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An Automated Assessment of Representation to Measure Ecological Representation by Protected Areas in Canada

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World Wildlife Fund Canada,

Technology Transfer Workshop, Edmonton, May 17-18, 2005





Presentation Outline

A) Background

- Current applications
- Ecological background and rationale for a national gap analysis

B) Assessment of Representation Methods

Representation criteria

Tembec example

C) The AoR 9 Extension

- Current Status
- Next steps



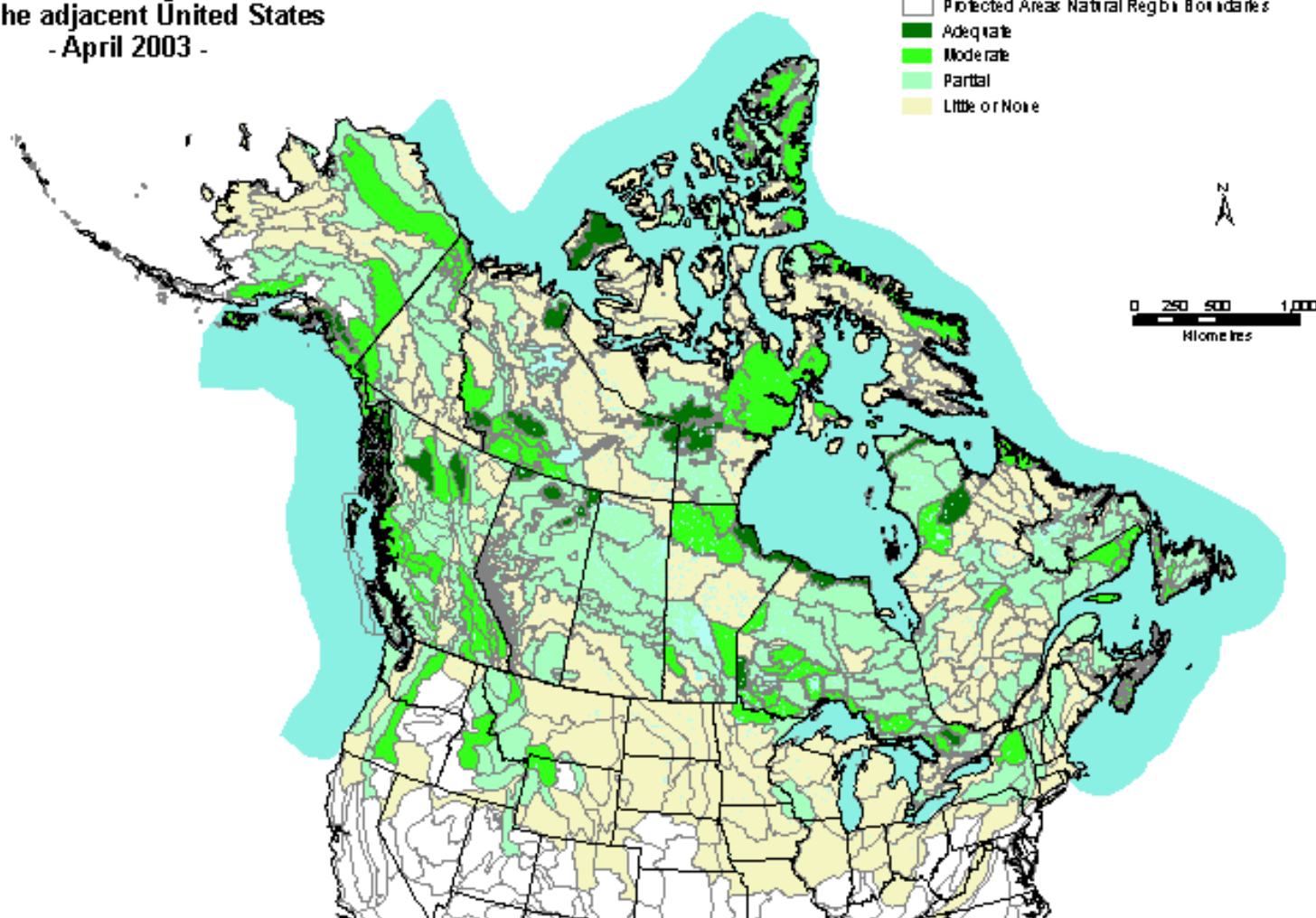


Nature Audit 2003

Level of Ecological Representation of
Terrestrial Natural Regions in Canada
and the adjacent United States
- April 2003 -

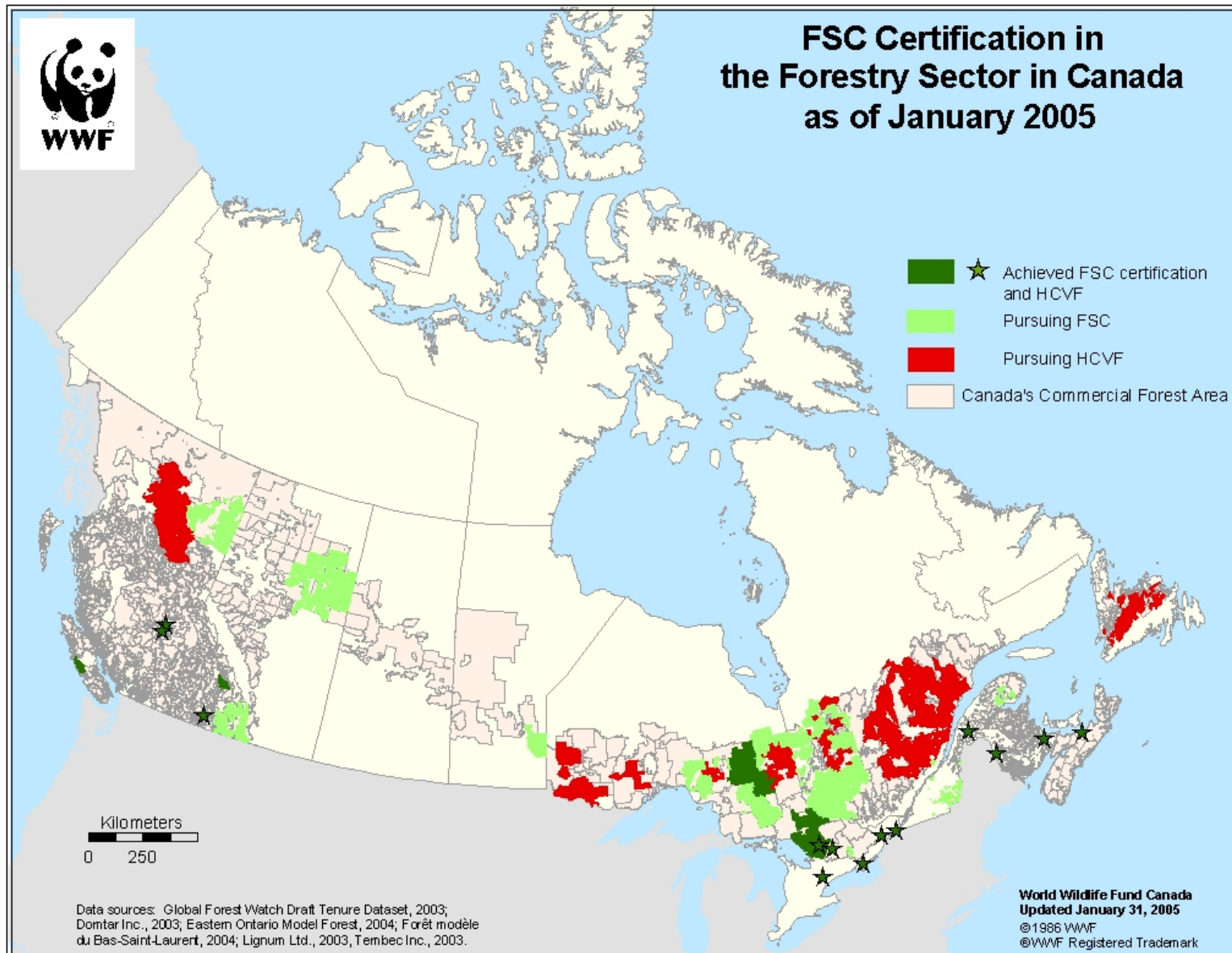
Level of Natural Region Representation

- Protected Areas Natural Region Boundaries
- Adequate
- Moderate
- Partial
- Little or None





Current application of the AoR





Ecological Representation

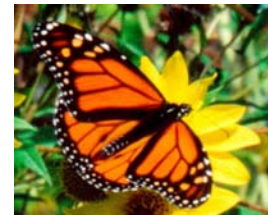
- Reserves must be large enough to incorporate functional natural disturbance regimes in order to accommodate seral stage diversity.
- Representation does not seek to preserve characteristic types of communities so much as to maintain the full spectrum of community variation along environmental gradients.

(Noss 1995)

Guiding Principles

- Maintain viable populations
- Sustain ecological processes

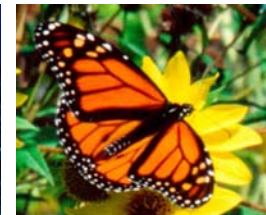
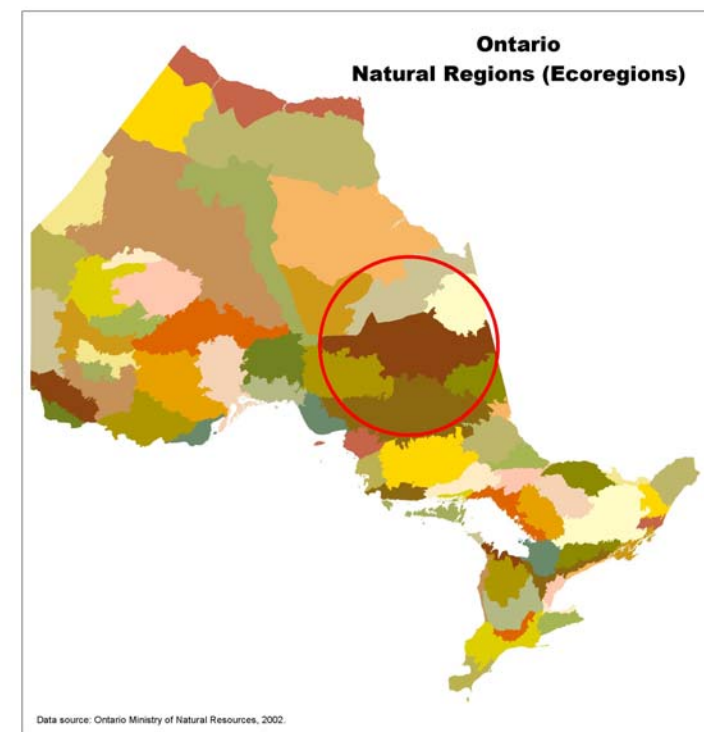
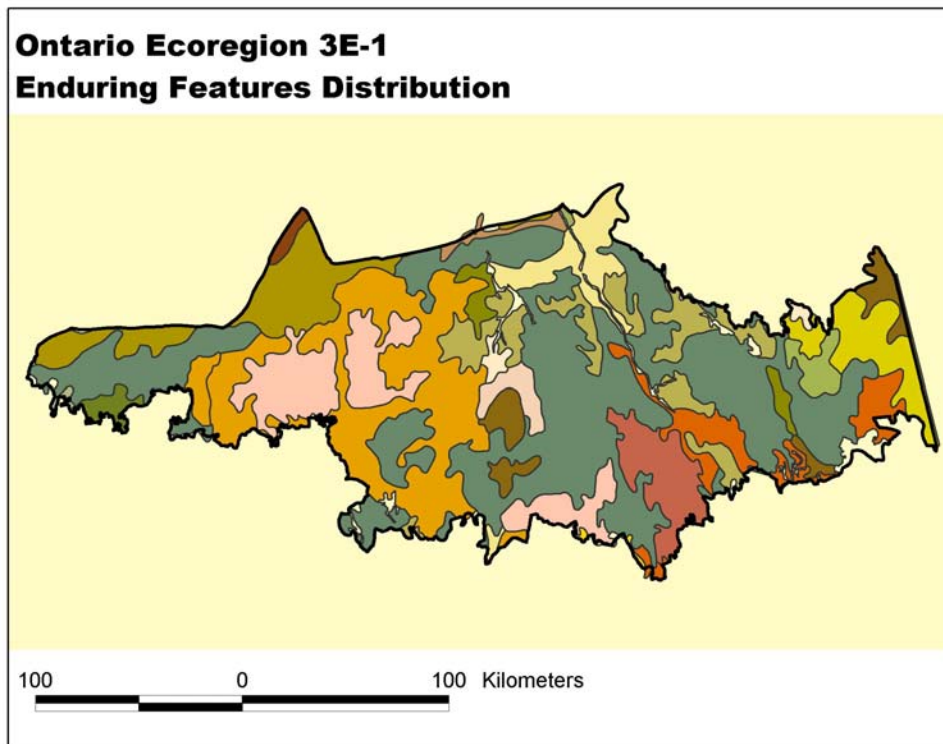
(Noss 1992)





Enduring Features and Natural Regions

- Spatial unit for measuring representation, based on landform and climate.





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Representation Criteria

Criteria used to assess the level of ecological representation by protected areas per enduring feature:

- 1) Size guidelines
- 2) Connectivity/Adjacency
- 3) Environmental gradients
- 4) Important physical habitat types (shorelines)
- 5) Habitat quality





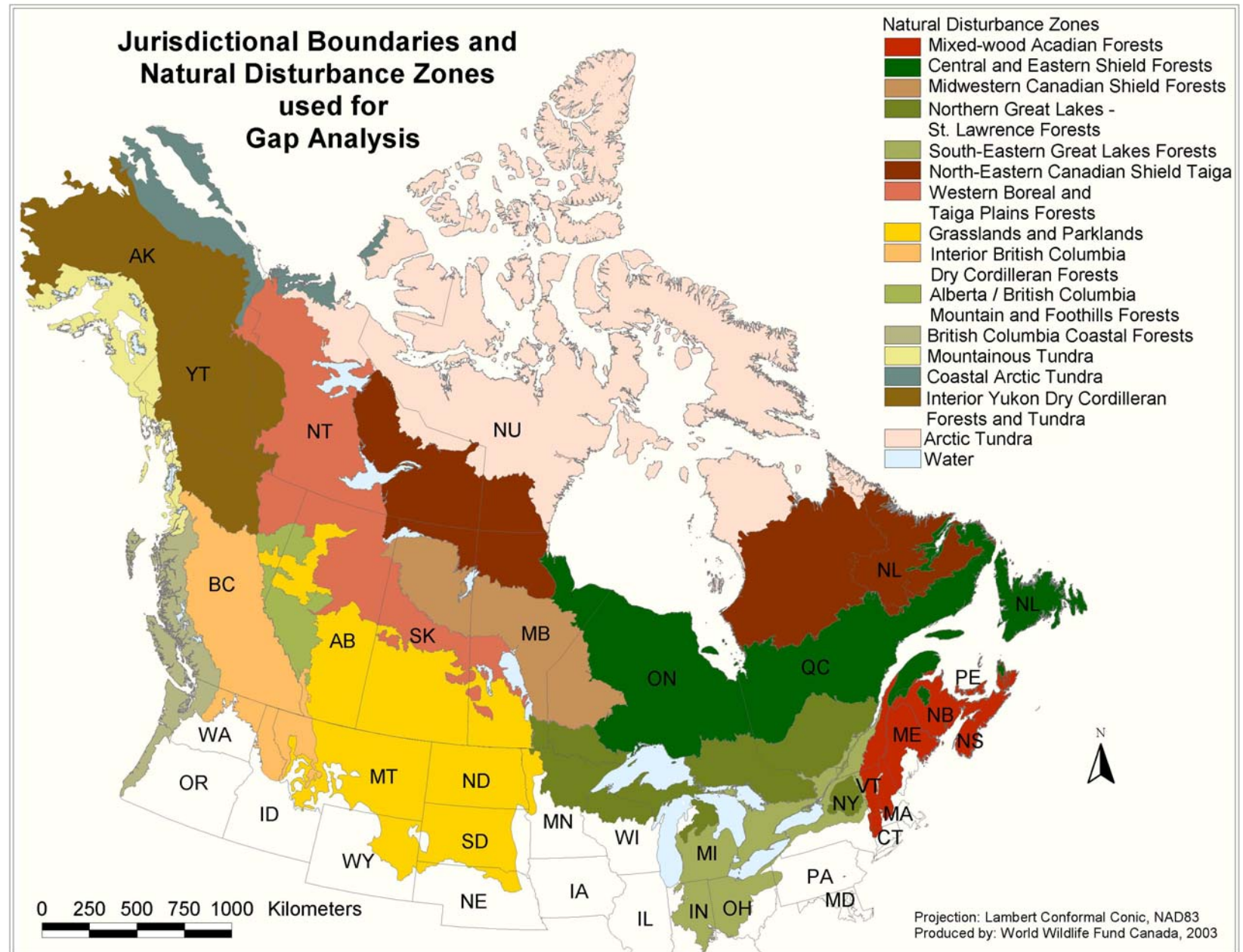
Size Guidelines – Disturbance Zone

- Size guidelines developed for each Disturbance zone in Canada
- Disturbance zones developed by grouping natural regions exhibiting similar disturbance patterns.





Disturbance Zones





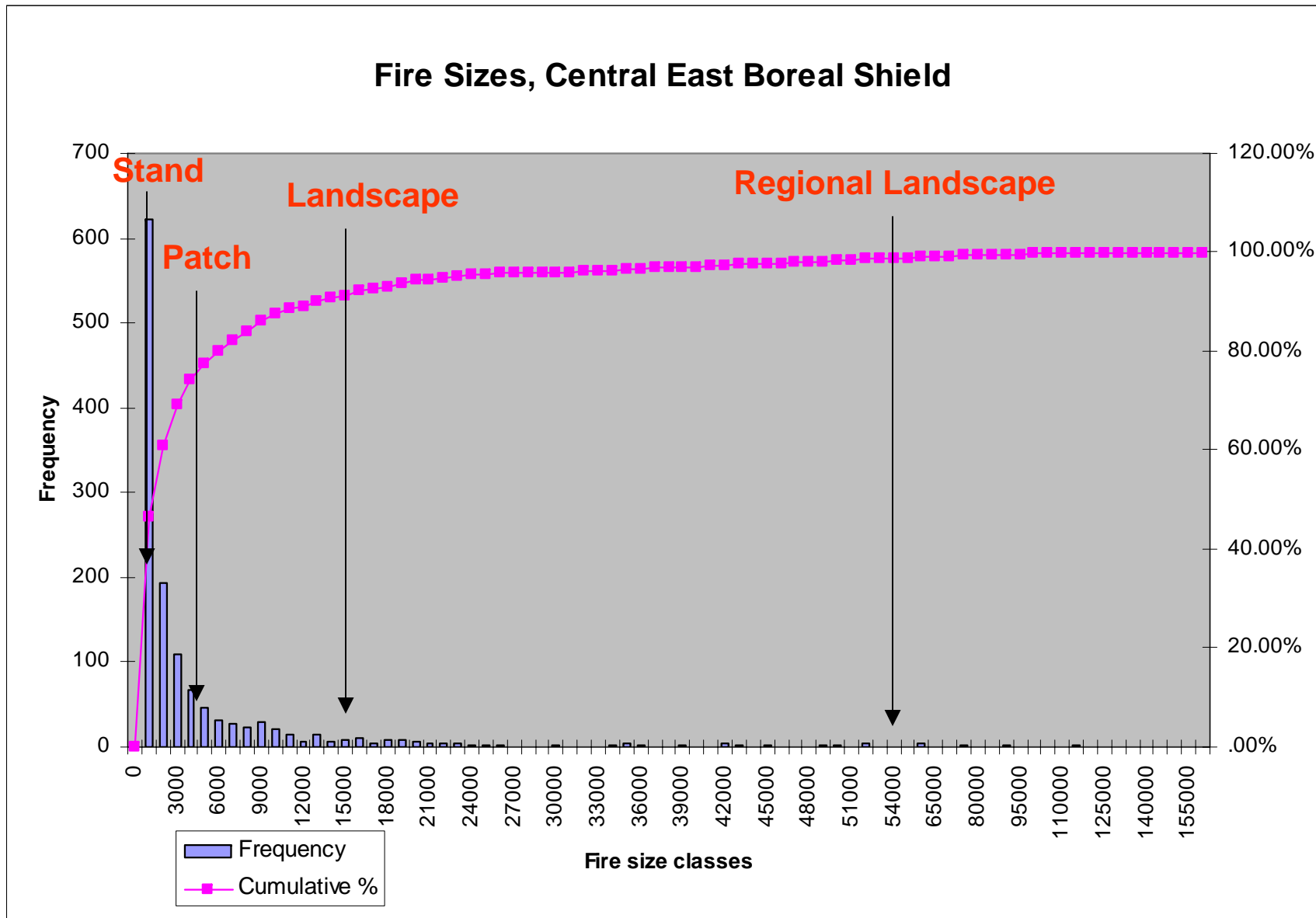
1) Protected Area Size Guidelines

- To determine the ecological size thresholds, reference to the guiding principles:
 - Sustaining ecological processes;
 - Maintaining viable populations of focal species
- Data used:
 - Stock's national fire database (2002)
 - Other natural disturbance information
 - Faunal habitat requirements.





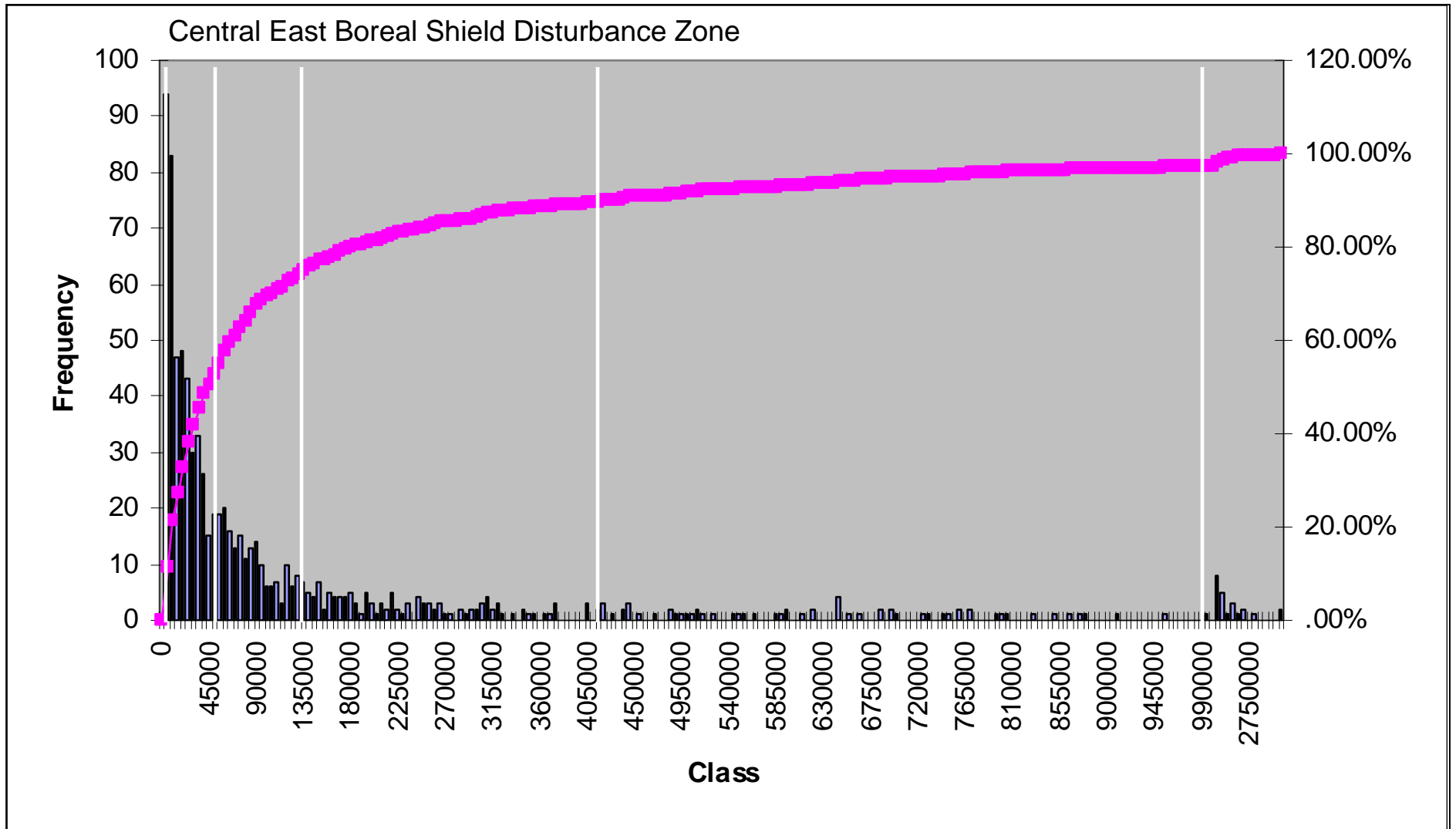
Size Guidelines – Fire Size Classes





Size Guidelines

– Enduring Feature Size Distribution





Size Guidelines

- In AoR9, log-log equations developed by matching the enduring feature size classes and protected area classes.

– *Refer to Central Boreal East spreadsheet*





Size Guidelines by Disturbance Zone - Ecosystem.mdb

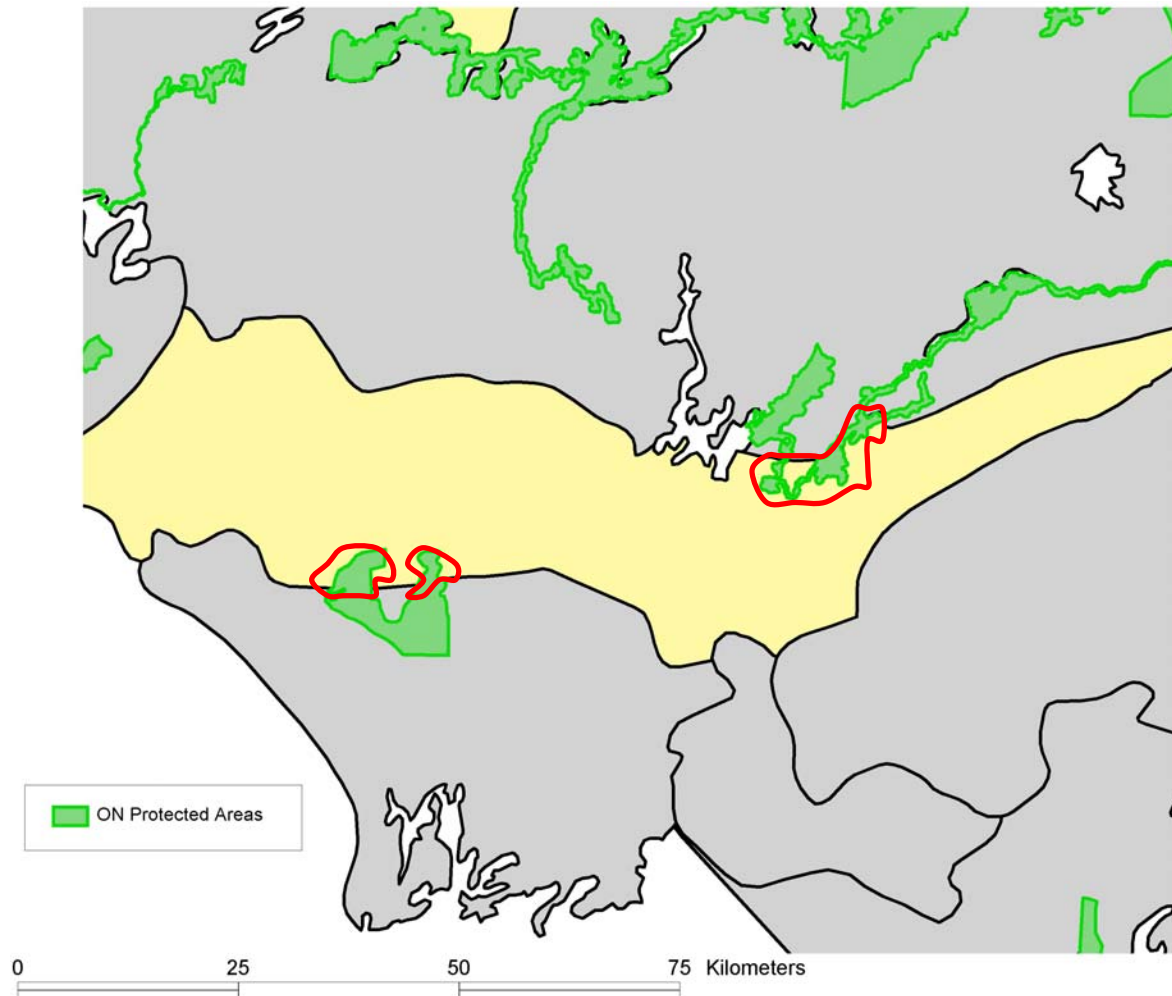
ecosystem : Table							
	ID	X	INTERCEPT	EQUATION	SYSTEM	TYPE	INTEGRITY
	31	0.904	-0.3583	$Y = 0.904X - 0.3583$	1 - Mixed-wood Acadian Forests - Fire	Log	50000
	32	0.8783	-0.246	$Y = 0.8783X - 0.246$	2 - Central East Shield - Fire	Log	100000
	33	0.7888	0.2503	$Y = 0.7888X + 0.2503$	3 - Midwestern Canadian Shield Forests - Fire	Log	150000
	34	0.8762	-0.2921	$Y = 0.8762X - 0.2921$	4 - Northern Great Lakes - St. Lawrence Forests - Fire	Log	60000
	35	0.8935	-0.4303	$Y = 0.8935X - 0.4303$	5 - South-Eastern Great Lakes Forests - Fire	Log	20000
	36	0.8024	0.2775	$Y = 0.8024X + 0.2775$	6 - North-Eastern Canadian Shield Taiga - Fire	Log	200000
	37	0.8343	0.2251	$Y = 0.8343X + 0.2251$	7 - Western Boreal and Taiga Plains Forests - Fire	Log	250000
	38	0.9291	-0.5495	$Y = 0.9291X - 0.5495$	8 - Grasslands and Parklands - Fire	Log	75000
	39	0.9287	-0.3299	$Y = 0.9287X - 0.3299$	9 - Interior British Columbia Dry Cordilleran Forests - Fire	Log	50000
	40	0.9789	-0.5508	$Y = 0.9789X - 0.5508$	10 - Alberta British Columbia Mountain and Foothills Forests - Fire	Log	100000
	41	0.862	-0.0822	$Y = 0.862X - 0.0822$	11 - British Columbia Coastal Forests - Windthrow, Hydrological Processes	Log	50000
	42	0.8081	0.187	$Y = 0.8081X + 0.187$	12 - Mountainous Tundra - Fire	Log	150000
	43	0.8081	0.187	$Y = 0.8081X + 0.187$	13 - Coastal Arctic Tundra - Fire	Log	200000
	44	0.8081	0.187	$Y = 0.8081X + 0.187$	14 - Interior Yukon Dry Cordilleran Forests and Tundra - Fire	Log	150000
	45	0.8024	0.2775	$Y = 0.8024X + 0.2775$	15 - Arctic Tundra - Fire	Log	200000
	46	0.3	0	$Y = 0.3X$	30% representation	Linear	50000
	47	0.5	0	$Y = 0.5X$	50% representation	Linear	50000
							0

Record: 18 of 18





Protected Area Size Criteria

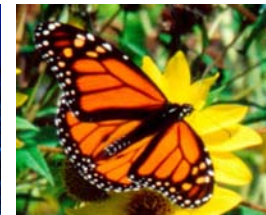


Size Score A assigned to EF if
**Largest Contiguous Block
(BLOCKHA) within the EF:**

<u>THRESHOLD</u>	<u>SCORE</u>
> 95% of recommended size	4
> 75% of recommended size	3
> 50% of recommended size	2
> 25% of recommended size	1
< 25% of recommended size and > 200 ha.	0.5

If Size Score A \leq 4, Size Score B
**assigned to EF if Total Protected
Area (PROTHA) within the EF:**

<u>THRESHOLD</u>	<u>SCORE</u>
> 95% of recommended size	1
> 50% of recommended size	0.5





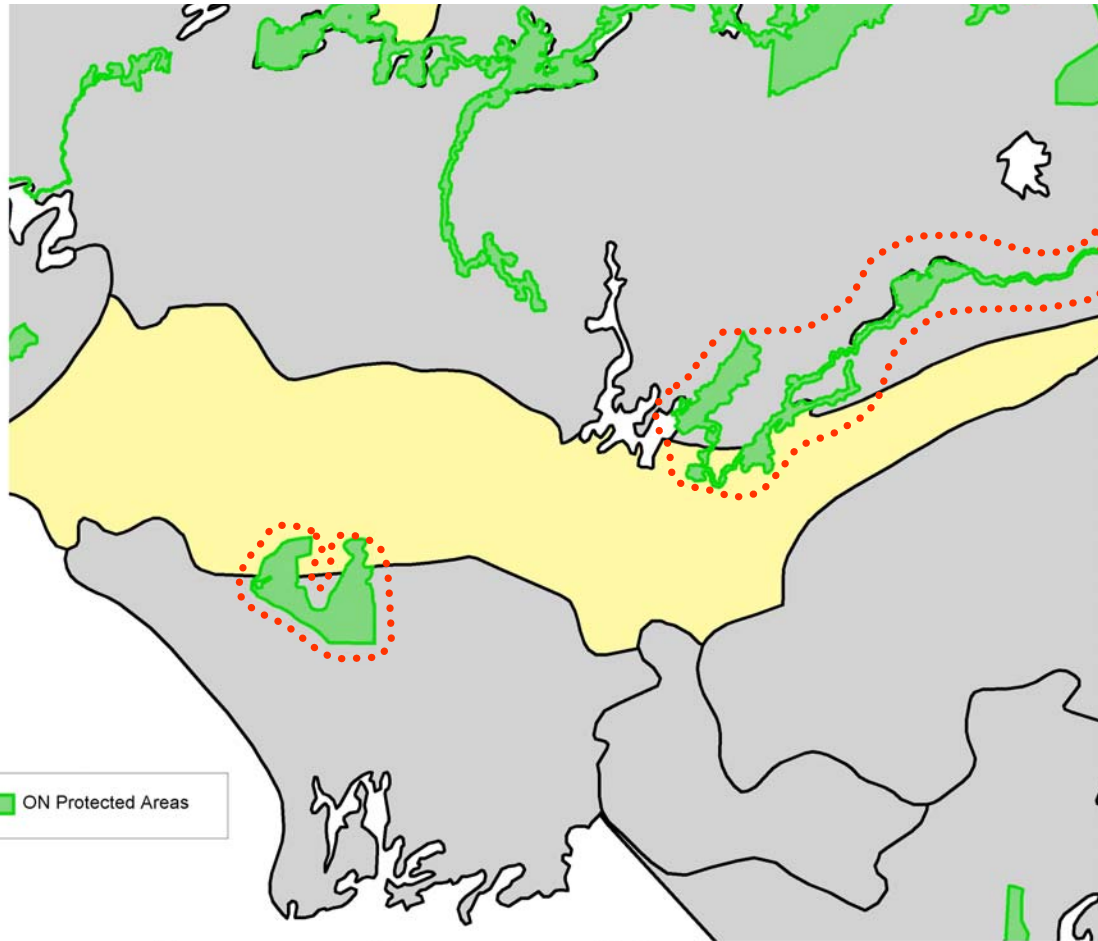
2) Connectivity Criterion and Values

- Connectivity criterion assesses the largest overlapping protected area complex on the enduring feature against an **ecological integrity** value (“*Connectivity Value*”).
- One Connectivity Value per disturbance zone
- Developed based on:
 - Largest protected area size associated with largest enduring feature
 - Regional landscape scale fire disturbance
 - Focal species area requirements.





Connectivity Criterion – Central East Boreal Shield



Size Score C assigned to EF if the
Largest Protected Area Complex
(TCMPLX) overlapping on the EF:

<u>THRESHOLD</u>	<u>SCORE</u>
> 200 ha within EF and ≥ 75% of recommended “Connectivity Value”	1
> 200 ha within EF and ≥ 25% of recommended “Connectivity Value”	0.5

Connectivity Value (i.e. 100,000 ha)
is based on:

- largest enduring feature class
- short term persistence for
wolf and caribou.





3) Environmental Gradients Criterion

- Use of digital elevation model;
- Surrogate for capturing habitat or community variability within the enduring feature;
- Elevation variability within the protected portion of the enduring feature is assessed against that of the entire feature.
- Student *t-test* assessment method:
 - Results too restrictive; scores too strict





Environmental Gradients Criterion

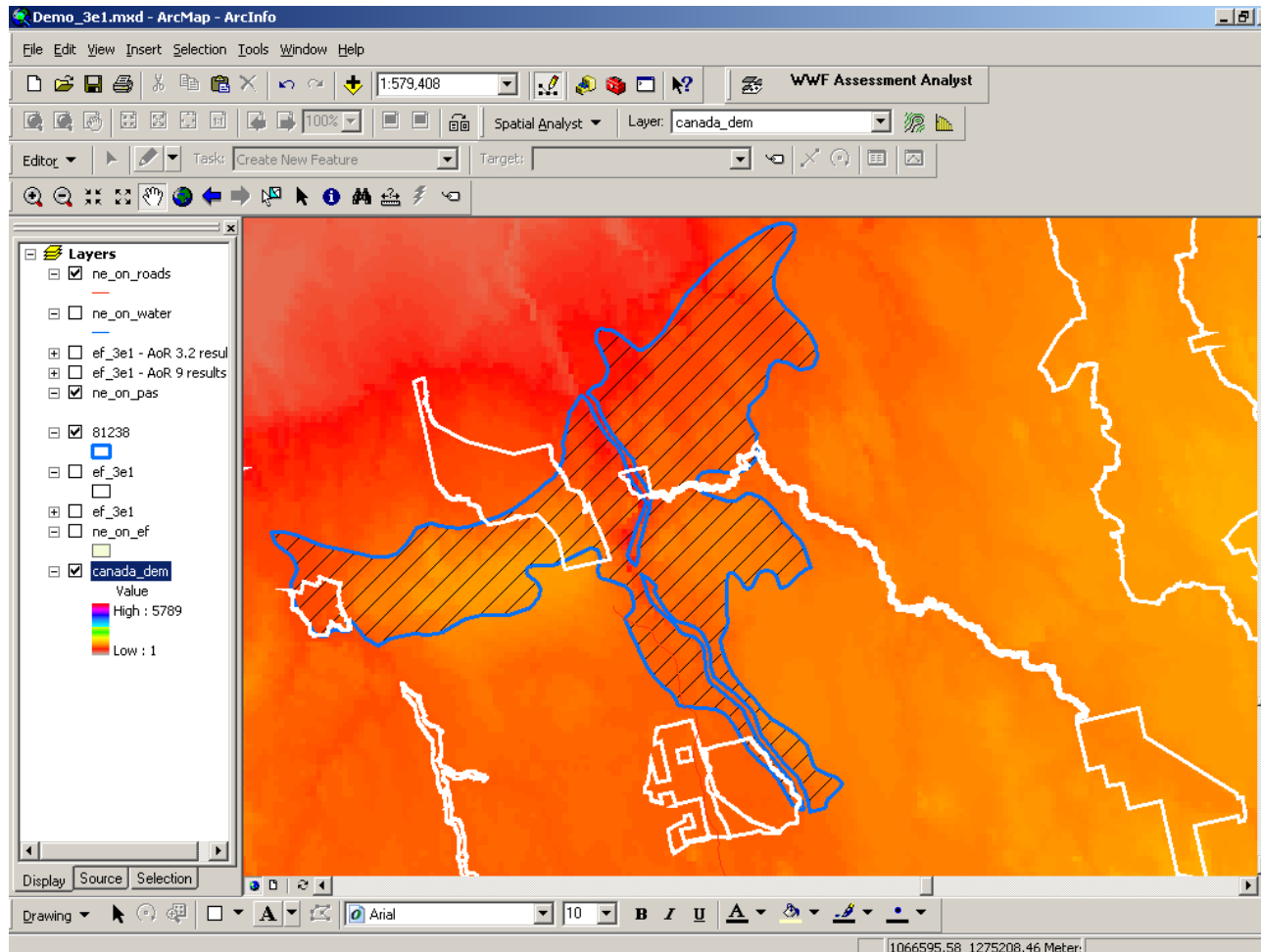
- Replaced Student t-test with a “modified variance” statistic (method not yet built in):
 - to compare the elevation range of the protected portion to that of the entire enduring feature.
 - Calculate difference in mean elevation values
= **MEANDIFF**
 - Calculate the average standard deviation
= **AVG(PSTD,ESTD)**
 - Calculate proportion of MEANDIFF over the AVG STD:

$$\text{MODVAR} = \text{MEANDIFF} / \text{AVG(PSTD,ESTD)}$$





Environmental Gradients



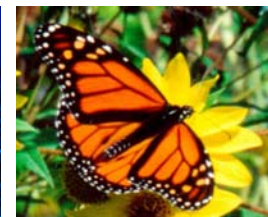
Environmental Gradients

Score assigned to EF if
protected portion:

<u>THRESHOLD</u>	<u>SCORE</u>
>200 ha within EF and MODVAR \leq 50%	1
> 200 ha within EF and MODVAR \leq 75%	0.5

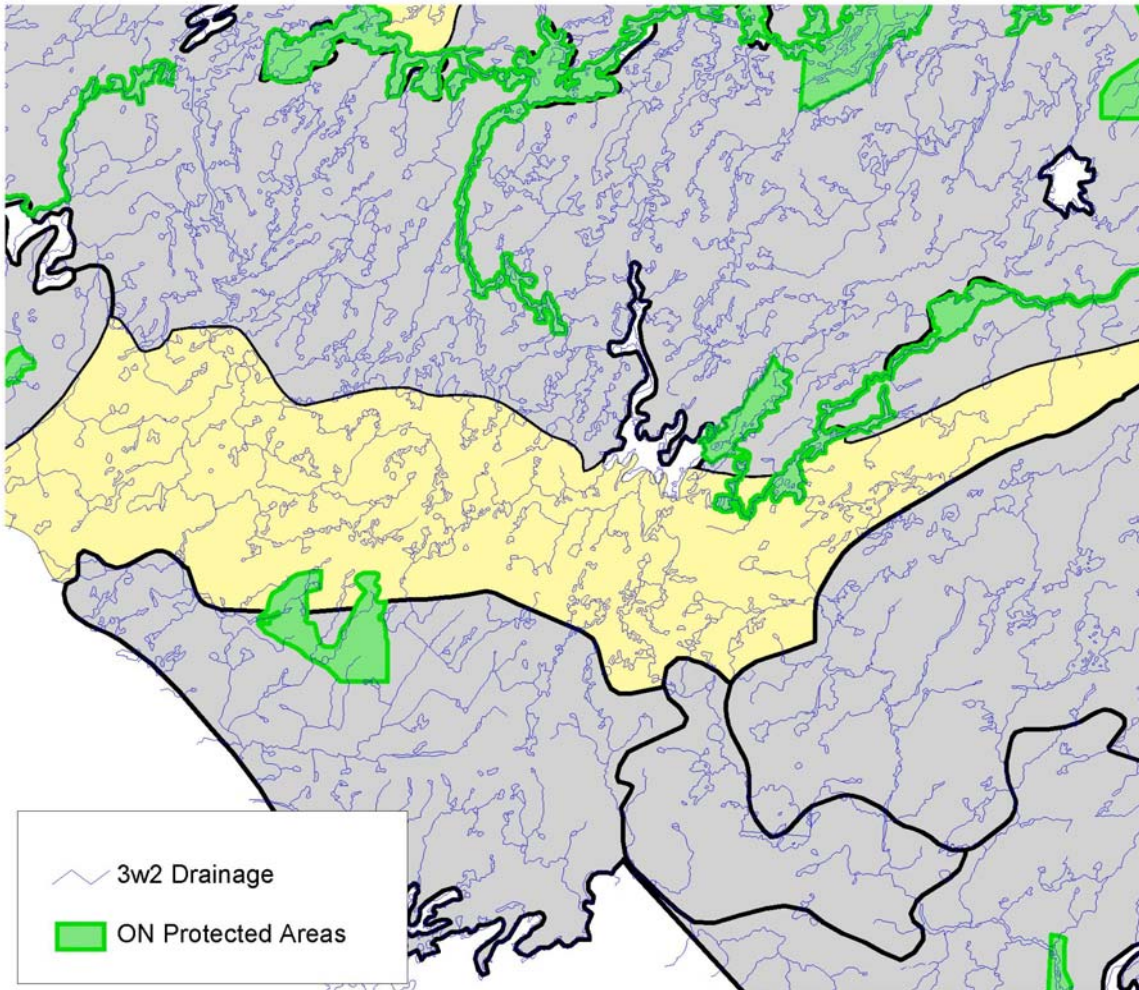
NOTES on new results:

- More in line with those of previous versions of the AoR
- Still being reviewed.



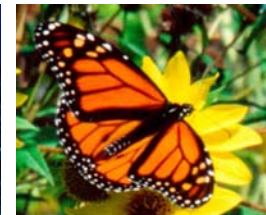


4) Important Physical Habitat Types



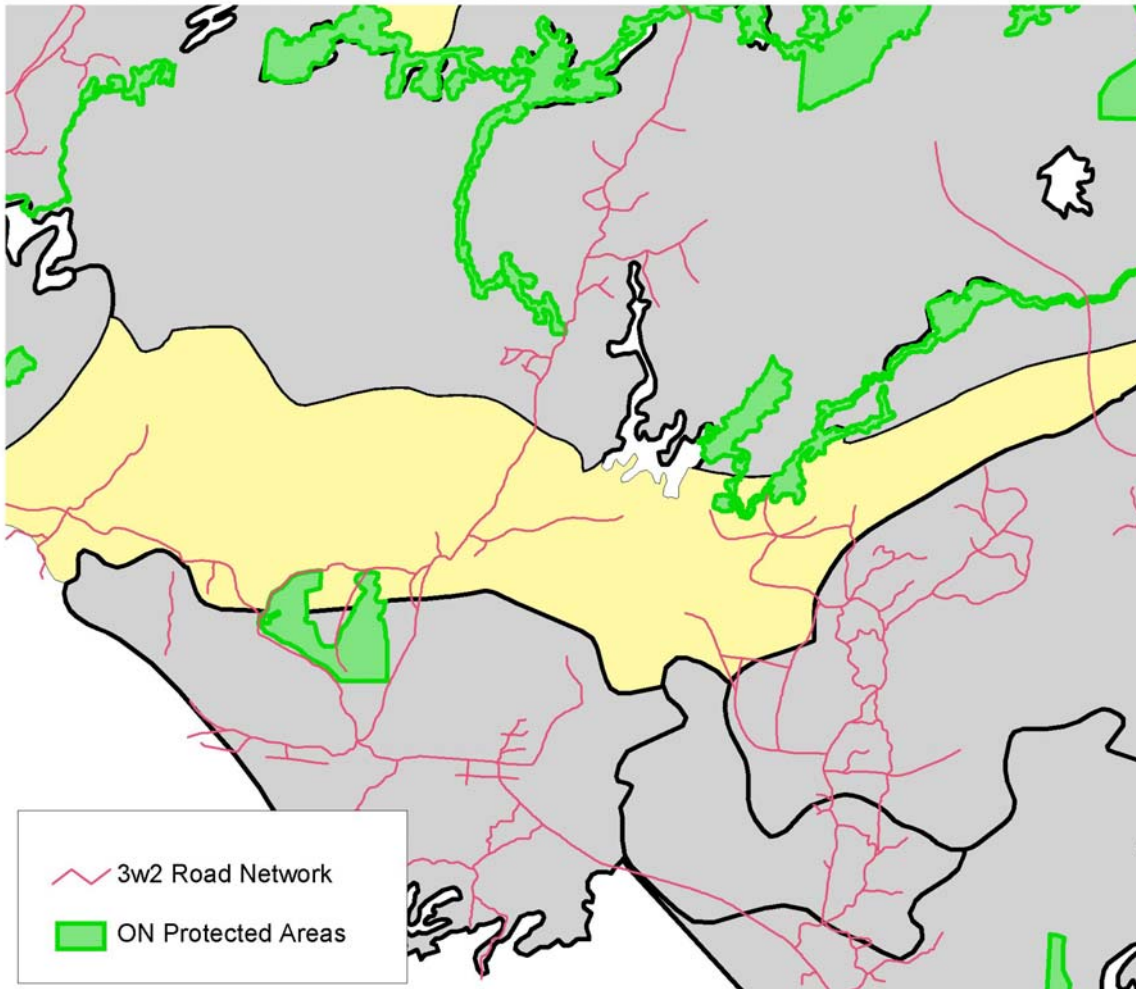
Score for Habitat Type assigned to EF based on proportion of shoreline density captured in the protected area relative to proportion of shoreline density in EF:

<u>THRESHOLD</u>	<u>SCORE</u>
No shoreline in EF, or Proportion in protected portion $\geq 95\%$ of proportion in EF	1
Proportion in protected portion $\geq 50\%$ of proportion in EF	0.75
Proportion in protected portion $\geq 5\%$ of proportion in EF	0.5



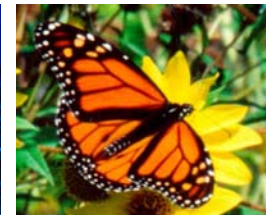


5) Habitat Quality Criterion



Score for Habitat Quality assigned to EF based on proportion of road density captured in the protected portion within the EF:

<u>THRESHOLD</u>	<u>SCORE</u>
Road density in protected portion < 0.5 m/ha	1
Road density in protected portion > 0.5 m/ha and < 1.75 m/ha	0.5





Representation Criteria Matrix

- Decision rule-based scoring matrix originally developed for the ArcView™ extension.

Representation Criteria	Scoring Guidelines for Representation Criteria (scores are indicated in brackets)						Maximum Possible Score
PROTECTED AREA SIZE AND ADJACENCY	A - Largest Single Protected Area Block on Enduring Feature:	Meets size guideline (>95% of recommended size is protected) (4)	Is at least 75% of the recommended size (3)	Is at least 50% of the recommended size (2)	Is at least 25% of the recommended size (1)	Is > 200 ha and <25% of the recommended size (0.5)	4
	B - Total Area Protected on Enduring Feature:	If Size Score A = 4, skip this step, otherwise:	Meets >= 95% of recommended size (1)		Meets at least 50% of the recommended size (0.5)		1
	C - Size of Largest Contiguous Protected Area Complex Intersecting the Enduring Feature (Adjacency):		Has a minimum of 200 ha overlapping the feature and is >= 75% of the Connectivity Value. (1)		Has a minimum of 200 ha overlapping the feature and is at least 25% of the Connectivity Value. (0.5)		1
							5
ENVIRONMENTAL GRADIENTS	If protected portion > 200 ha, and the calculated mean difference over the average standard deviation <= 50%. (1)		If protected portion > 200 ha, and the calculated mean difference over the average standard deviation <= 75%. (0.5)		If protected portion > 200 ha, and the calculated mean difference over the average standard deviation > 75%. (0)		1
IMPORTANT HABITAT TYPES (SHORELINE)	Size Score A < 0 and no shoreline habitat recorded in the enduring feature (precautionary approach); or the shoreline habitat in the protected portion >= 95% of the proportion of shoreline habitat in the enduring feature. (1)		Size Score A < 0 and shoreline habitat in the protected portion is at least 50% of the proportion of shoreline habitat in the enduring feature. (0.75)		Size Score A < 0 and shoreline habitat in the protected portion is at least 5% of the proportion of shoreline habitat in the enduring feature. (0.5)		1
HABITAT QUALITY	Size Score A < 0 and protected portion is relatively intact: road density < 0.5m/ha. (1)		Size Score A < 0 and protected portion is less intact: road density > 0.5m/ha and < 1.75m/ha. (thresholds interpreted from Noss 1995) (0.5)		Size Score A < 0 and protected portion is not intact: road density > 1.75m/ha. (0)		1



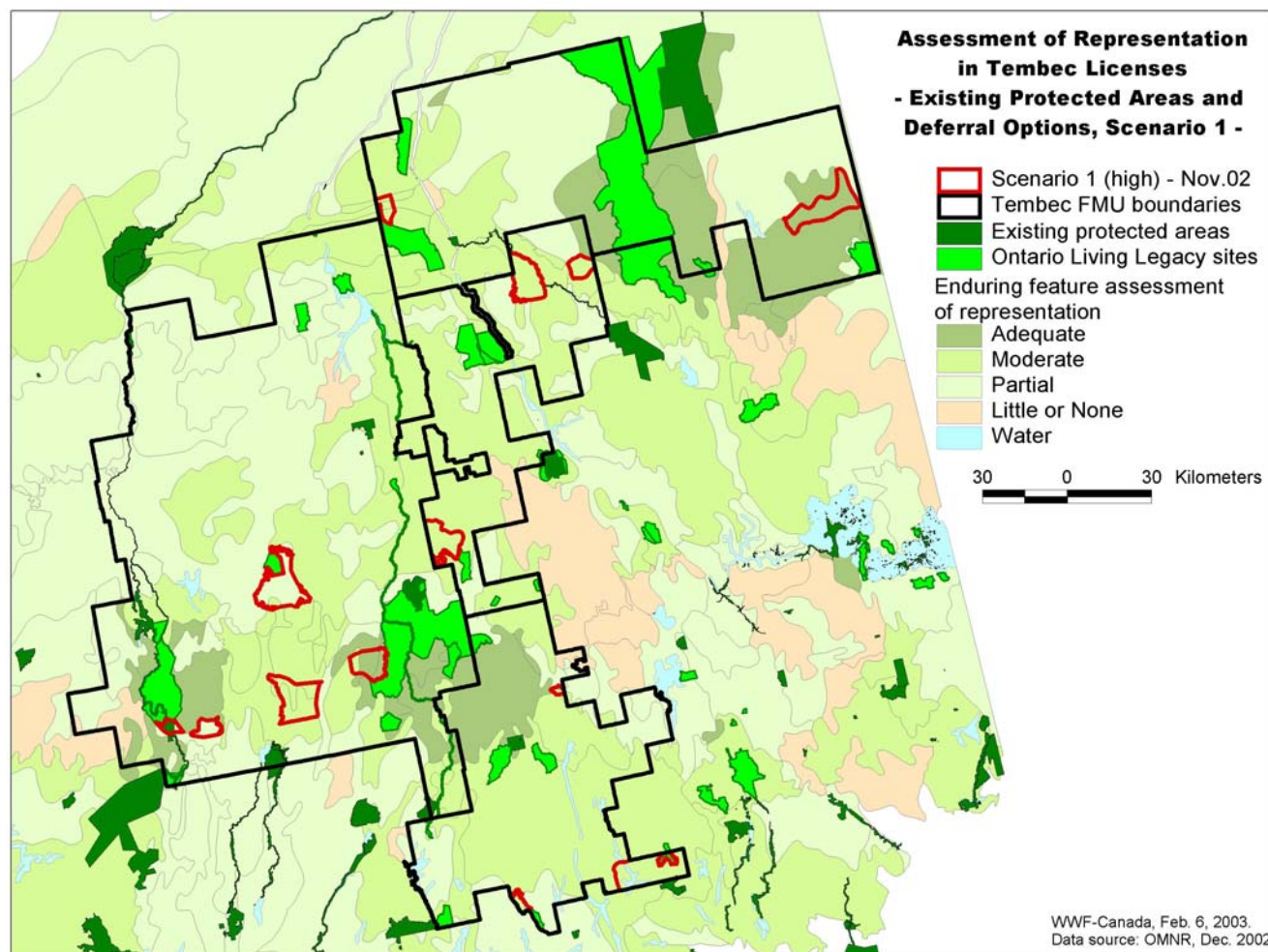
Representation Scores

- Total Scores grouped into Classes:
 - **Adequate** representation = 6.25-8
 - **Moderate** representation = 3.75-6
 - **Partial** Representation = 1-3.5
 - **Little or No** Representation = 0-0.75





AoR (ArcView 3.2) Results – Tembec Example

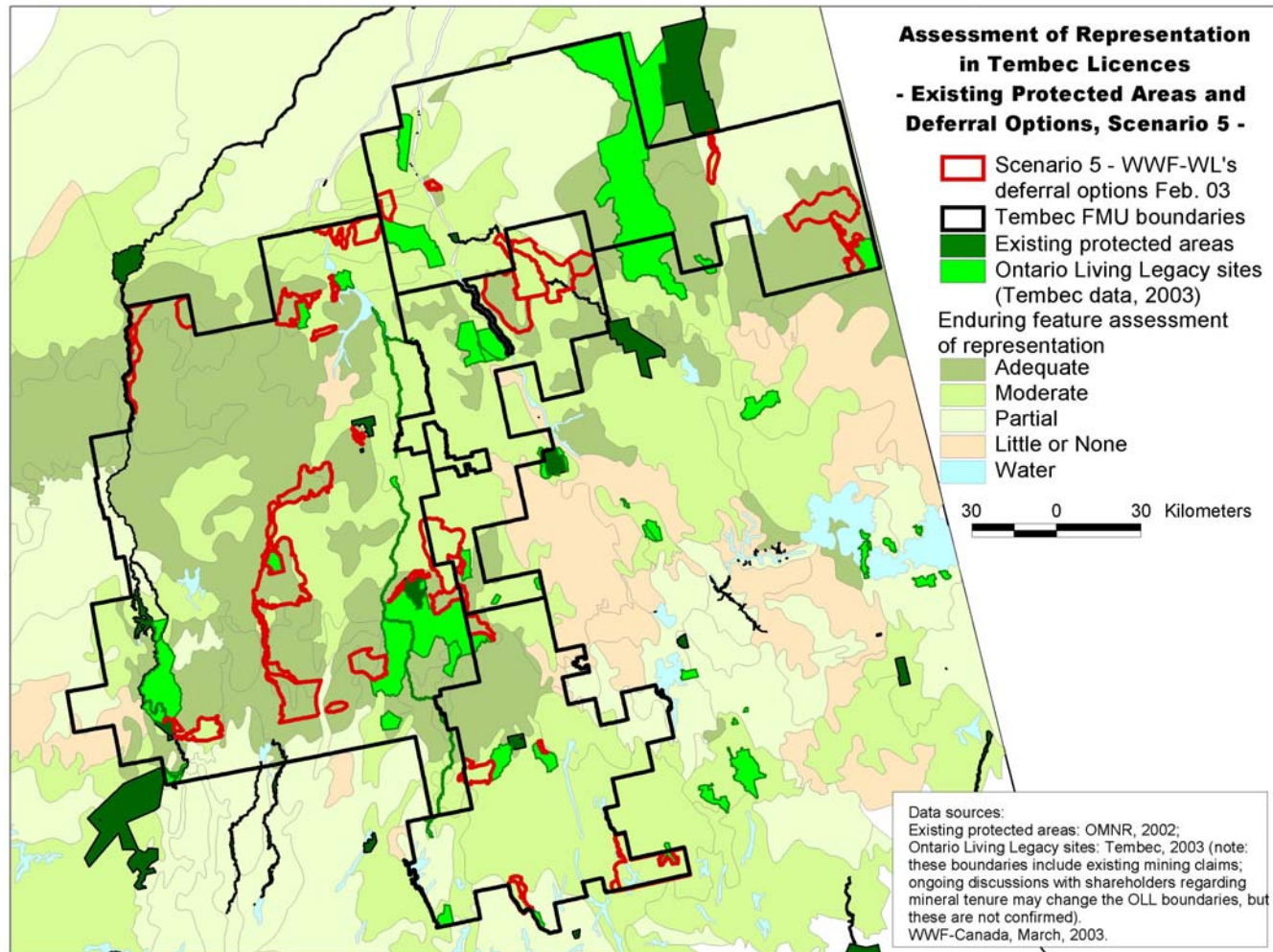


Scenario 1:
existing protected areas
+ Tembec draft
deferral options

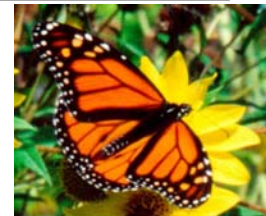




AoR (ArcView 3.2) Results – Tembec Example



Scenario 5:
existing protected areas
+ Tembec FINAL
deferral options





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B) Current Status & What's New in AoR 9

- ArcView 3.2/ArcGIS 8.3 versions underwent extensive peer review;
- ESRI programming
- Several glitches fixed;
- Several criteria modified and improved:
 - Size guidelines;
 - Adjacency/connectivity;
 - Environmental gradient criterion





AoR Extension – Step 1

WWF - Assessment of representation analyst

WWF Assessment of Representation Analyst V9.0 **Step 1/4**

Welcome to The World Wildlife Fund Canada's (WWF) landscape-based protected areas gap analysis and GIS tool for conservation planning.

Before running the Assessment of Representation, the user should read the User's Guide provided with the extension.

Assessment Settings

I am using:

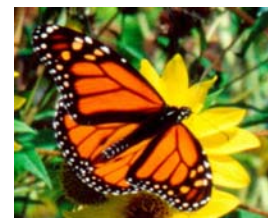
- ☒ Shapefile feature classes
- ☐ Personal geodatabase feature classes

Assess representation using *:

- ☒ All protected areas and enduring features
- ☐ Current Selection of enduring features and protected areas

* The assessment can only assess one layer of protected areas and one layer of enduring features at a time

< Prev Next >





AoR Extension – Step 2

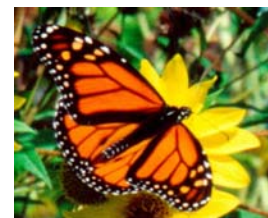
WWF - Assessment of representation analyst

Assessment layers Step 2/4

Set the layers and fields to be used in the Assessment of Representation

1. Enduring feature layer or equivalent (POLY)	onlf
Unique feature code field	EFCODE
Natural region field	WWFCODE
2. Protected areas layer (POLY)	ON_pas_2003
Field uniquely identifying each polygon	FID
3. Road/rail/utility line layer (LINE)	ROADSEG_lc83
4. Drainage - river/streams and shoreline layers (LINE)	can_water
5. Digital Elevation Model (GRID)	canada_dem

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AoR Extension – Step 3

WWF - Assessment of representation analyst Step 3/4

Ecosystem settings

Location of ecosystem.mdb file distributed with this extension:

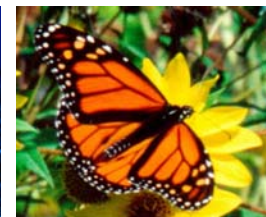
WWF has developed protected area size guidelines for the various natural disturbance zones across the country. The methods and data used to determine these size guidelines and disturbance zones were based on the spatial scales of natural disturbances, habitat requirements of selected focal species, and the enduring features.

Select a disturbance/ecological process regime that is characteristic of the area that you wish to assess:

To determine in which WWF natural disturbance zone the enduring features are found, refer to the natural disturbance zone map or the DIST_ZONE field in the enduring features layer. Alternatively, the user can select a proportional value (i.e. 30% of the enduring feature).

The equation listed below represents the relationship between the Protected Area size (Y) and the Enduring Feature size (X), or a pre-determined proportion of the enduring feature. The equation is the basis for determining the recommended protected area size for this assessment. Details on the methods used to derive the equations are available in the

ID	X	INTERCEPT	EQUATION	SYSTEM	TYPE	INTEGRITY
32	0.8783	-0.246	$Y = 0.8783X - 0.246$	2 - Central East Shield - Fire	Log	100000





AoR Extension – Step 4

WWF - Assessment of representation analyst

Step 4/4

Output specifications

Select the output format for the assessment results

Natural Region Representation Results

☒ Calculate natural region representation statistics

(Natural region field must be identified in the assessment layers panel for this option)

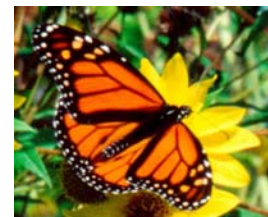
Enduring Feature Representation Results - File Specifications

☒ Tabular file only

☐ Tabular file joined to the enduring feature layer

CONDUCT ASSESSMENT

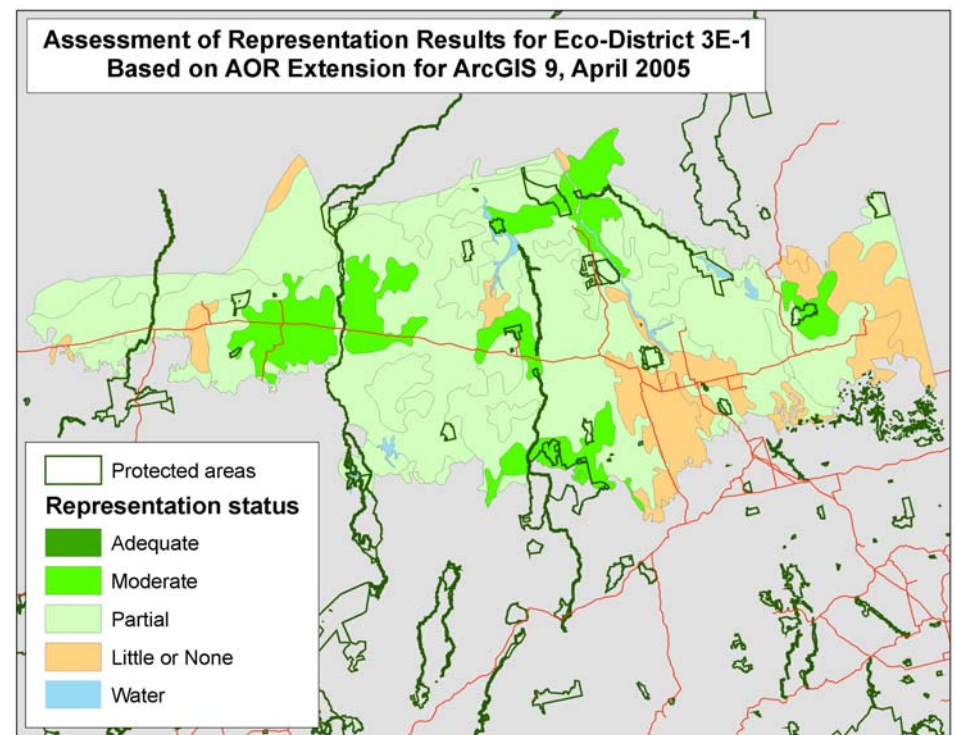
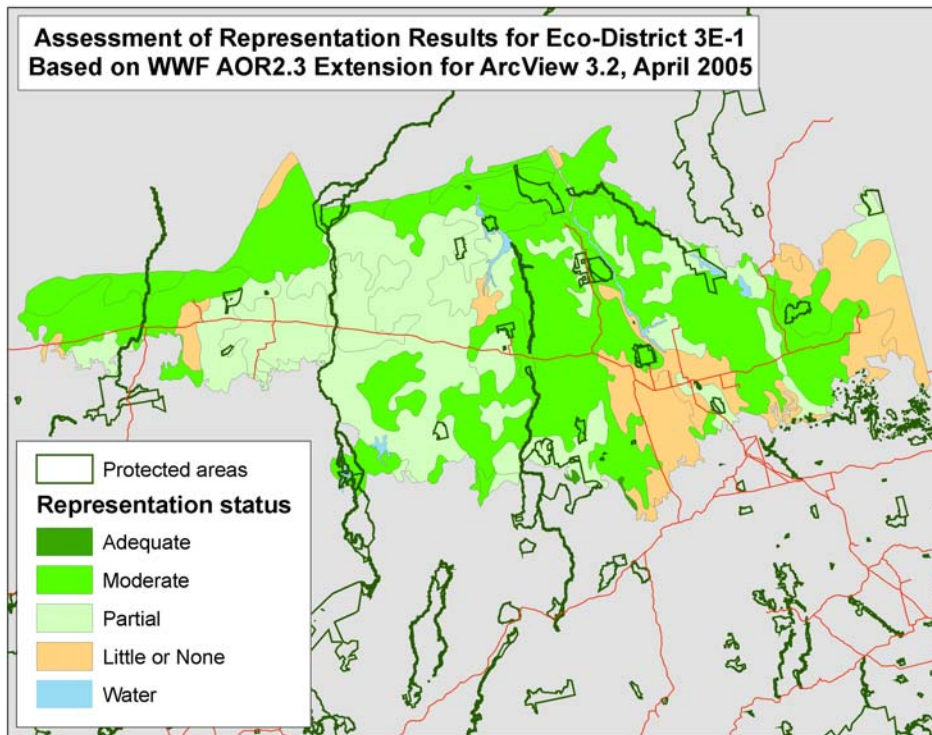
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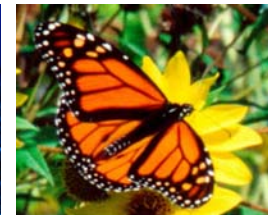


Applying the AoR9 Routine

- 3E1 example base on existing protected areas



Refer to Excel Spreadsheet “3E1 comparison”





NOTES on the AoR 9

- The routine produces repeatable results, however, the data inputs need to be consistent:
 - Scale of the data can affect scores
 - Projection of the data layers may affect area calculations
 - Inconsistent feature selections may result in inconsistent results
 - Variations in data layers may affect all criteria





Advantages of the AoR 9

- Uses freely available data
- Canada wide
- Peer-reviewed
- Up-to-date with ESRI software
- Improved assessment of criteria
- Produces repeatable results





Limitations of the AoR 9

- Downloadable base data is coarse
- Technical limitations inherent to ArcGIS 9
- Limited to ArcGIS 9 users
- Not a candidate selection tool
- Not a habitat suitability model
- Requires a few data preparation steps before running





Next Steps

- Incorporate new features into AoR9
- Further review the criteria thresholds and size guidelines.
- Update accompanying documentation and release new routine.
- Post the AoR routine on the WWF website.





Current Availability of AoR

- AoR extension, enduring features data and documentation are found on WWF's FTP:
 - <ftp://forests:gc678yy@wwf.ca>
- *Notes:*
 - *The AoR9 extension and the User's Guide are currently being updated to be posted.*

