# EnSym: Environmental Systems Modelling Platform

Mark Eigenraam, Economics and Policy Integration Branch, Victoria, Australia

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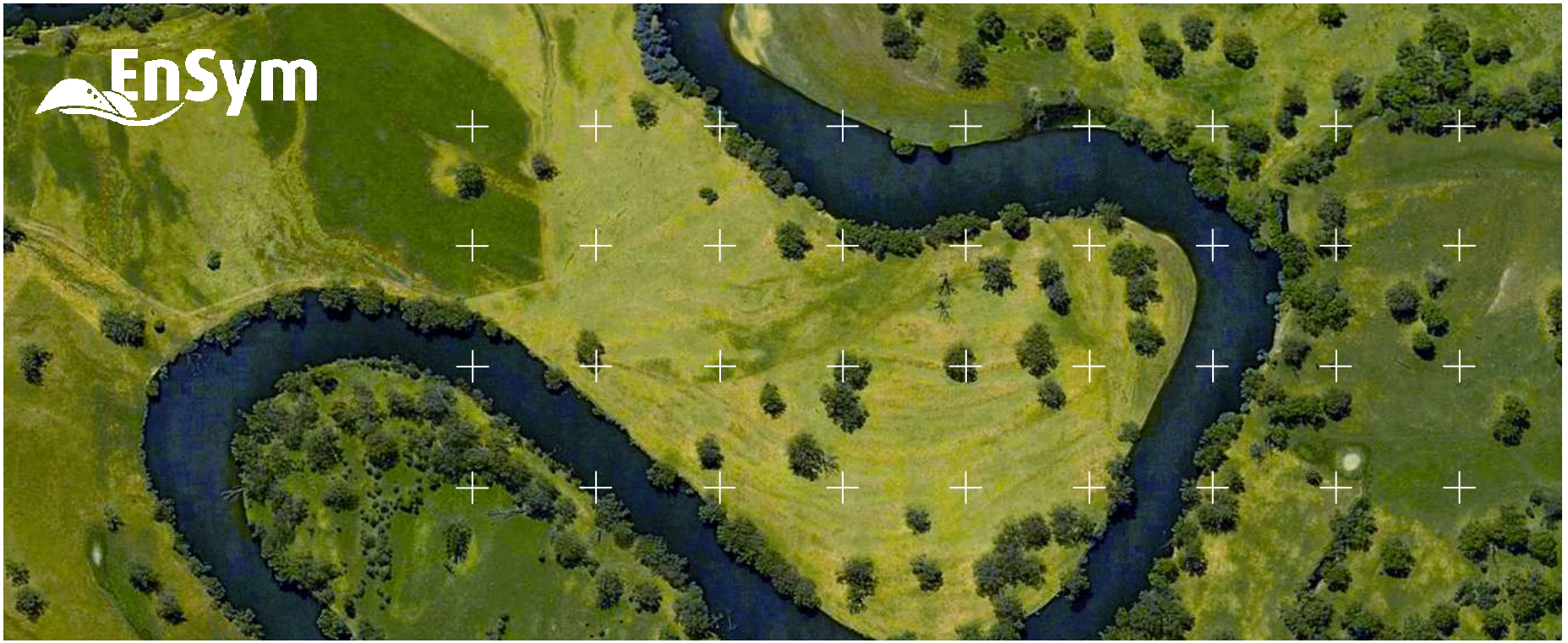



ecoMarkets
VALUING OUR ENVIRONMENT

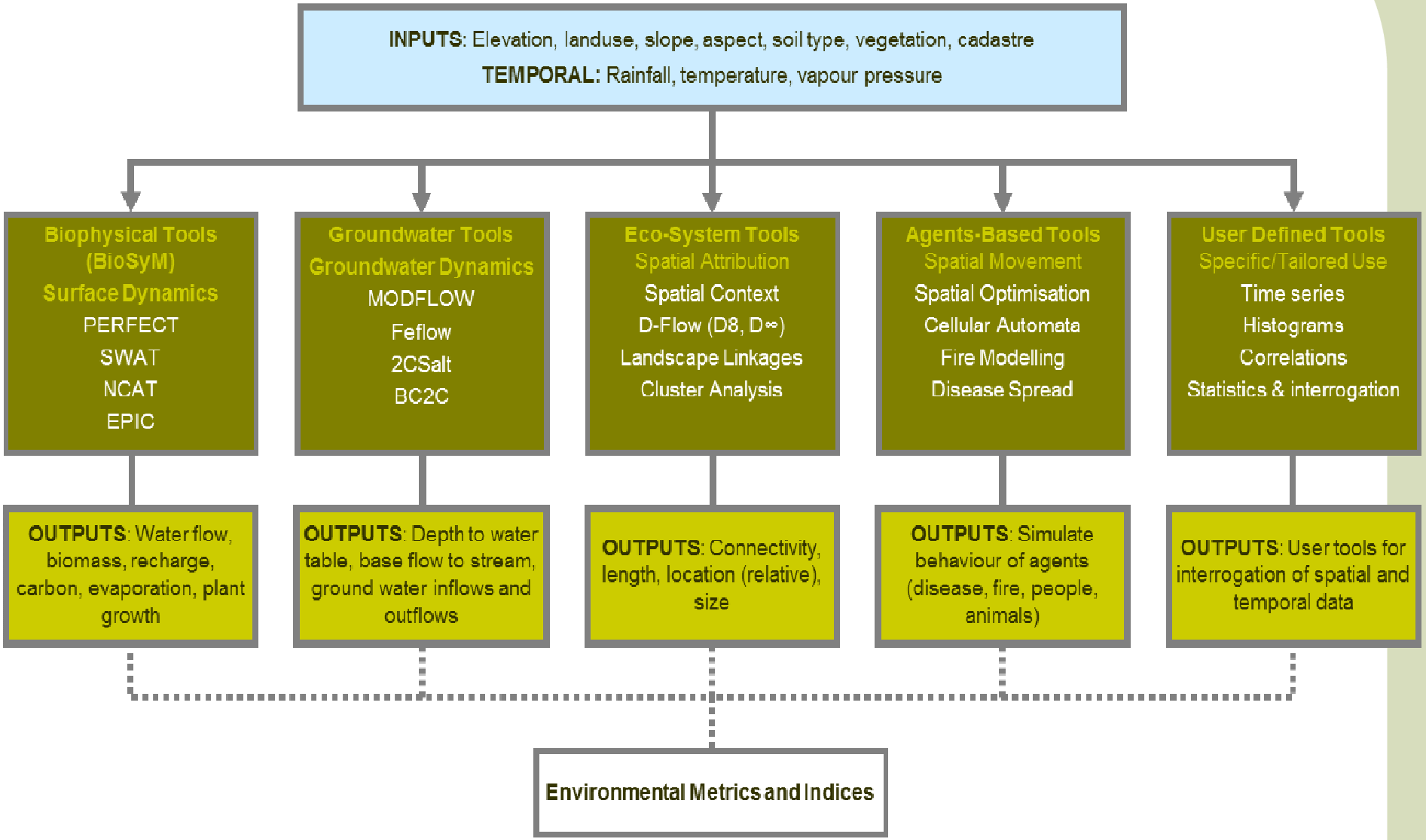
Department of Environment and Primary Industries
State Government Victoria

# ‘Platform’ for integration and reporting

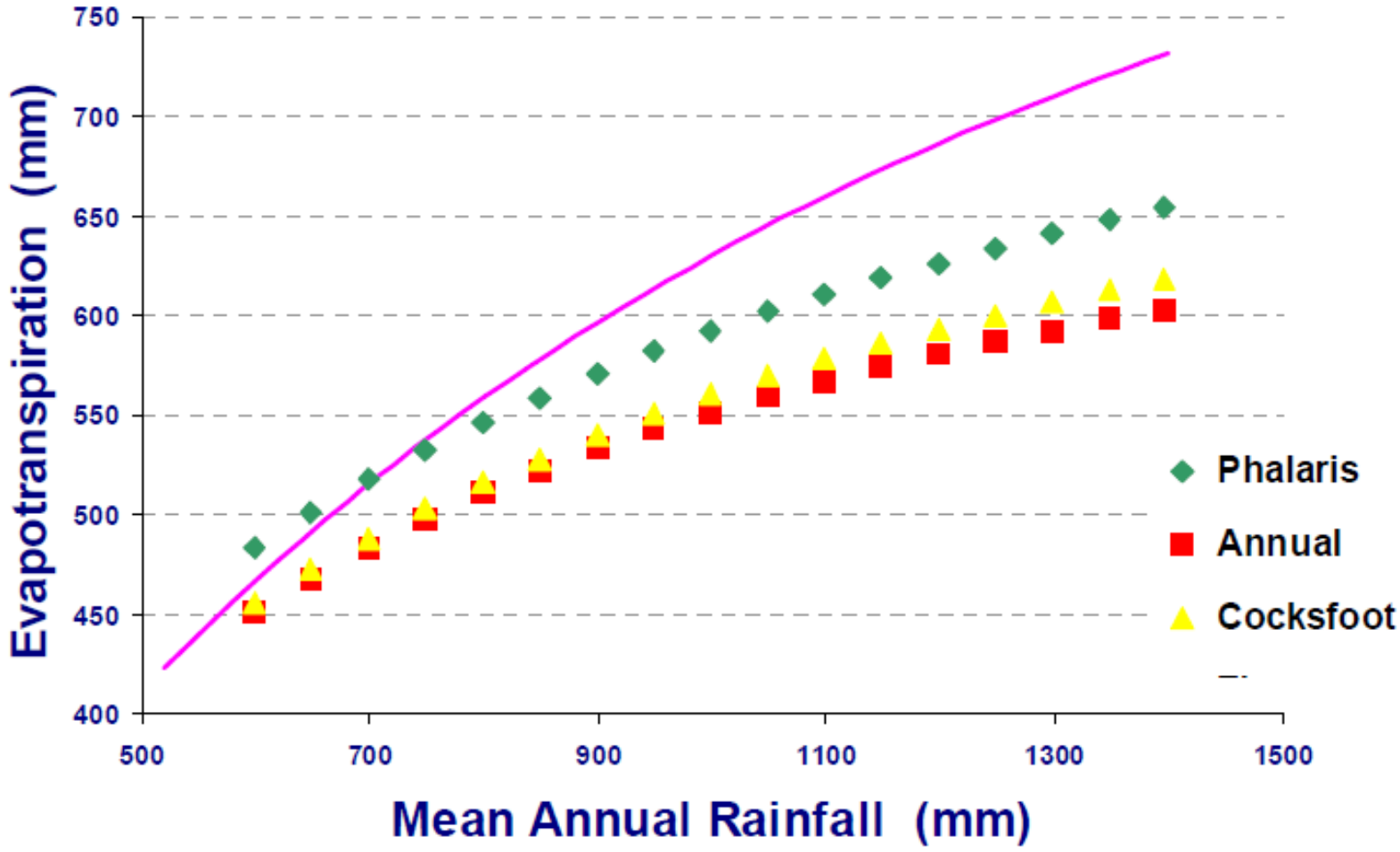
- Carbon
  - Biophysical models (biomass)
  - National Carbon Accounting Tool (NCAT), via web services
- Water
  - Biophysical daily simulation (time and space)
    - Climate change, groundwater and surface water estimates
    - 110 years historic daily climate data (100m resolution)
    - 100 years predicted daily climate change (200m resolution)
- Biodiversity
  - Nature Print (strategic biodiversity values)
  - Terrestrial, wetland, river, coastal, grassland, etc site specific metrics for condition and extent (100m)

EnSym

# EnSym Overview



# Process based versus generalised approaches




Beverly et al 2003

# Criteria

- Quantitative output
  - Water (quantity and quality), carbon, biodiversity metrics (wetland, rivers, terrestrial, coastal, grasslands, etc)
  - Units, ha, tonnes, ML, mm, indices of condition – normalised
  - Replicable across the whole landscape
- Biophysical models
  - All models are published and referenced (PERFECT, EPIC, SWAT, 3PG, etc)
  - Process based rather then generalised approach
  - Union space (common units)
- Adaptability
  - EnSym built in Matlab©
  - Models built in Fortran, C, C++, Excel, etc
    - Can apply any model if it has an API or can be compiled as a DLL
  - Soils – (Northcote et al, 1960-68)
  - Executable is free and downloadable

# Criteria continued

- Classification
  - Land use and management (Land accounts)
  - Other – ecological vegetation classes, ownership, administrative boundaries, drainage basins, etc
- Labour and infrastructure requirements
  - Training materials on web
  - One day for EnSym overview, Two full days per tool
  - Skills – GIS awareness, general computer capability
  - PC for whole of Victoria (100m * 100m, 227,000 sq/km)
  - Open source* (public good for partnership work, funding new users?)
- Data requirements and uncertainty
  - Land use and management, DEM, climate (daily), soil (Northcote)
  - Uncertainty – at all stages – probabilistic

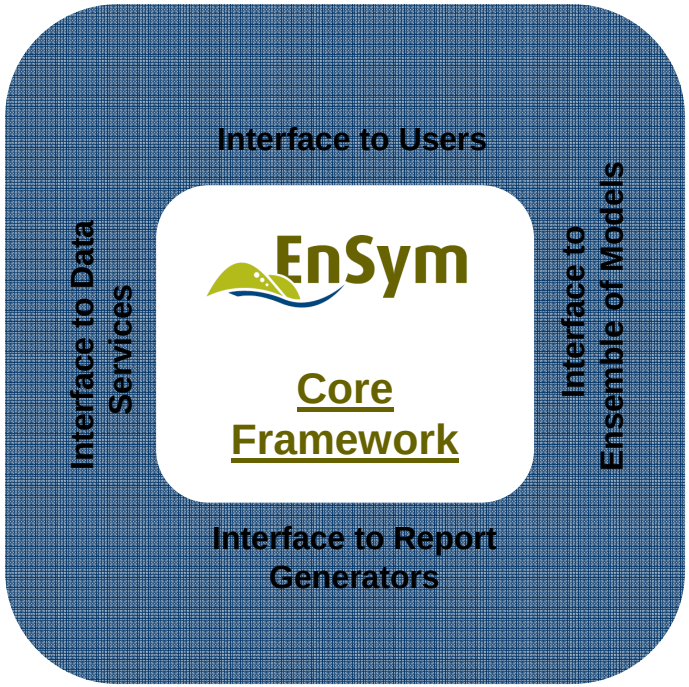
# Criteria continued

- Scalability and spatial considerations
  - Site, local, state, national
  - Any unit for aggregation – based on grid data
  - Scenario file – binary with all data built in
- Beneficiaries and Policy
  - Surface water flows – cell by cell
    - Regulated water and non-regulated
    - Stream versus channel (irrigation)
- Big P versus Little P
  - Big P - Across program areas at the institutional level
  - Little P – within policy or program areas – delivery on the management of assets and services
  - Bottom up approach – aggregate site level outcomes (BSU)
  - **Information needs to move in both direction seamlessly**

EnSym

# EnSym

**En**vironmental **Sy**stems **M**odelling Platform



# Linking actions/scenarios to outcomes

* **ACTION**

*Build 500m fence*
*Plant 1000 tubestock*

**OUTPUT**

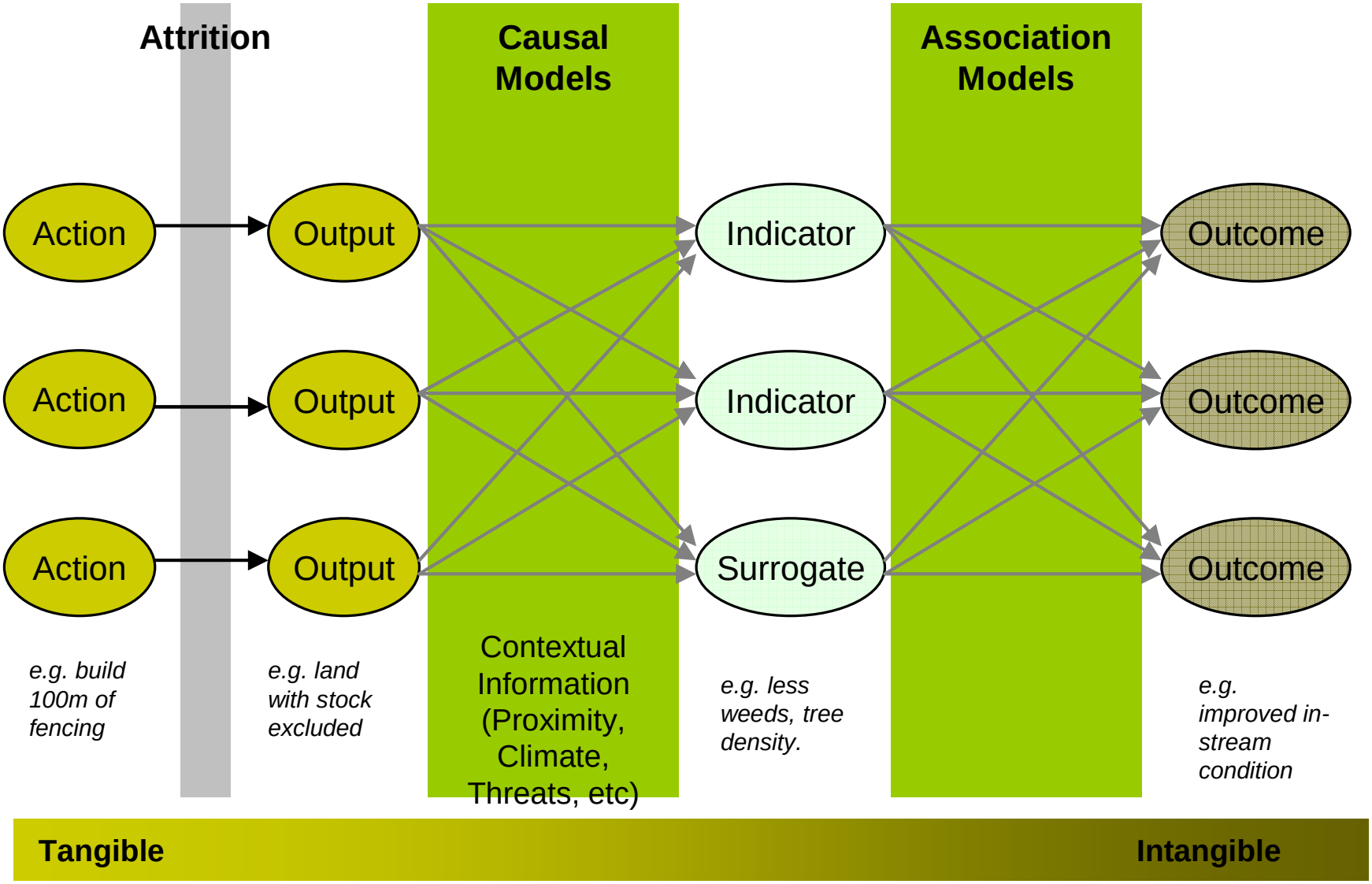
Exclusion of stock
River site revegetated

**SURROGATE/INDICATOR**

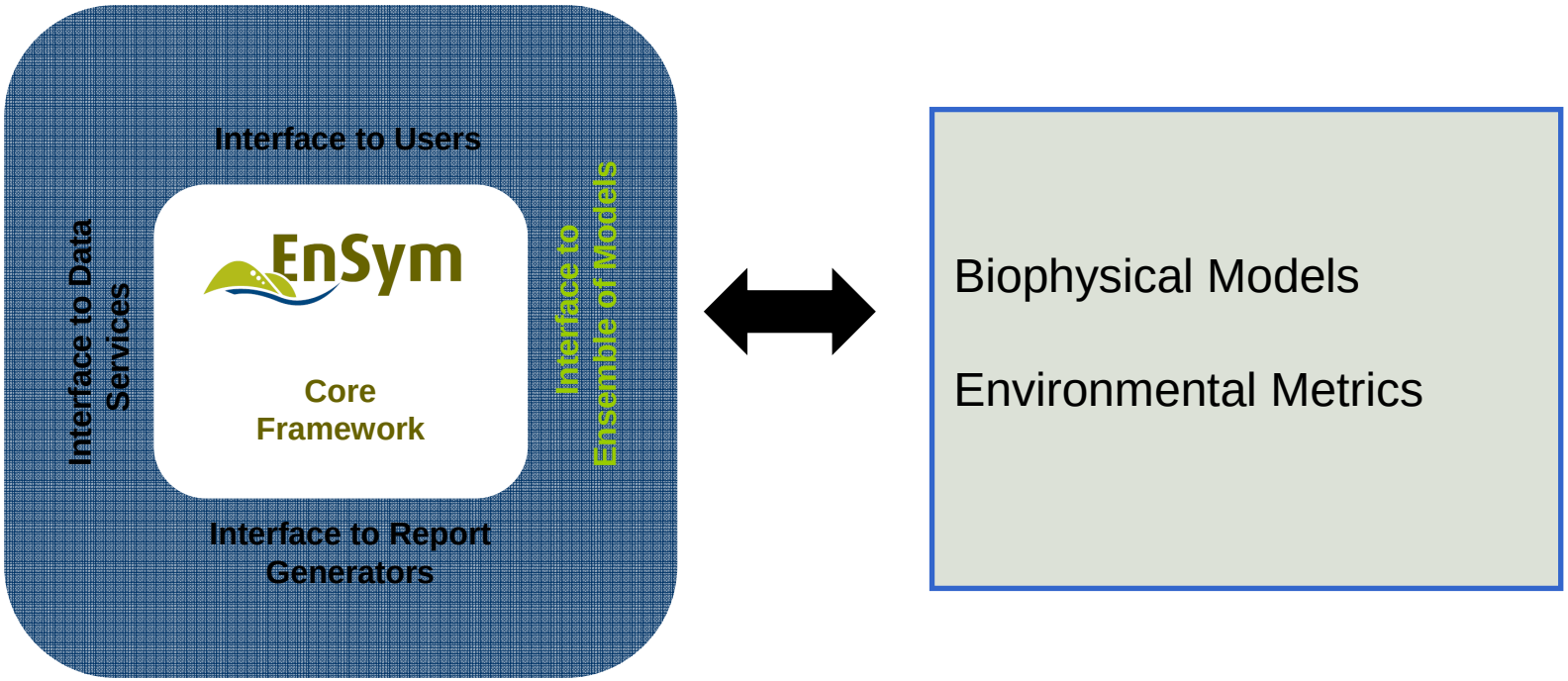
* Measurements
– *current condition & gain*
e.g. Large trees, Bank stability

***OUTCOME***

*Habitat for wildlife*
*Reduction in erosion*
*Improved water quality*


Attrition
Causal Models
Association Models
Action
Action
Action
Output
Output
Output
Indicator
Indicator
Surrogate
Outcome
Outcome
Outcome
e.g. build 100m of fencing
e.g. land with stock excluded
Contextual Information (Proximity, Climate, Threats, etc)
e.g. less weeds, tree density.
e.g. improved in-stream condition
Tangible
Intangible

EnSym




Biophysical Models

Environmental Metrics

# METRIC

**Estimated change in condition**

As a result of actions that will improve canopy health, understorey regeneration, wetland health etc

**AND**

**Sites we prefer**

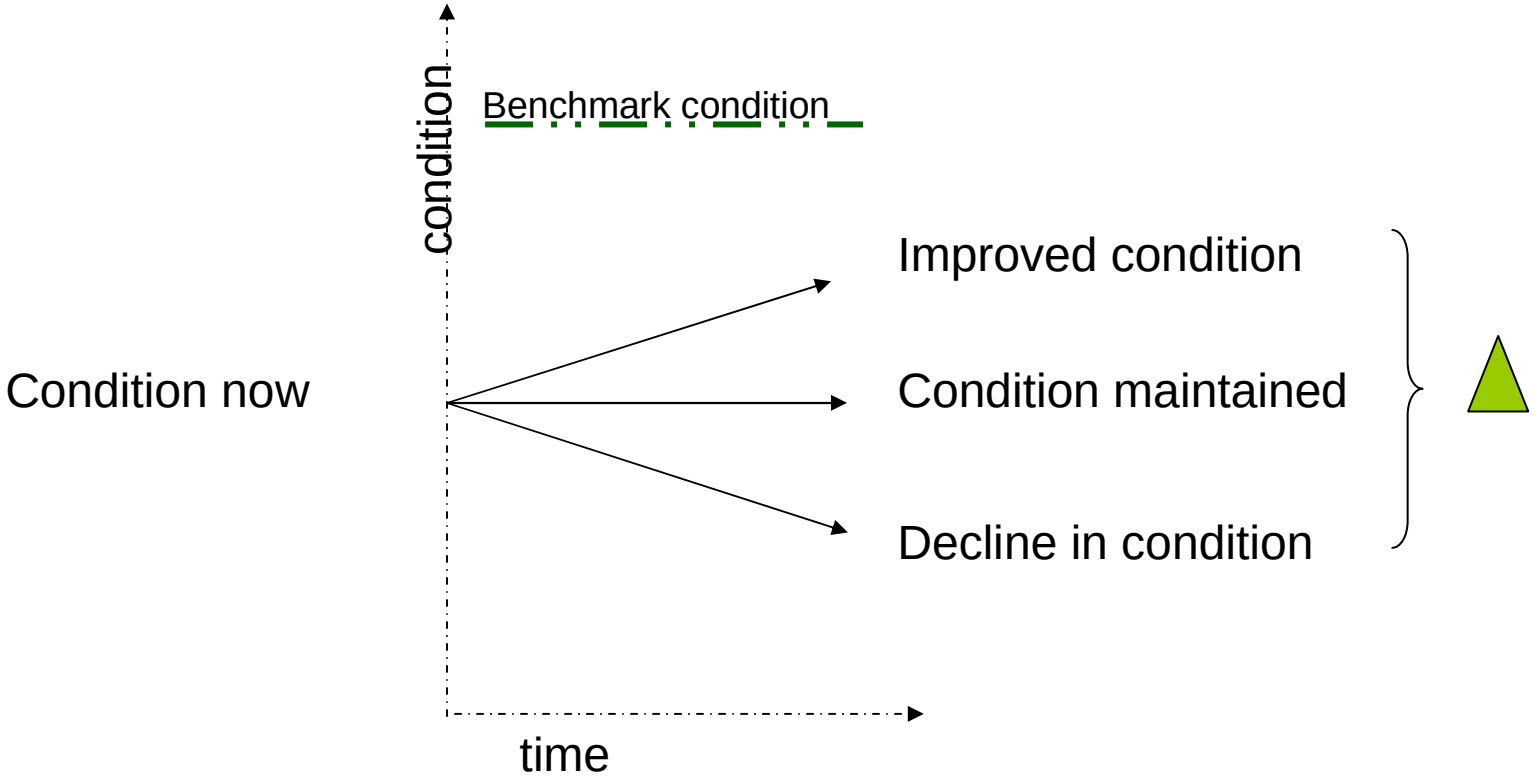
Quality, size, significance (threatened species, Ramsar, Conservation Status, catchment value, proximity to vegetation, rivers) ….

EnSym

**GAIN-**

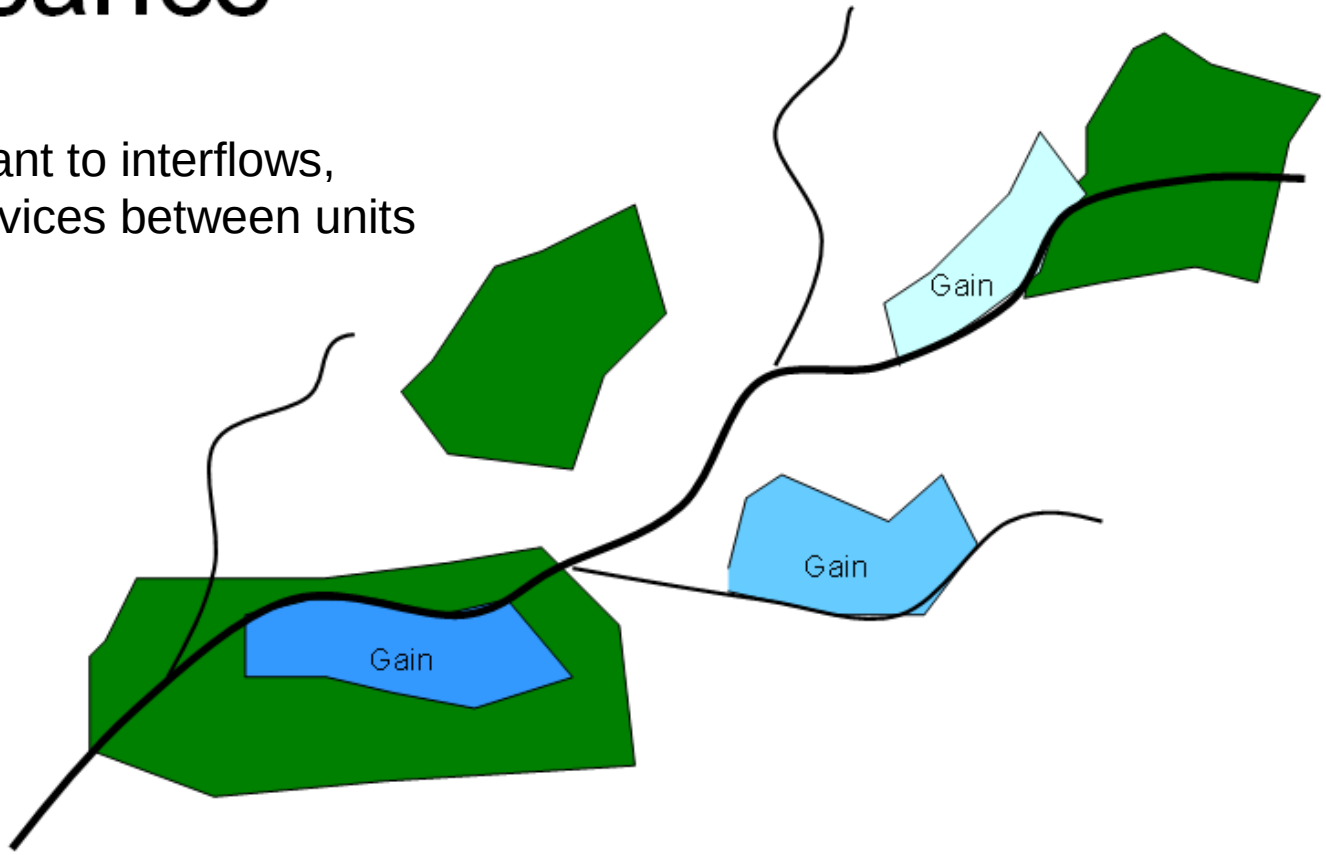
What will the future condition of the site be?

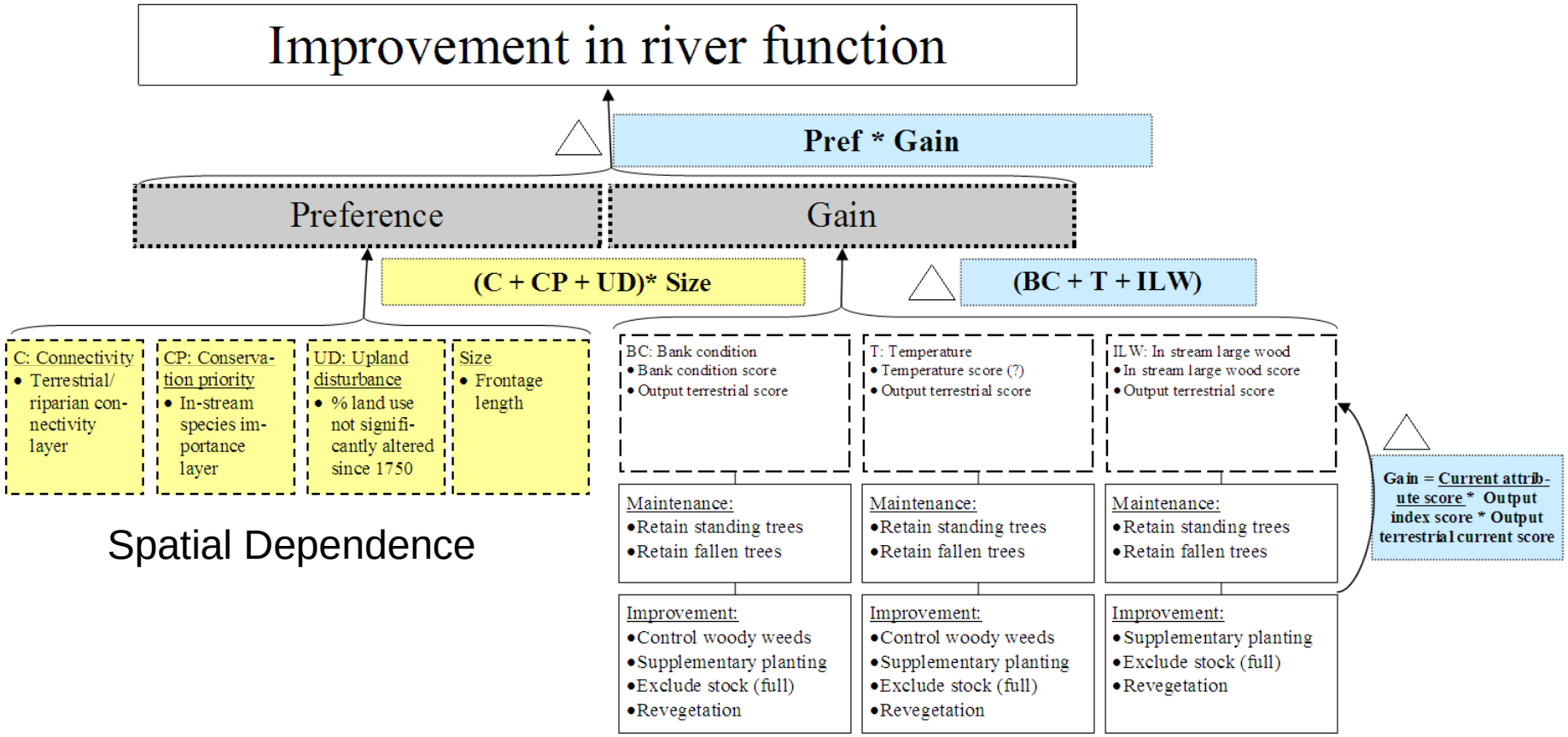
What is the measured change from its condition now?



# Significance

Location is relevant to interflows, movement of services between units





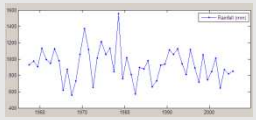

Spatial Dependence

https://ensym.dse.vic.gov.au/cms/

# Combined Indices

| Attribute | Change in level of function | Significance |
|---|---|---|
| **Native Vegetation** | ∆ Habitat Score (increase)<br>(Habitat maintained or improved / ha) | EVC & Threatened Species Status<br>Site Condition<br>Strategic Landscape-scale "preference" |
| **Aquatic Function** | ∆ Water quantity<br>(Flows, mm/ha at stream)<br>∆ Water Quality<br>(Erosion, t/ha at stream) | River Health Index<br>Priority River Reaches |
| **Estuarine Function** | ∆ Water quantity<br>(Flows, mm/ha at stream)<br>∆ Water Quality<br>(Erosion, t/ha at stream)<br>Distance to Estuary (m) | River Health Index<br>Priority River Reaches<br>Significance of river reach closest to estuary |
| **Carbon Sequestration** | ∆ Carbon Stocks (increase) | None |

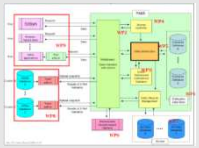
# EnSym



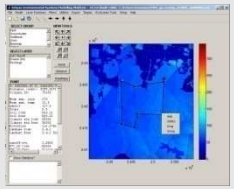
**Time series data**
(e.g. climate, stochastic events, etc)

**Priorities**
(e.g. NaturePrint, EPBC, Ramsar, etc)

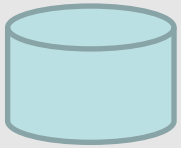
**Field data**
(e.g. Threats, current condition, polygon, etc)



**Aspatial data**
(e.g. benchmarks and best-practices for site management)



**Spatial data**
(e.g. Soil, slope, etc)



**Geo-spatial DB**
NDG Raster Storage Archive

**Statutory Rules**
(e.g. planning controls, on-title restrictions, etc)

**Model Library**
Assumptions and Parameters


**Web services**
ViCMAP, RoadMaps, imagery, etc

Interface to Users

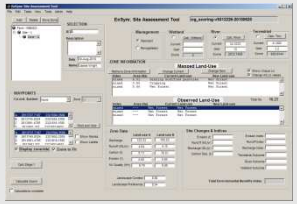
Interface to Data Services

EnSym

Core Framework

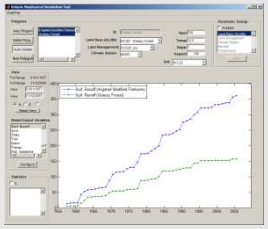
Interface to Ensemble of Models

Interface to Report Generators

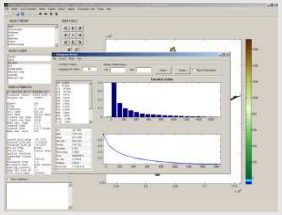


Site Assessment Tool

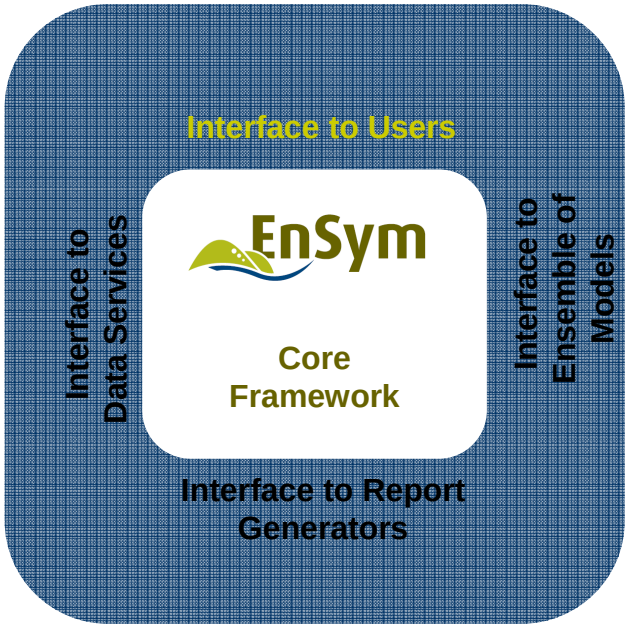
Landscape Preference Tool



Biophysical Simulation Tool



Analytical and Visualisation Tools

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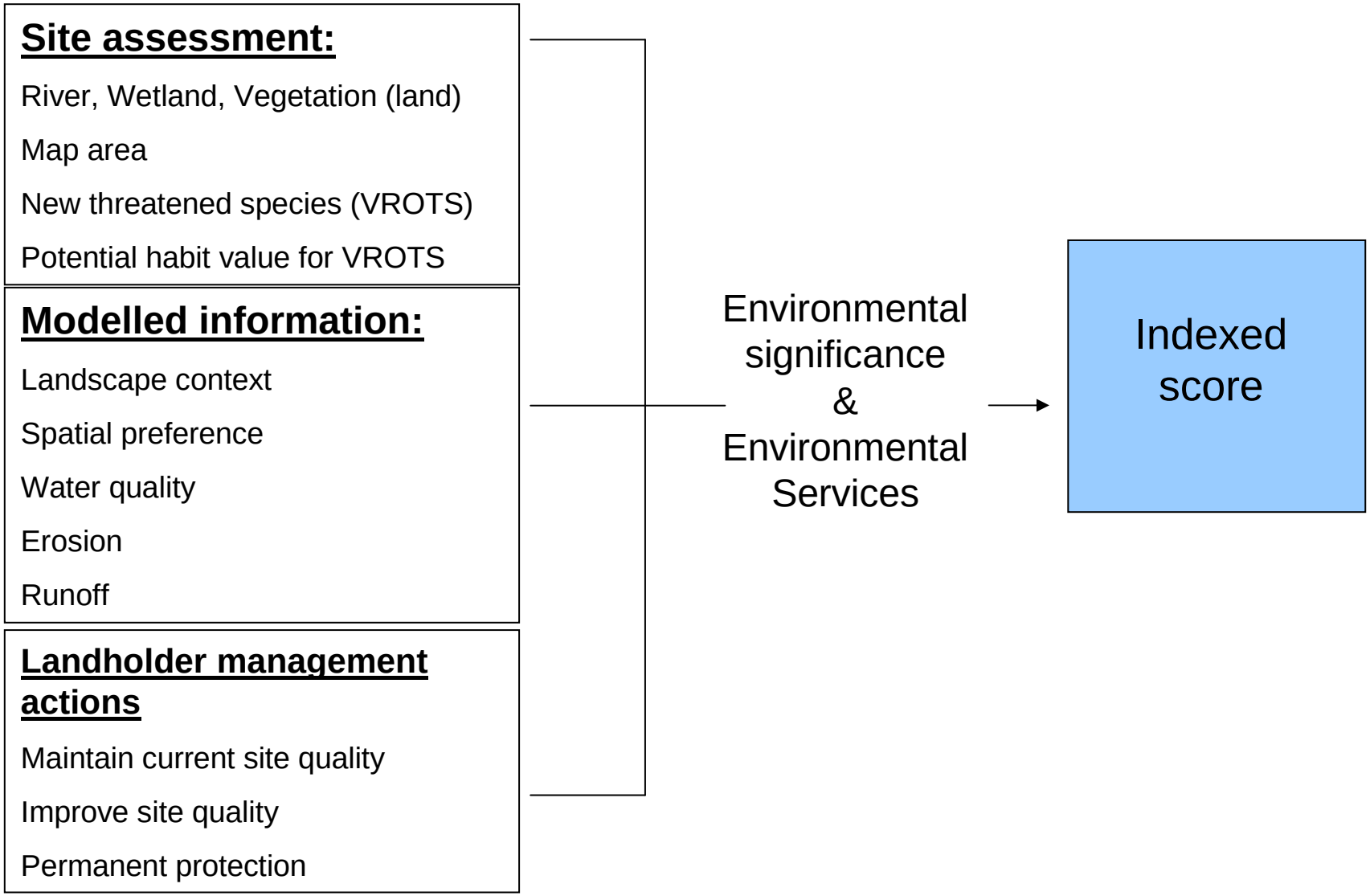
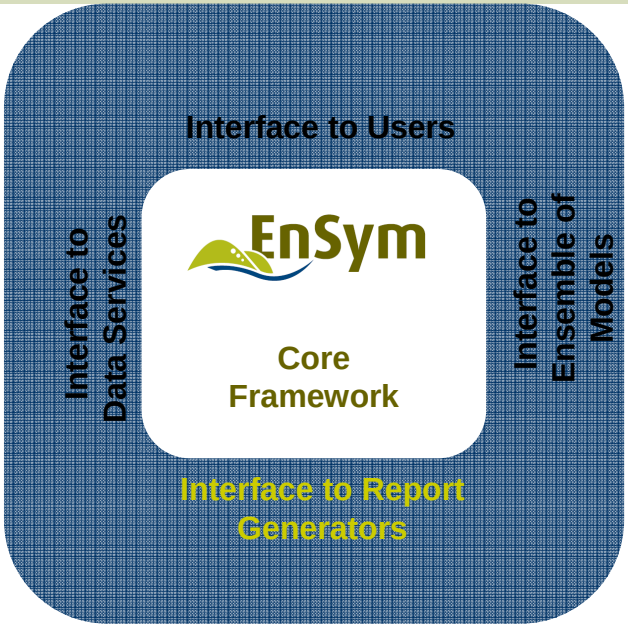
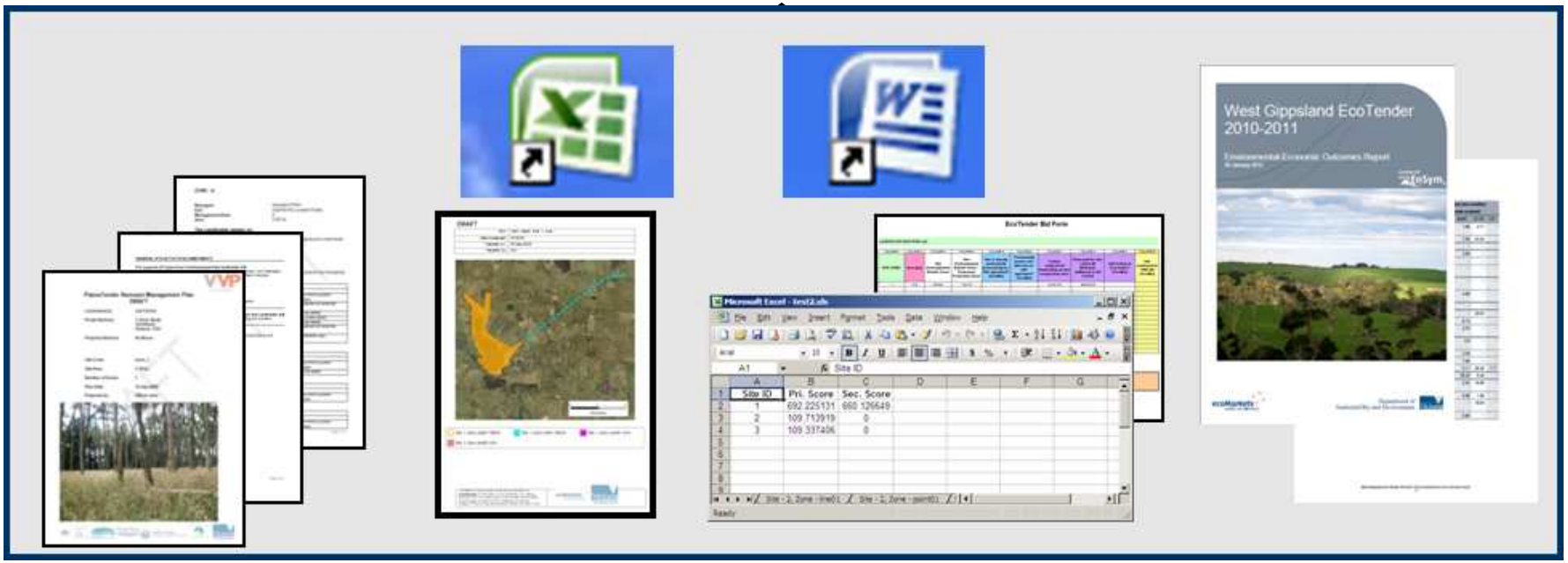

Site assessment:
River, Wetland, Vegetation (land)
Map area
New threatened species (VROTS)
Potential habit value for VROTS
Modelled information:
Landscape context
Spatial preference
Water quality
Erosion
Runoff
Landholder management actions
Maintain current site quality
Improve site quality
Permanent protection
Environmental significance & Environmental Services
Indexed score




- Leverage existing technologies (e.g. Microsoft products on standard desktops)
- User-customisable templates

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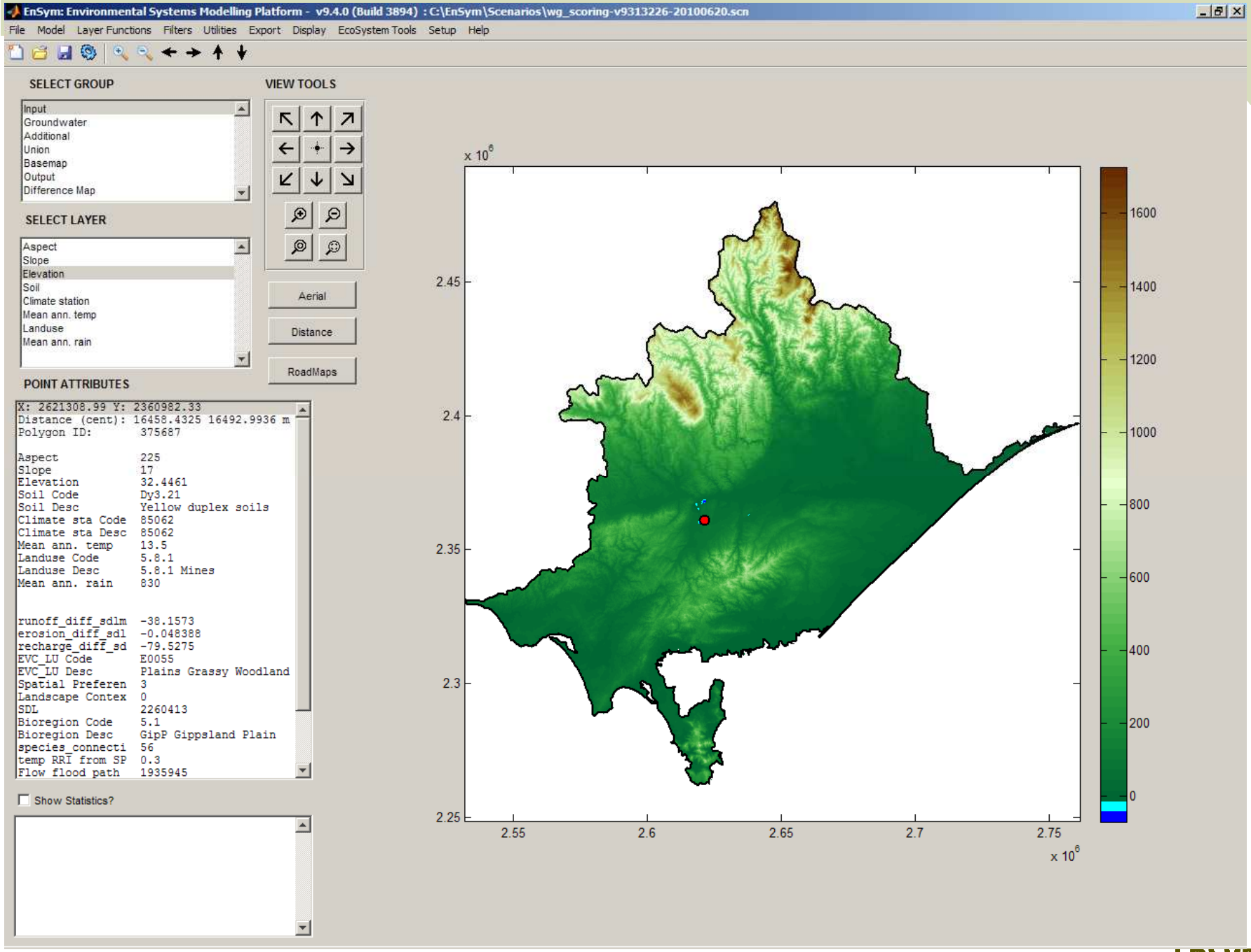
EnSym: Environmental Systems Modelling Platform - v9.4.0 (Build 3894) : C:\EnSym\Scenarios\wg_scoring-v9313226-20100620.scn
File Model Layer Functions Filters Utilities Export Display EcoSystem Tools Setup Help
SELECT GROUP
Input
Groundwater
Additional
Union
Basemap
Output
Difference Map
SELECT LAYER
Aspect
Slope
Elevation
Soil
Climate station
Mean ann. temp
Landuse
Mean ann. rain
VIEW TOOLS
Aerial
Distance
RoadMaps
POINT ATTRIBUTES
X: 2621308.99 Y: 2360982.33
Distance (cent): 16458.4325 16492.9936 m
Polygon ID: 375687
Aspect 225
Slope 17
Elevation 32.4461
Soil Code Dy3.21
Soil Desc Yellow duplex soils
Climate sta Code 85062
Climate sta Desc 85062
Mean ann. temp 13.5
Landuse Code 5.8.1
Landuse Desc 5.8.1 Mines
Mean ann. rain 830
runoff_diff_sdlm -38.1573
erosion_diff_sdl -0.048388
recharge_diff_sd -79.5275
EVC_LU Code E0055
EVC_LU Desc Plains Grassy Woodland
Spatial Preferen 3
Landscape Contex 0
SDL 2260413
Bioregion Code 5.1
Bioregion Desc GipP Gippsland Plain
species_connecti 56
temp RRI from SP 0.3
Flow flood path 1935945
Show Statistics?
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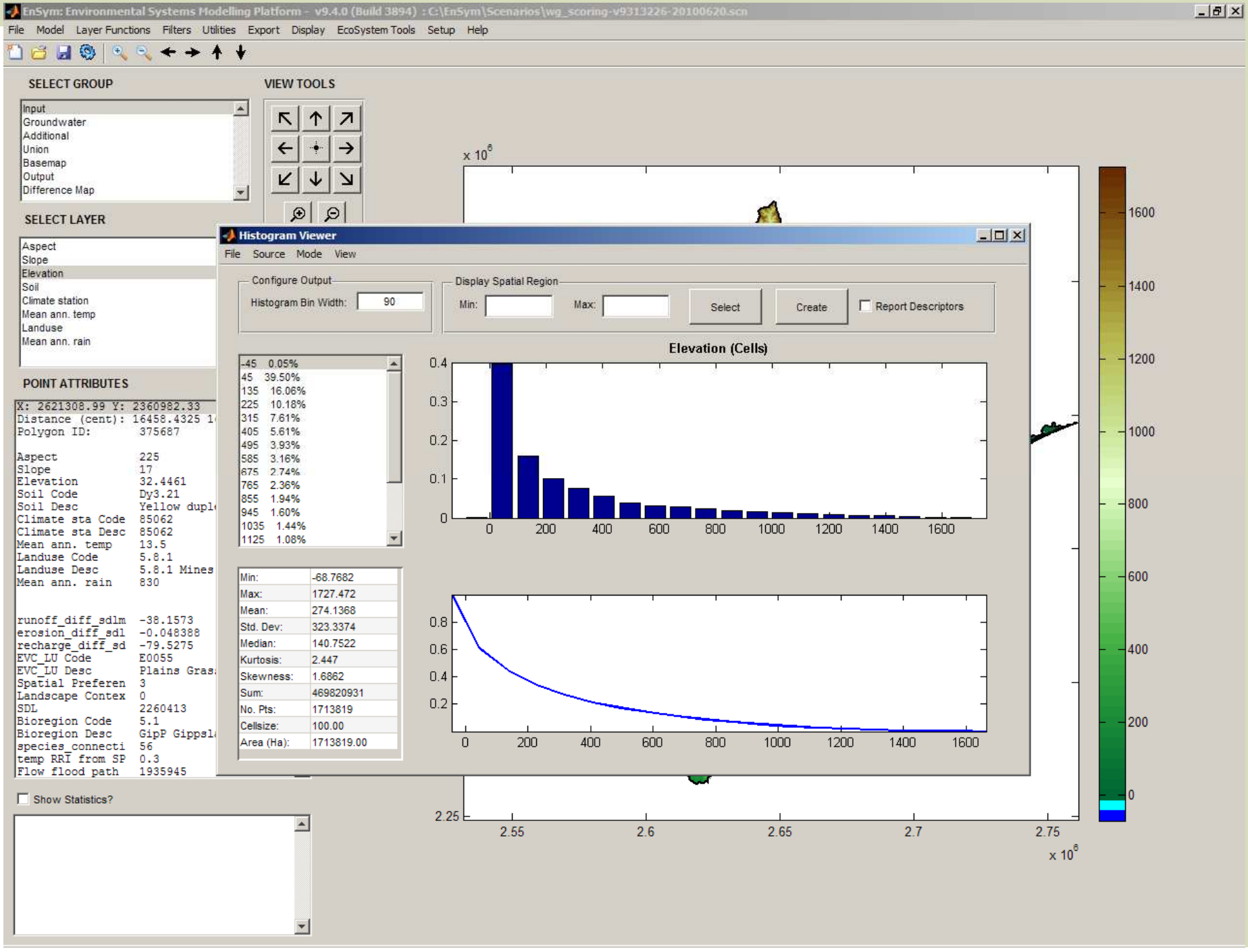
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File Model Layer Functions Filters Utilities Export Display EcoSystem Tools Setup Help
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VIEW TOOLS
SELECT LAYER
Aspect
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Spatial Preferen 3
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Histogram Viewer
File Source Mode View
Configure Output
Histogram Bin Width: 90
Display Spatial Region
Min:
Max:
Select
Create
Report Descriptors
-45 0.05%
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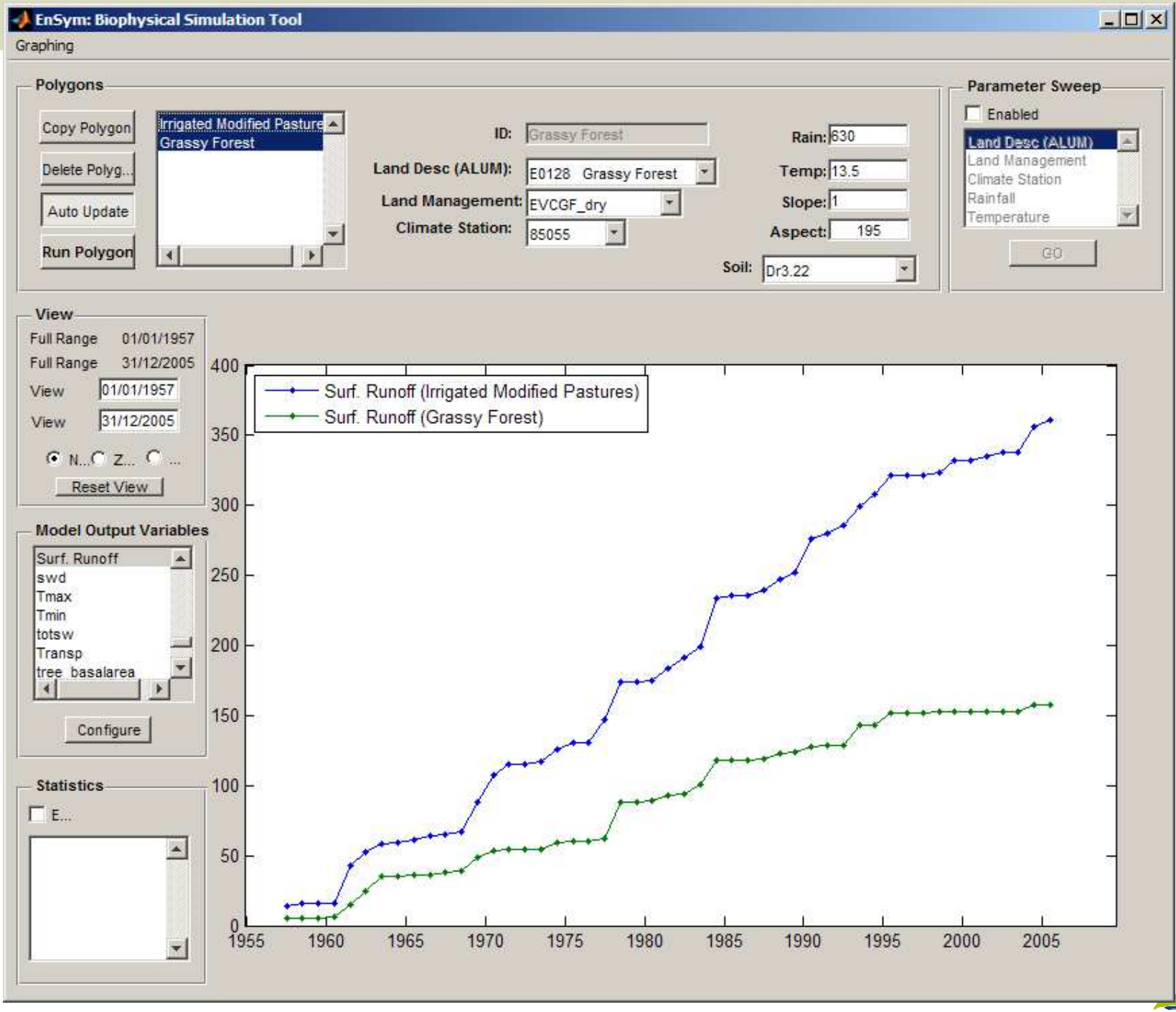
135 16.06%
225 10.18%
315 7.61%
405 5.61%
495 3.93%
585 3.16%
675 2.74%
765 2.36%
855 1.94%
945 1.60%
1035 1.44%
1125 1.08%
Elevation (Cells)
0.4
0.3
0.2
0.1
0
0 200 400 600 800 1000 1200 1400 1600
Min: -68.7682
Max: 1727.472
Mean: 274.1368
Std. Dev: 323.3374
Median: 140.7522
Kurtosis: 2.447
Skewness: 1.6862
Sum: 469820931
No. Pts: 1713819
Cellsize: 100.00
Area (Ha): 1713819.00
0.8
0.6
0.4
0.2
0 200 400 600 800 1000 1200 1400 1600


EnSym: Biophysical Simulation Tool
Graphing
Polygons
Copy Polygon
Delete Polyg...
Auto Update
Run Polygon
Irrigated Modified Pasture
Grassy Forest
ID:
Grassy Forest
Land Desc (ALUM):
E0128 Grassy Forest
Land Management:
EVCGF_dry
Climate Station:
85055
Rain:
630
Temp:
13.5
Slope:
1
Aspect:
195
Soil:
Dr3.22
Parameter Sweep
Enabled
Land Desc (ALUM)
Land Management
Climate Station
Rainfall
Temperature
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View
Full Range 01/01/1957
Full Range 31/12/2005
View 01/01/1957
View 31/12/2005
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Reset View
Model Output Variables
Surf. Runoff
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Tmin
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Transp
tree_basalarea
Configure
Statistics
E...
Surf. Runoff (Irrigated Modified Pastures)
Surf. Runoff (Grassy Forest)
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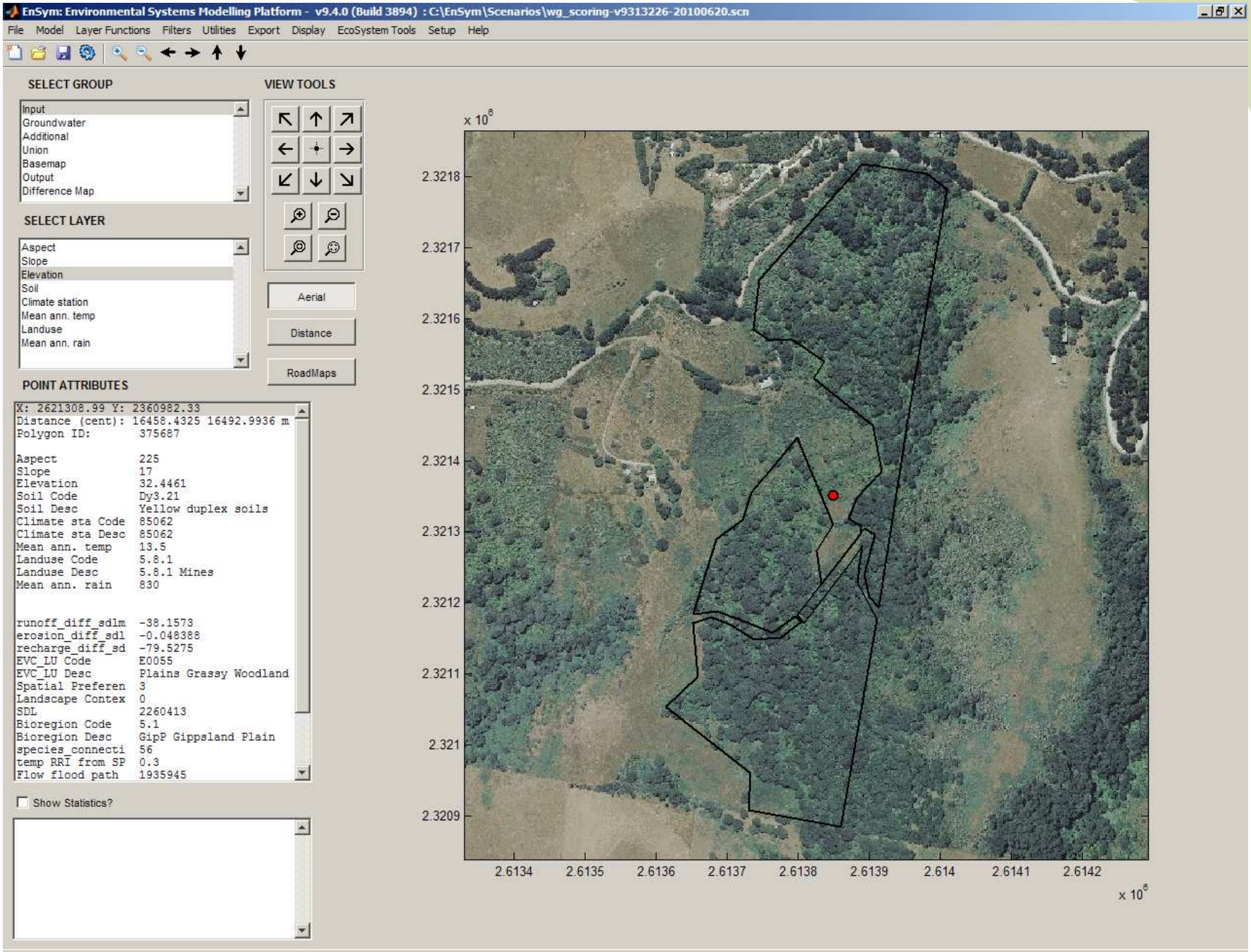
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File Model Layer Functions Filters Utilities Export Display EcoSystem Tools Setup Help
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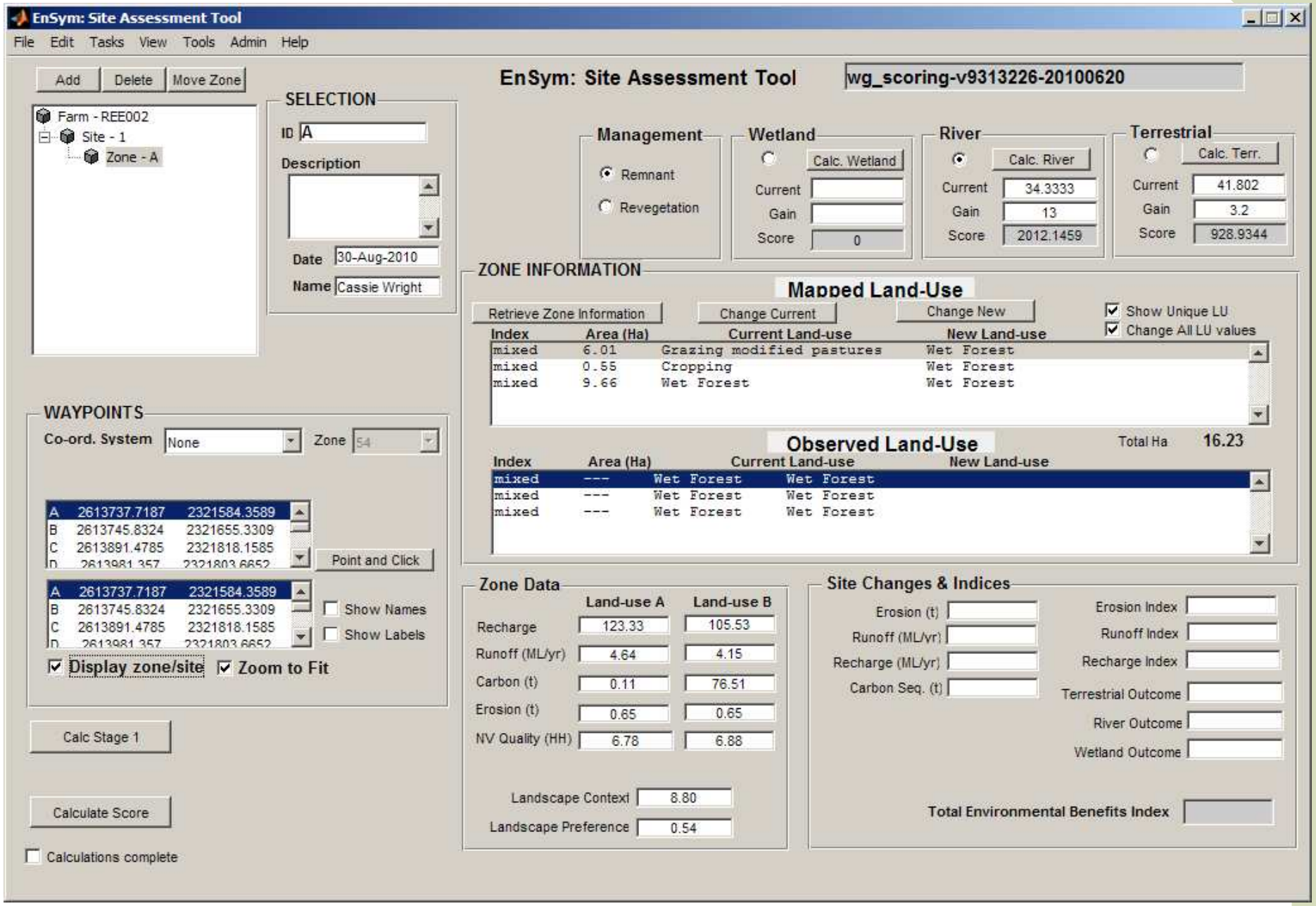
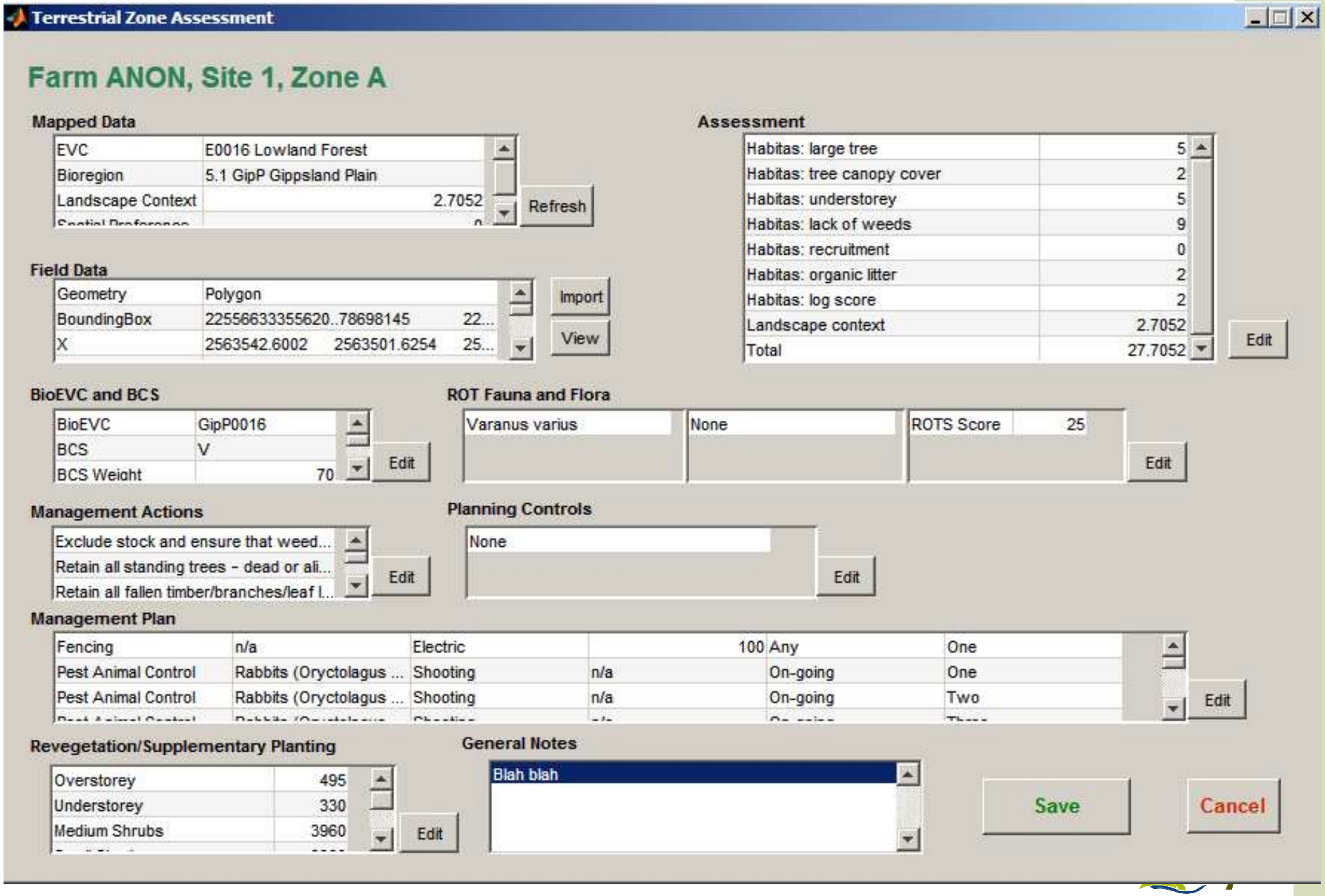
2.3217
2.3216
2.3215
2.3214
2.3213
2.3212
2.3211
2.321
2.3209
2.6134
2.6135
2.6136
2.6137
2.6138
2.6139
2.614
2.6141
2.6142
x 10^6


EnSym: Site Assessment Tool
File Edit Tasks View Tools Admin Help
Add Delete Move Zone
Farm - REE002
Site - 1
Zone - A
SELECTION
ID A
Description
Date 30-Aug-2010
Name Cassie Wright
EnSym: Site Assessment Tool
wg_scoring-v9313226-20100620
Management
Remnant
Revegetation
Wetland
Calc. Wetland
Current
Gain
Score 0
River
Calc. River
Current 34.3333
Gain 13
Score 2012.1459
Terrestrial
Calc. Terr.
Current 41.802
Gain 3.2
Score 928.9344
ZONE INFORMATION
Mapped Land-Use
Retrieve Zone Information
Change Current
Change New
Show Unique LU
Change All LU values
Index Area (Ha) Current Land-use New Land-use
mixed 6.01 Grazing modified pastures Wet Forest
mixed 0.55 Cropping Wet Forest
mixed 9.66 Wet Forest Wet Forest
Observed Land-Use
Total Ha 16.23
Index Area (Ha) Current Land-use New Land-use
mixed --- Wet Forest Wet Forest
mixed --- Wet Forest Wet Forest
mixed --- Wet Forest Wet Forest
WAYPOINTS
Co-ord. System None
Zone 54
A 2613737.7187 2321584.3589
B 2613745.8324 2321655.3309
C 2613891.4785 2321818.1585
Point and Click
Show Names
Show Labels
Display zone/site
Zoom to Fit
Zone Data
Land-use A Land-use B
Recharge 123.33 105.53
Runoff (ML/yr) 4.64 4.15
Carbon (t) 0.11 76.51
Erosion (t) 0.65 0.65
NV Quality (HH) 6.78 6.88
Landscape Contexi 8.80
Landscape Preference 0.54
Site Changes & Indices
Erosion (t)
Runoff (ML/yr)
Recharge (ML/yr)
Carbon Seq. (t)
Erosion Index
Runoff Index
Recharge Index
Terrestrial Outcome
River Outcome
Wetland Outcome
Total Environmental Benefits Index
Calc Stage 1
Calculate Score
Calculations complete


Terrestrial Zone Assessment
Farm ANON, Site 1, Zone A
Mapped Data
EVC
E0016 Lowland Forest
Bioregion
5.1 GipP Gippsland Plain
Landscape Context
2.7052
Refresh
Field Data
Geometry
Polygon
BoundingBox
22556633355620..78698145
22...
X
2563542.6002
2563501.6254
25...
Import
View
Assessment
Habitas: large tree
5
Habitas: tree canopy cover
2
Habitas: understorey
5
Habitas: lack of weeds
9
Habitas: recruitment
0
Habitas: organic litter
2
Habitas: log score
2
Landscape context
2.7052
Total
27.7052
Edit
BioEVC and BCS
BioEVC
GipP0016
BCS
V
BCS Weight
70
Edit
ROT Fauna and Flora
Varanus varius
None
ROTS Score
25
Edit
Management Actions
Exclude stock and ensure that weed...
Retain all standing trees - dead or ali...
Retain all fallen timber/branches/leaf l...
Edit
Planning Controls
None
Edit
Management Plan
Fencing
n/a
Electric
100
Any
One
Pest Animal Control
Rabbits (Oryctolagus ...
Shooting
n/a
On-going
One
Pest Animal Control
Rabbits (Oryctolagus ...
Shooting
n/a
On-going
Two
Edit
Revegetation/Supplementary Planting
Overstorey
495
Understorey
330
Medium Shrubs
3960
Edit
General Notes
Blah blah
Save
Cancel

## GENERAL SITE ACTIVITIES/COMMITMENTS

**For a period of 5 years from Commencement the landholder will**

- Take all reasonable steps to prevent fire on the land under contract. Any firebreaks established must be outside of the perimeter of the site specified in the plan.
- Take all reasonable steps to eliminate woody weeds on the site.
- Maintain all existing fencing in a stock-proof condition.
- Complete all activities specified in this contract to DSE standards.
- Not apply fertiliser to the site or crop the site.
- Not remove rocks or extract or introduce soil.
- Not allow supplementary feeding of stock within the site.
- Not plant non-indigenous plant species on the site.

---

**For a period of ten years from the commencement of this contract, the Landholder will**

- Maintain all fencing constructed under this contract, in a stock-proof condition.

---

**Reporting**

- As soon as practicable after the end of each year of the contract, the Landholder will submit a Progress Report to DSE.
- The landholder must allow access to the site for monitoring purposes.



## ZONE : A

| | |
|---|---|
| **Bioregion** | Strzelecki Ranges |
| **EVC** | (Strz0030) Wet Forest |
| **Management Zone** | A |
| **Area** | 16.23 ha |

### The Landholder agrees to:

- Exclude stock and ensure that weed cover does not increase beyond current levels
- Retain all standing trees – dead or alive
- Retain all fallen timber/branches/leaf litter
- Supplementary planting

### Yearly Management Activities

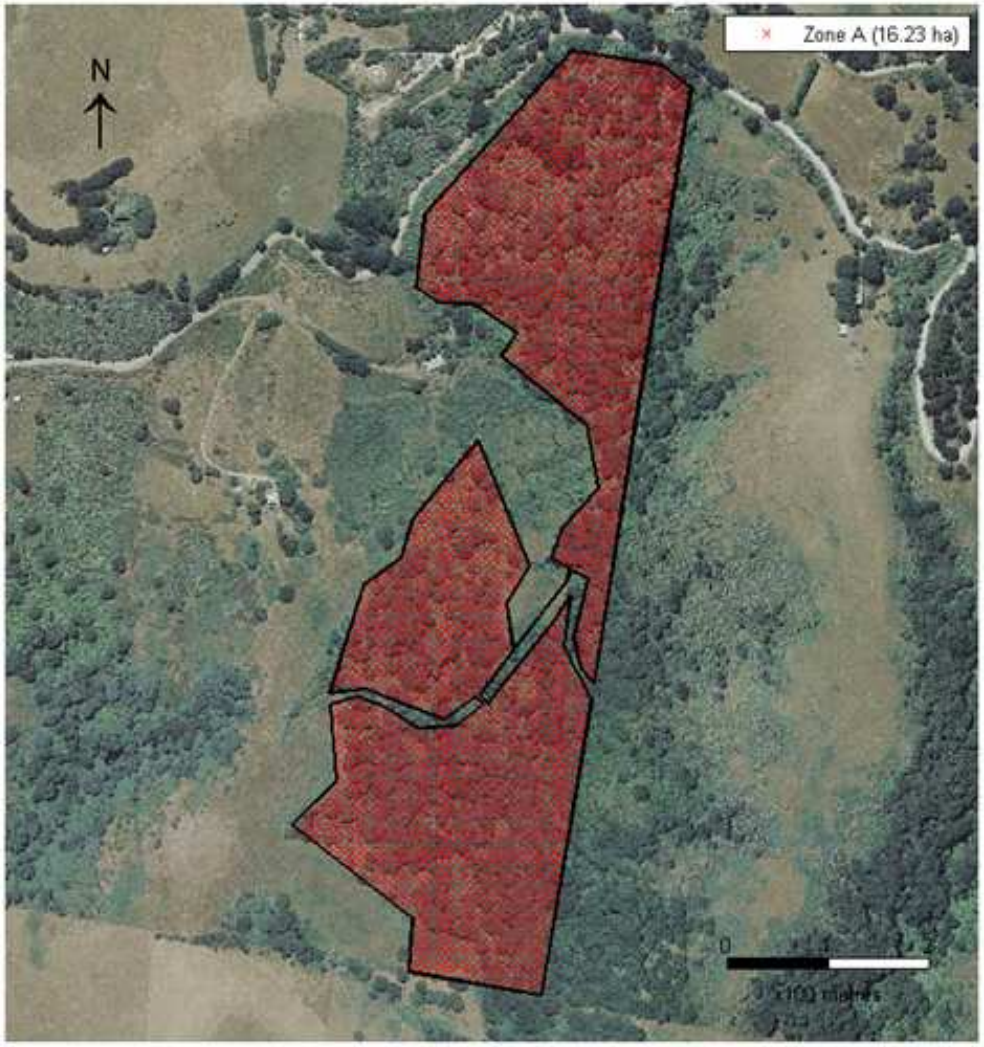
The landholder will complete the following management actions on zone for the time periods specified in the tables below.

**Notes:**
Works on Waterways permit required.
Potential habitat for Strzelecki Burrowing Cray.

| Year One | | |
|---|---|---|
| *Season* | *Activity* | *Species* |
| On-going | Monitor and control | New and Emerging Pest Animals |
| | Monitor and control | New and Emerging Weeds |
| | Monitor and control<br><br>Notes: Shooting by appropriately qualified and experienced people is the most appropriate method of deer control. | Deer (*Cervus dama*) |
| Spring/Summer | Spot spray | Hemlock (*Conium maculatum*) |
| | Cut and Paint - apply suitable herbicide | English Holly (*Ilex aquifolium*) |
| Summer | Spot spray | Blackberry (*Rubus fruticosus spp agg.*) |
| Throughout the year | Ringbark/cut down | Radiata Pine (*Pinus radiata*) |
| Within 1 year of signing contract | Fencing: Maintain or repair existing fencing, 335 metres (as per minimum standards)<br>Location: Along north-western side of protea paddock and driveway, adjacent to site | n/a |
| | Fencing: Standard, 570 metres (as per minimum standards)<br>Location: Along south-western side of site | n/a |

## DRAFT

| | |
|---|---|
| EOI: | Site 1 |
| Site Address: | Somewhere |
| Landowner(s): | Mr Farmer |
| Date Assessed: | 30-Aug-2010 |
| Prepared on: | 05-Oct-2010 |
| Prepared by: | Cassie Wright |

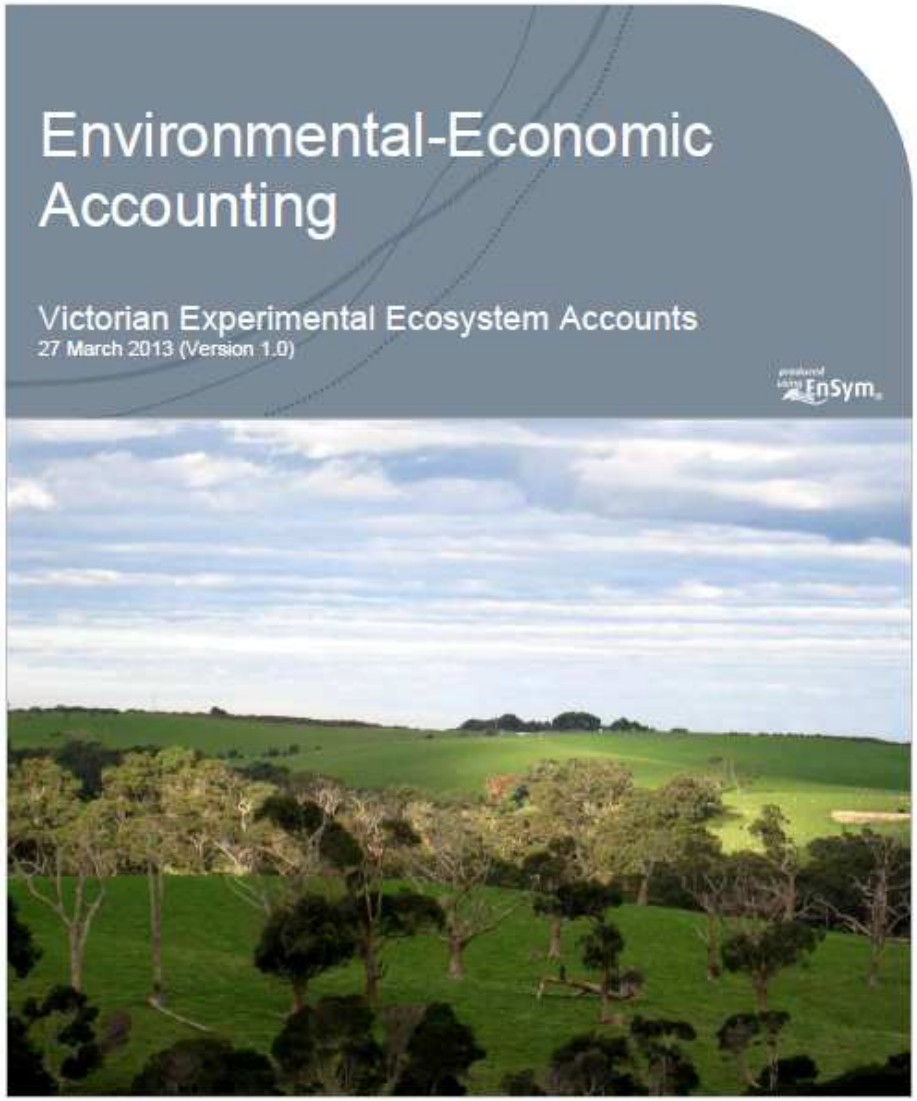



EnSym

# Applications

- Scenarios
  - Land use change, climate change,
- Trade-off analysis
  - Carbon, surface water, ground water, biodiversity, species, fire, landscape connectivity, etc
- Planning
  - Combining empirical data with qualitative data
  - Social capability, local interest, past work
  - Asset prioritisation and attribution
- Investment
  - Prioritise land use change/management based on desired outcomes
  - **Environmental Accounts**

# Producing Environmental Accounts with EnSym




Data integration and reporting using EnSym

https://ensym.dse.vic.gov.au/cms/

EnSym

# References

**Habitat Hectares methodology**

http://www.environment.gov.au/archive/biodiversity/toolbox/templates/pubs/habitat-hectares.pdf

**Native Veg Net Gain documentation - terrestrial metric**

http://www.dse.vic.gov.au/CA256F310024B628/0/AC29C99DDB4591A8CA257236001D6D06/$File/NativeVeg_Gain_Approach.pdf

**IWC methodology**

http://www.dse.vic.gov.au/DSE/nrence.nsf/LinkView/3EA5B6AEFB53EE3DCA25708B00145F44522C816829EBF3F7CA25700C00240E63

**Wetland Metric document**

contact ecoMarkets at ensym.support@dse.vic.gov.au

**ISC methodology**

http://www.ourwater.vic.gov.au/monitoring/river-health/isc

**River health metric document**

contact ecoMarkets at ensym.support@dse.vic.gov.au

**Overall site scoring document**

contact ecoMarkets at ensym.support@dse.vic.gov.au