvious and easy to categorize, particularly when the area of disturbance was large and continuous (e.g., clearcut logging, suburban housing development) rather than patchy or small (e.g., selective logging, minor roads and trails); however, there were some cases when it was necessary to refer to the original air photos and polygon linework to distinguish between ‘new’ disturbance and pre-existing disturbance (i.e., disturbance that had been included as part of the original polygon). The original SEI allowed for some fragmentation if, in the opinion of the qualified professional interpreting the air photos or doing the groundtruthing, disturbance was considered not to compromise the integrity of a functioning ecosystem.

Some forms of disturbance were impossible to identify within the scope of this project (e.g., invasion of exotic species), and others were easier to identify in some units than in others (e.g., trail networks in nonforested versus forested units). Natural disturbances that altered the composition or boundaries of a polygon were not considered to be a disturbance in the context of this project, although a brief descriptive comment was added to the database. Examples of such natural disturbances included changes to a river course that affected bank and island polygons, and erosion or depositional changes to soft-sediment islands in marine or estuarine environments.

Disturbances that infringed on the edges of a polygon were assessed as to whether they were an actual infringement on the polygon or whether the appearance of infringement was actually an artifact of inaccurate digitizing of the original polygon. This distinction was generally based on an assessment of how accurate the rest of the polygon appeared to be or how easily distinguished the ecosystem unit was, or by referring to the original photos.

More specifically, the disturbance types were identified as follows:

- **Cleared/Logged**: This disturbance type was generally easy to identify and was the most common type of disturbance encountered. The combination of cleared and logged land as a single disturbance type may have overestimated the amount of industry-based logging that had taken place since removal of tree cover could precede nonforestry related developments in forested units. Where adjacent land use indicated the purpose for which clearing had taken place, such as agriculture or urban use, the appropriate disturbance type was selected rather than simply identifying the polygon as Cleared/Logged. The boundaries of clearcuts were readily apparent, but areas of selective logging were often harder to delineate and sometimes required reference to the original photos. Areas of low volume selective logging may have been missed in some cases. The boundaries of logging were harder to delineate in polygons that were a complex of Herbaceous Terrestrial and forested units because recent clearcuts could appear on air photos to be similar to Herbaceous Terrestrial units.
- **Industrial Use**: Disturbances included in this category were gravel pits, dams, work yards, fish farms, and large buildings in rural or low density settings that were not associated with fields (although some of these 'light industry' buildings may actually have been commercial). This disturbance type might have included activities that could have been classified as other disturbance types (e.g., Urban Use) and vice versa.
- **Agriculture**: Fields that appeared to be actively tilled or mowed or were obviously planted were included in this category unless the ecosystem type was Seasonally Flooded Agricultural Field, in which case these activities were not considered to be a disturbance. This disturbance type likely included activities that could have been classified as Rural Use and vice versa.
- **Trails/Recreation**: This disturbance type included golf courses, playing fields, and trails. As noted previously, trails were likely underestimated, particularly in forested units.
- **Rural Use**: Farm buildings, fields, and pastures (nonmowed, nontilled, or nonplanted), docks, isolated houses, or houses in low density on large properties were considered to be rural use. Irrigation ponds and reservoirs were considered to be a disturbance in Wetland types but not in Seasonally Flooded Agricultural Field ecosystems. This disturbance type likely included activities that could have been classified as agriculture and vice versa.
- **Urban Use**: Suburban housing developments, malls, and office complexes were considered to be urban use. This disturbance type might have included activities that could have been classified as other disturbance types (e.g., Industrial Use) and vice versa.
- **Road(s)**: This disturbance type included all categories of roads from multi-lane highways to logging spur roads. Highway bridges were also included in this category.
- **Other**: This disturbance type category was seldom used but included airport developments, borrow pits (associated with logging activities), channels, and other human-made structures with unknown purposes.

A polygon may have been impacted by more than one type of disturbance. In such cases, the dominant disturbance was selected and the other disturbance(s) were noted in the comments field of the database.

Fragmentation

Fragmentation was considered to be patches of disturbance that were less than 0.2 ha in area, or linear disturbances that were too narrow to be digitized at 1:10,000 (e.g., roads across riparian corridors). Polygons were originally included in the SEI when fragmented if, in the opinion of the ecologist interpreting the air photos, they were still considered to be functioning, viable ecosystems or to provide adequate representation of the ecosystem type. A notation of 'Fragmented' was added to the polygons where this situation occurred. A 'fragmentation rate' (percentage of the polygon affected) assignment was begun but is not currently complete; consequently, the values stored in the 'Disturbance Fragmentation' field of the database described below should not be considered to be comprehensive.

Polygon Deletion

SEI polygons that ceased to be viable due to disturbance were marked as 'Deleted'. They were not physically deleted from the SEI but were given an attribute which stated that the polygon was no longer a valid SEI unit. The original ecosystem value was retained as an attribute to allow change statistics to be calculated. A polygon was 'deleted' if the disturbance affected the whole polygon or if any remaining intact portions were less than 0.2 ha. Small polygons were also 'deleted' if the level of fragmentation within the polygon was greater than 25% of its area. A good example of where this criterion might be applied is in areas of selective logging and extensive road and trail networks in nontreed units. Any remaining intact parts (> 0.2 ha) of a disturbed polygon were considered to be 'reduced', and thus were classed as 'remnant polygons'. In a few cases, it was necessary to revise the ecosystem interpretation for the remnant polygon if it had been part of a complex unit but now was composed of a pure type.

Wetland units were the exception to this protocol in that the original typing included wetland polygons that were less than 0.2 ha in area. This methodology was adhered to in the update; therefore, some remnant wetland polygons may be less than 0.2 ha in area.

Disturbance Comments

The disturbance 'Comments' field in the database was used to note the location of pre-existing disturbance (e.g., old roads). Comments on the location of new disturbance in fragmented polygons were provided if the situation was not immediately obvious (e.g., selective logging); otherwise, the codes for disturbance type and fragmentation percentage were considered adequate.

Modification of Database Structure

To allow temporal land use attributes to be stored, the structure of the database was updated to allow polygonal changes and attribute classifications to be tracked over time. Both the state of the SEI before adding the disturbances and the updated (2003) state of the SEI were retained in a single polygonal coverage whose attributes indicate areas that have been disturbed and the nature of the disturbance. The database modifications enable disturbance type and affected area to be mapped and quantified over time. For discussion purposes, the original SEI database is referred to as ‘Version 1’; the altered database with updated polygons is referred to as ‘Version 2’.

The process of monitoring SEI disturbance involved making additions to the existing database structure, as indicated in Table 1.

Table 1. Fields added to the Sensitive Ecosystems Inventory (SEI) data structure.

Field name	*Contents*
PARENT_ID	The polygon ID of the previously existing SEI polygon (Version 1)
REV2_ECOSYS1	Dominant or primary ecosystem type after 2003 assessment (Version 2)
REV2_ECOSYS2	Secondary ecosystem type after 2003 assessment

Table 1. Fields added to the Sensitive Ecosystems Inventory (SEI) data structure (cont'd).

Field name	*Contents*
MOD_TYPE	Type of modification made to the SEI polygon using the following codes: **N** = No change; all SEI polygons left intact after the 2003 reassessment will have this value **DD** = Deleted due to disturbance; polygons are not physically deleted from the database. This flag functionally toggles the polygon on/off based on the temporal scenario being mapped **DF** = Deleted due to fragmentation; greater than 25% of the polygon has been fragmented by disturbances that are too small to be mapped individually. Polygons are not physically deleted from the database. This flag functionally toggles the polygon on/off based on the temporal scenario being mapped **DR** = Deleted due to 'remnant assessment'; a polygon has been reduced in size due to disturbance, and the remaining intact ecosystem is deemed to be no longer viable **R** = Reduced; some portion of this polygon has been deleted due to disturbance, thus reducing the size of the intact ecosystem **F** = Fragmented; disturbance areas are too small to digitize or are spread throughout a larger polygon and cannot be differentiated **I =** Reinterpretation; a change was made in the ecosystem classification for the polygon **A** = Addition; a new Riparian ecosystem identified as part of the 2004 assessment Note that the codes A, R, F, and I may be used in combination (e.g., 'RF' indicates Reduced and Fragmented; a remaining portion of an ecosystem after disturbed areas are deleted which has also been fragmented by smaller disturbances).
DIST_TYPE	Disturbance type which caused the deletion of the polygon or portion of the polygon (see 'Methodology' section for detailed discussion of disturbance types) • Trails/Recreation • Road(s) • Urban use • Rural use • Agriculture • Industrial Use • Cleared/Logged (selectively or completely) • Other (will be specified)
DIST_DESC	Disturbance description; used when disturbance type (DIST_TYPE) is 'Other' or when some explanation is necessary to describe complex or pre-existing disturbance
DIST_FRAG	Disturbance fragmentation; when disturbance areas are too small to digitize, an existing SEI polygon is classified with the degree of fragmentation • < 6% • 6–25% • > 25%; polygon will be assigned a 'DF' (deleted) attribute in the MOD_TYPE field if disturbance exceeds 25%

Table 1. Fields added to the Sensitive Ecosystems Inventory (SEI) data structure (cont'd).

Field name	*Contents*
REV2_ PHOTO	The 'quad' number on which the polygon is delineated (e.g., 92F0662)
REV2_SCALE	The scale of the air photo(s) on which the polygon is delineated; for 2002 imagery, the scale is 1:10,000
REV2_DATE	Date of the air photo(s) used for delineation. For 2002 imagery other than Lasqueti Island, this date is 'July–August 2002'. For Lasqueti Island imagery, the date is '2002'

Existing SEI polygon attributes were updated, where necessary, during the airphoto interpretation process to reflect the fact that modifications had been made. This affected the following fields:

POLYGON_ID	When polygons are divided (e.g., when a portion is deleted due to disturbance), the two new polygons will have modified polygon identifiers. Each new polygon will have a '-R1', '-R2', etc., appended to the polygon identifier. For example, if a polygon with an identifier of 'S0035' is split, the two resulting polygons would have identifiers 'S0035-R1' and 'S0035-R2'.
HECTARES	The total area of the polygon in hectares, calculated digitally

Digitizing Polygon Changes

Updating the polygon boundaries involved the following:

- The polygons were digitized on screen in ArcMap (version 8.3; ESRI) using the digital orthophoto as a backdrop to define the revised spatial extents of the polygons being updated.
- On-screen digitizing was performed with a display scale of 1:10,000.
- Resulting polygons had to be at least 0.2 ha in size (with the exception of wetlands). Areas of disturbance less than 0.2 ha were noted in the database by updating the 'Disturbance Fragmentation' field for the polygon to indicate the percent disturbance. Remnant polygons under 0.2 ha were not retained.
- In unusual cases where problems were encountered with either boundary definition or attribute assignment, the identifier(s) for polygons in question were noted for review by the SEI Technical Advisory Group.

Figure 1 illustrates an example of a straightforward polygon disturbance. More often, however, situations were encountered which produced a much larger number of new polygons. Some large second-growth polygons, for example, were divided into more than 40 new polygons.

Figure 2 shows the resulting revised polygons for a single original SEI polygon. In this case, 17 new polygons resulted from the disturbances found within the original polygon.

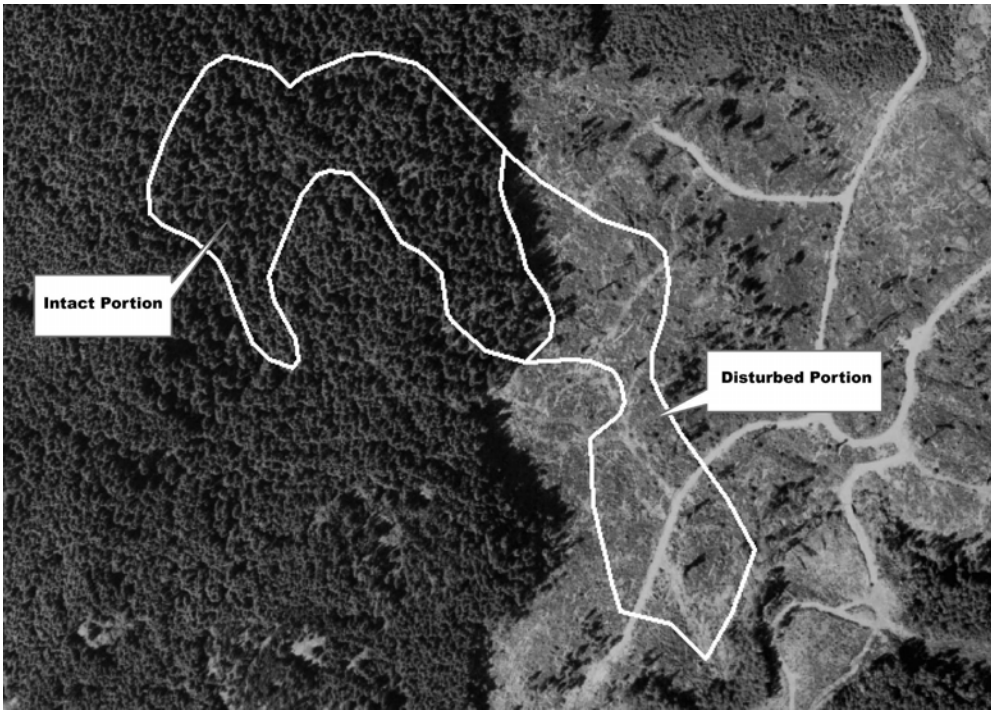

Figure 1. Example of a simple modification of an original SEI polygon.

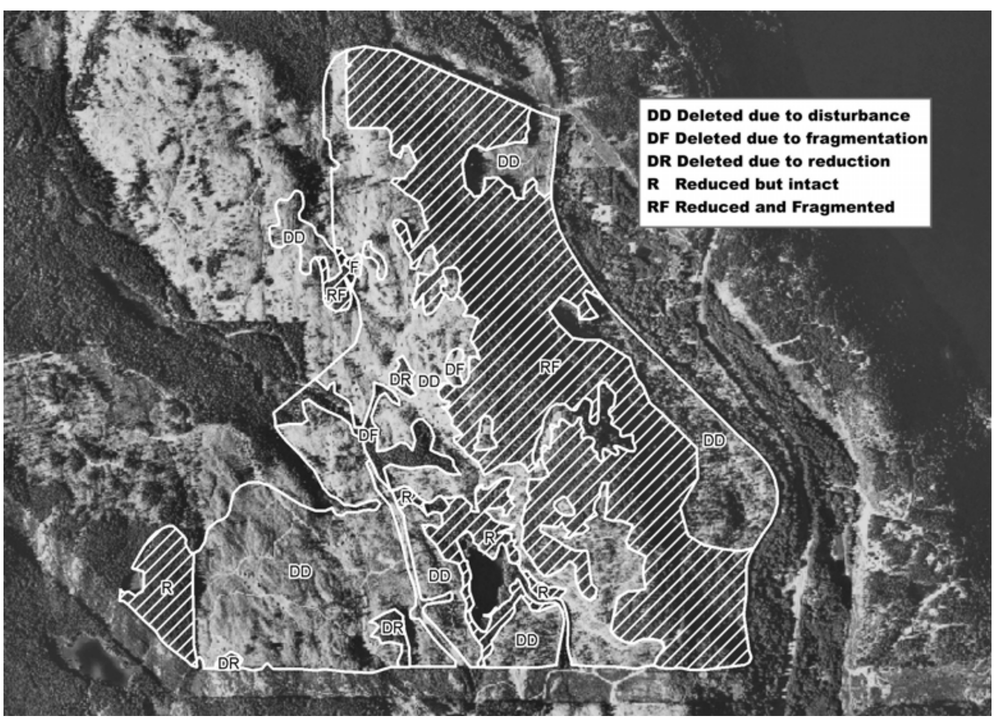

Figure 2. Example of a complex modification of an original SEI polygon.

Concurrent Projects

Concurrent with the work described in this report, two tasks (remnant assessment and reevaluation of major riparian corridors and other areas) were performed which affected the completed SEI database. A report containing a full description of the scope, methods, and results for these tasks is being prepared.

Remnant Assessment

The remnant assessment process reviewed each SEI polygon that was reduced by disturbance to ensure it remained as a viable ecosystem. Polygons that were considered to be nonviable due to size, shape, or neighboring disturbances were flagged in the database as 'Deleted due to Remnant Assessment' (DR) (Table 1), and were not considered to be an SEI unit.

Reevaluation of Major Riparian Corridors and Other Areas

The original SEI mapping of riparian ecosystems avoided areas that showed recent human disturbance; however, the linear corridors formed by riparian ecosystems comprise a continuous ecological unit with very high conservation values. Major riparian corridors were reevaluated to reflect these values and to encourage land use decisions that consider entire riparian ecosystems as well as the larger watersheds of which they are a part.

The riparian reevaluation added 256 new Riparian polygons in major corridors such as the Cowichan, Chemainus, Koksilah, Nanaimo, Englishman, Little Qualicum, Puntledge, Quinsam, Oyster, Tsolum, and Trent River valleys. Where riparian ecosystems were identified within an existing nonriparian polygon, the Riparian ecosystem type was added.

For consistency, the new air photo interpretation was conducted at a scale of 1:10,000. Since this scale was larger than some of the original air photos (many of which were between 1:15,000 and 1:20,000), more accurate interpretation was possible; however, budget and time constraints did not allow for a comprehensive reinterpretation of the entire study area at this scale.

Where previously unidentified SEI ecosystems were noticed during the riparian reevaluation, new polygons were added. Approximately 25 nonriparian polygons were identified, representing Older Forest, Wetland, and Seasonally Flooded Agricultural Field. A few Older Second Growth Forest polygons were also identified where they occurred adjacent to a sensitive ecosystem.

Disturbance Mapping Results

This section summaries the change in the SEI during the period between the original inventory (1984–1992) and 2002. Loss of ecosystem area was calculated using those polygons identified as 'Deleted' (see the description of codes 'DD', 'DR', and 'DF' in Table 1). Loss due to fragmentation was not calculated due to the limitations discussed below in the 'Limitations' section.

Where loss by ecosystem was quantified, as with the original SEI summary of results (Ward et al. 1998), the primary ecosystem alone was used. This tended to slightly underestimate ecosystem loss since an ecosystem may have been present as a secondary ecosystem in a complex polygon, and thus would not be quantified in the summaries that follow.

Loss proportions were calculated using the original (1997) SEI area in order to maintain consistency; therefore, the area occupied by new polygons created during the riparian reevaluation (see above) was not considered in the area loss calculations summarized below.

Table 2 summarizes the loss of sensitive ecosystems and other important ecosystems by region. Loss of sensitive ecosystem area was relatively low in all regions, with the greatest loss occurring in the Nanaimo region. Loss of other important ecosystem area was due primarily to the harvest of Older Second Growth Forest, and was greatest in the Comox-Strathcona and Nanaimo regions. The loss of other important ecosystems in these two regions comprised the majority (53%) of all loss to SEI area, primarily as loss of Older Second Growth Forest ecosystems. The high loss of Older Second Growth Forest is of particular concern because much of the logging that has taken place in the last several years has been in preparation for conversion of the land to other uses, such as rural subdivision. This land conversion (rather than logging and subsequent regeneration) results in permanent loss of forest ecosystems. This phenomenon, and the fact that older forests are virtually extirpated on the east coast of Vancouver Island and the Gulf Islands, make maturing stands of second-growth forest increasingly valuable as recruitment areas.

Table 2. Loss of SEI ecosystems by region.

	Sensitive ecosystems			*Other important ecosystems*		
SEI region	*original SEI (ha)*	*loss (ha)*	*loss (%)*	*original SEI (ha)*	*loss (ha)*	*loss (%)*
Capital	8500.5	140.2	1.6%	11080.0	865.9	7.8%
Comox-Strathcona	8684.8	483.6	5.6%	9085.6	2649.3	29.2%
Cowichan	4416.9	205.5	4.7%	4066.5	306.4	7.5%
Islands	5128.8	223.6	4.4%	14751.8	1539.3	10.4%
Nanaimo	5779.2	411.3	7.1%	8685.3	2017.5	23.2%
Total	32510.1	1464.2	4.5%	47669.3	7378.4	15.5%

Table 3 shows the loss to the SEI by ecosystem type. Again, loss was dominated by the harvest of Older Second Growth Forest. Loss of the Older Forest ecosystem type accounted for 62% of the total loss of sensitive ecosystems.

Table 3. Sensitive Ecosystems Inventory (SEI) loss by ecosystem type.

	Original SEI area (ha)	*Loss (ha)*	*Loss (%)*
Sensitive ecosystem type			
Coastal Bluff	1042.9	1.2	0.1%
Terrestrial Herbaceous	4242.9	24.4	0.6%
Older Forest	10613.8	915.4	8.6%
Riparian	6712.3	310.8	4.6%
Sparsely Vegetated	325.6	4.5	1.4%
Woodland	2518.7	66.1	2.6%
Wetland	7053.9	141.8	2.0%
Total loss of sensitive ecosystem types	32510.1	1464.2	4.5%
Other important ecosystem types			
Seasonally Flooded Agricultural Field	2778.6	15.3	0.5%
Older Second Growth Forest	44890.6	7363.1	16.4%
Total loss of other important ecosystem types	47669.2	7378.4	15.5%
Total SEI loss	80179.3	8842.5	11.0%

Table 4 summarizes the SEI loss by disturbance type and region. Not surprisingly, the dominant disturbance type was Cleared/Logged, which occurred primarily in the Comox-Strathcona and Nanaimo regions. This reflects the significant harvest of Older Second Growth Forest and Older Forest ecosystem types.

Table 4. Sensitive Ecosystems Inventory (SEI) loss by disturbance type and region.

		Loss (ha) by region					
Disturbance type	*Ecosystem*	*Capital*	*Comox-Strathcona*	*Cowichan*	*Islands*	*Nanaimo*	*Total*
Agriculture	Sensitive	0.0	4.4	3.1	4.1	16.8	28.4
	Other	0.0	9.9	0.0	3.3	0.0	13.2
Cleared/Logged	Sensitive	89.7	376.5	168.3	202.6	338.8	1175.9
	Other	794.8	2329.5	299.4	1417.1	1992.4	6833.3
Industrial Use	Sensitive	3.2	6.1	0.6	0.0	0.2	10.2
	Other	2.0	0.0	0.4	0.0	0.0	2.4
Other	Sensitive	0.0	0.7	0.0	0.0	0.0	0.7
	Other	0.0	0.0	0.0	0.0	0.0	0.0
Road(s)	Sensitive	1.9	34.5	0.0	1.2	31.2	68.8
	Other	0.0	234.6	0.0	3.4	17.6	255.6

Table 4. Sensitive Ecosystems Inventory (SEI) loss by disturbance type and region (cont'd).

		Loss (ha) by region					
Disturbance type	*Ecosystem*	*Capital*	*Comox-Strathcona*	*Cowichan*	*Islands*	*Nanaimo*	*Total*
Rural Use	Sensitive	21.1	43.0	17.0	12.8	14.9	108.8
	Other	40.8	28.3	5.0	113.2	7.5	194.7
Trails/Recreation	Sensitive	0.0	0.0	0.0	1.4	0.4	1.8
	Other	6.9	0.0	0.0	2.3	0.0	9.2
Urban Use	Sensitive	24.2	18.3	16.5	1.6	8.9	69.5
	Other	21.3	47.0	1.6	0.0	0.0	70.0

Table 5 summarizes the SEI loss by ecosystem type and disturbance type for the entire study area.

Table 5. Sensitive Ecosystems Inventory (SEI) loss by disturbance type and primary ecosystem type for the entire study area.

	Loss (ha) by ecosystem type										
	sensitive ecosystems								*other important ecosystems*		
Disturbance type	*Coastal Bluff*	*Terrestrial Herbaceous*	*Older Forest*	*Riparian*	*Woodland*	*Wetland*	*Sparsely Vegetated*	*Total*	*Seasonally Flooded Agricultural Field*	*Older Second Growth Forest*	*Total*
Agriculture	0.0	0.0	0.6	2.5	0.0	25.4	0.0	28.4	0.9	12.2	13.2
Cleared/Logged	0.0	9.9	866.1	249.1	17.3	33.6	0.0	1176.0	0.0	6833.3	6833.3
Industrial Use	0.0	4.1	1.5	2.6	0.6	1.4	0.0	10.2	0.4	2.0	2.4
Other	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0
Road(s)	0.0	1.2	26.2	27.9	2.4	11.2	0.0	68.8	1.7	254.0	255.6
Rural Use	0.5	0.0	14.5	15.8	20.2	54.8	3.0	108.8	2.7	191.9	194.7
Trails/Recreation	0.0	0.4	0.0	0.0	0.0	1.4	0.0	1.8	2.3	6.9	9.2
Urban Use	0.7	8.2	6.6	12.9	25.5	14.1	1.5	69.5	7.2	62.8	70.0
Total	1.2	24.4	915.4	310.8	66.1	141.8	4.5	1464.2	15.3	7363.1	7378.4

Limitations

In a small number of cases, photo quality issues or missing air photos prevented rigorous evaluation of polygon disturbance. Where the new imagery was missing or of poor quality, 'No Change' was assumed, and the fact that a thorough assessment was not possible was noted in the disturbance comments for that polygon. This was the case for 22 polygons. Where the original photo was unavailable or of poor quality, it was impossible to determine if disturbance present in the 2002 imagery was also present when the polygon was originally delineated. Assumptions were made regarding the state of the polygon in 1992 based on the nature, appearance, and extent of the disturbance in 2002. In most cases, a conservative approach was taken and the assumption was made that the disturbance was new. Polygons were then categorized as ‘Fragmented’ or ‘Disturbed’, as appropriate. Polygons with small encroaching disturbances (such as trails or rural houses) may have been assumed to be ‘No Change’. A total of 54 polygons were assessed in the absence of original photos.

The assessment of disturbance was done with two very distinct imagery sets. Most of the study area was assessed using black and white 1:10,000 scale imagery, but a small area surrounding and including Lasqueti Island was assessed using color imagery. It is possible that the polygons in the Lasqueti Island area were assessed more rigorously with respect to loss from fragmentation, as houses and cabins in forested areas were more readily detectable with the color imagery; however, with respect to other more common and obvious forms of disturbance, such as clearcut logging, there were no perceived differences in identification ability between the two image types.

Where the disturbance areas were too small to be digitized or were spread throughout a larger polygon, the polygon was classified with the degree of fragmentation (< 6%, 6–25%), and comments were added regarding the type and extent of disturbance. No redigitizing of these polygons was done. Polygons with > 25% fragmentation were marked for deletion, and thus were included in the results figures; however, because polygons showing < 6% or 6–25% fragmentation were not redigitized, they were not included in the results figures. The 1521 fragmented polygons comprised almost 48% of the total area of SEI polygons. Although we cannot make concrete statements regarding the area lost due to fragmentation, the fact that almost half of the SEI polygon area had some level of fragmentation suggests there has been a significant impact. These fragmentation figures help illustrate the incremental but escalating degradation and loss of remaining natural areas. The area of disturbance may be relatively small, but the cumulative effects of incremental ecosystem loss must be considered.

Conclusions

Ecosystem mapping provides a valuable land use planning tool when used to establish benchmark data against which changes to the landscape over time can be measured. When ecosystem mapping data is reevaluated at five- to ten-year intervals, compelling data on ecosystem losses and trends can be produced. This information helps build the case for conservation of remaining natural ecosystems and facilitates the development of strategic conservation plans.

The results of this mapping project raise concerns over the rate and extent at which rare and ecologically sensitive ecosystems continue to be altered or lost in the east Vancouver Island and Gulf Islands region. The results make it clear that a site-specific, ad hoc approach to land use planning driven largely by development applications is resulting in widespread and increasing loss of natural ecosystems. A more strategic approach to land use planning is clearly needed if we are to protect the region's biological diversity.

It is critical that all possible land use options be evaluated before initiating any further changes to sensitive ecosystems. It is hoped that this project and its map products will not only raise awareness of escalating ecosystem loss on the east coast of Vancouver Island and the Gulf Islands, but will also facilitate the development of comprehensive conservation strategies to ensure the protection of the remaining natural ecosystems through a landscape-level ecosystem approach to land use planning.

A pilot biodiversity conservation strategy is underway in the Greater Vancouver Regional District, and local and regional biodiversity conservation strategies are being developed in other areas of British Columbia. Sensitive Ecosystems Inventory mapping has been completed for the Sunshine Coast, Central Okanagan, and part of the North Okanagan in addition to east Vancouver Island and Gulf Islands. These mapping projects provide valuable scientific data for use in the development of conservation strategies. SEI monitoring projects over the next five to ten years will provide a more conclusive evaluation of whether SEI projects have made an important difference to the landscape.

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