

# BIODIVERSITY ASSESSMENT FOR AGRICULTURE STEWARDSHIP PILOTS



Australian  
National  
University

# Agriculture biodiversity stewardship pilots

- Part of Commonwealth package announced in 2020
- ANU a key delivery partner alongside National Farmers Federation and Natural Resource Management organisations
- Three ‘market’ concepts trialled:
  1. Carbon plus biodiversity (C+B)
  2. Enhancing remnant vegetation (ERV)
  3. Australian Farm Biodiversity Certification Scheme
- Common information framework proposed for biodiversity assessment
- Funding decisions in C+B and ERV based on cost/benefit assessment -> need to quantify ‘benefit’ on an appropriate scale

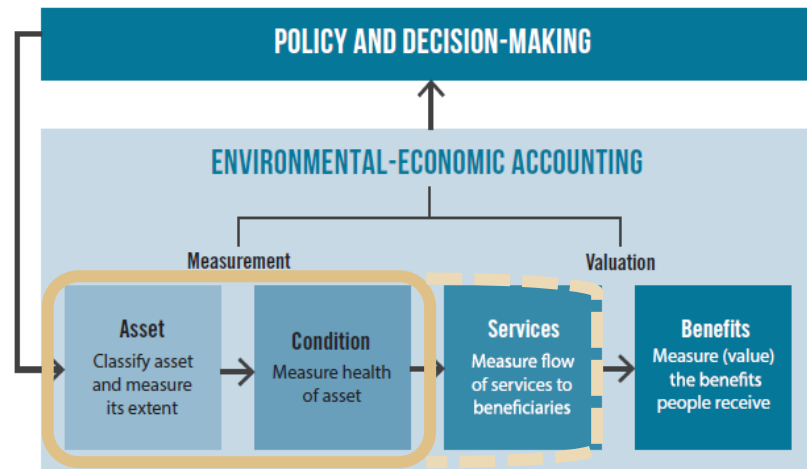


# Information framework design choices

- Evidence based, repeatable, transparent, cost effective, scalable
- Consistent concepts nationally but using best available data – most of which is developed by States and Territories
- Foundation in environmental accounting
  - align with global momentum
  - demonstrate utility of, and benefit from development of, new national datasets
  - facilitate awareness and uptake of accounting
  - extends concepts for co-benefits under QLD Land Restoration Fund, alongside Accounting for Nature



# Information framework design choices



## Assets

Native ecosystems

Threatened species habitats

Riparian buffers

## Condition

The overall quality of an ecosystem asset, in terms of its characteristics

Composition, structure & function

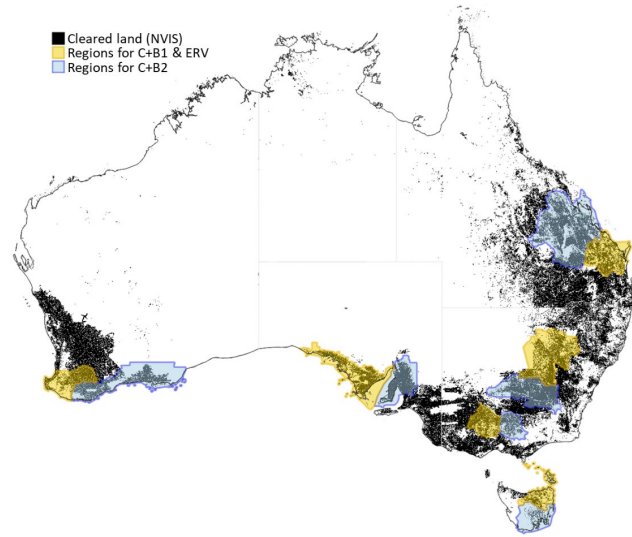
Undegraded native state is used as reference (100/100)

## ‘Service’: persistence of native biodiversity

Modelled as a function of regional asset condition using species area relationship



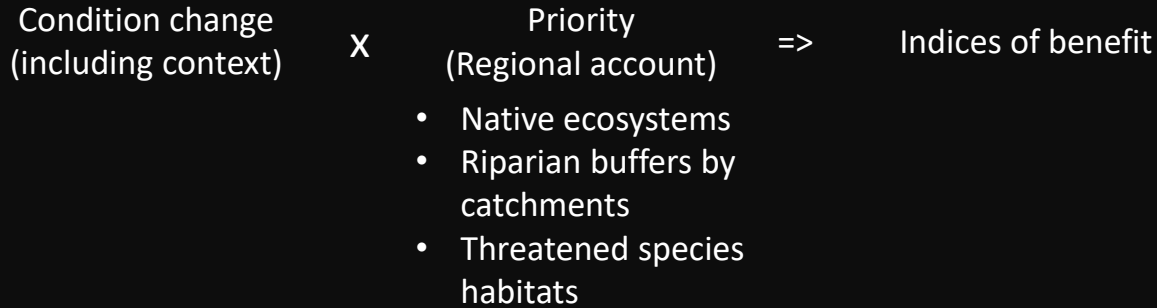
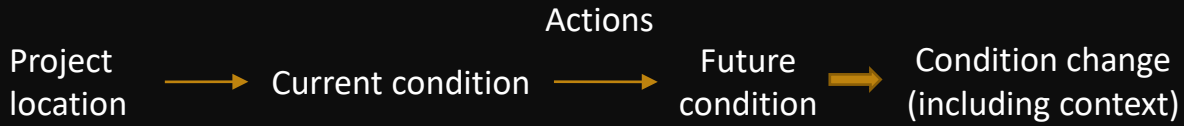
# Application to pilots



$\text{Benefit}(\text{asset}) \sim \Delta \text{ service} \sim \Delta(\text{project condition}) * (\text{regional priority of project assets})$

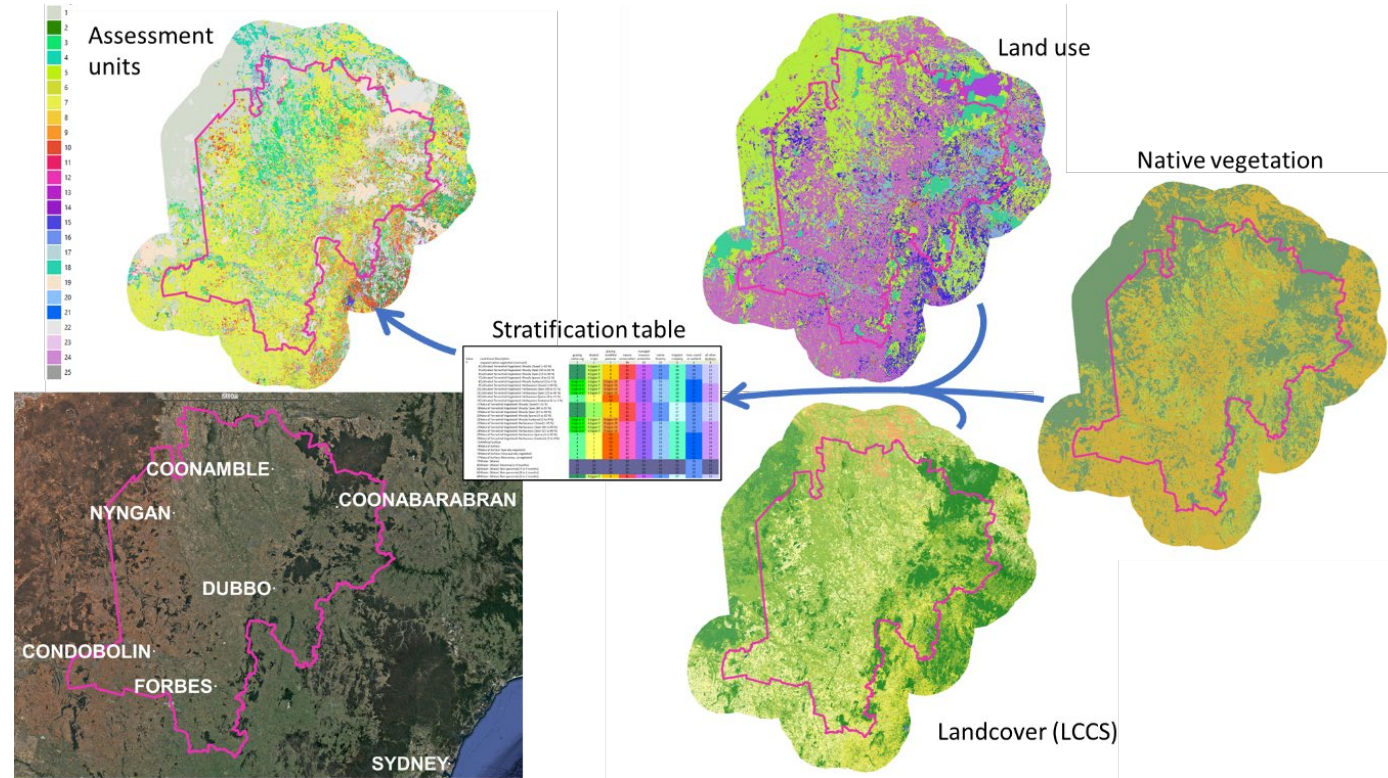
Weighted sum of benefits to different asset classes, discounts for impermanence





# Condition model

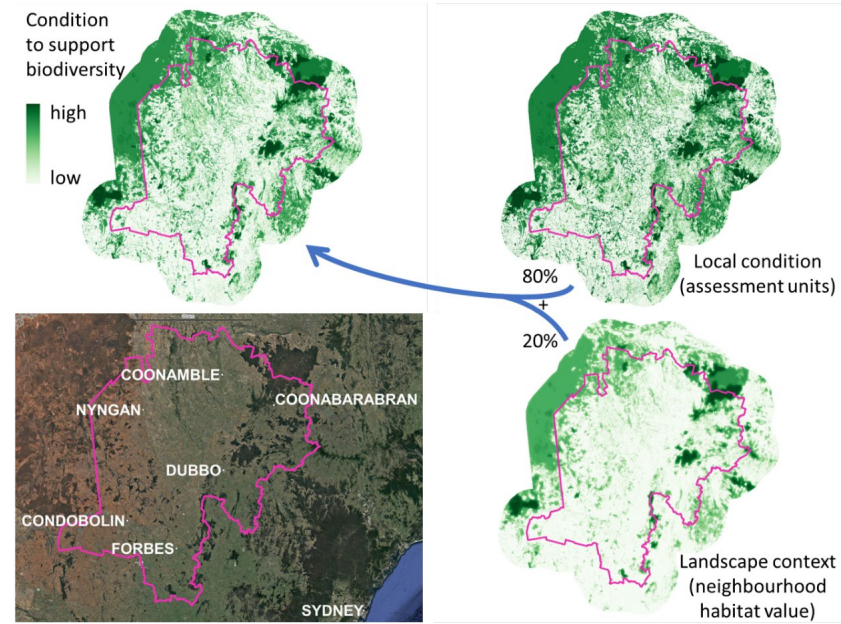
1. NRM Regions (+50km) broken into spatial subsets of land (assessment units) in similar condition to support biodiversity (25m raster)



# Condition model

2. Estimate average local site condition of ecosystems in each assessment unit (HCAS, state condition maps, expert opinion)
3. Apply average values to spatial assessment units to create a local condition map

4. Connectivity algorithm applied to local condition map to calculate 'neighbourhood habitat value' layer (thanks M. Drielsma and J. Love, NSW OEH)



5. Combine local condition (80% weighting) and neighbourhood habitat value (20% weighting) to produce condition map



# Regional accounts for asset types

## 1. Native ecosystems

- Natural extent (pre-clearing)
- Major Vegetation Subgroups (NVIS) x Bioregions (IBRA) in most regions (sources on next slide)
- Proportional allocation of condition values to heterogeneous classes

## 2. Threatened species habitats

- Spatial models for target species
- Selection based on relevance of activity; birds for C+B, birds + mammals for ERV
- whole range

## 3. Riparian buffers by catchment

- Buffers applied to stream network within catchments from Australian Hydrological Geospatial Fabric (Geofabric)

	Hierarchy class	
Perenniality	Minor	Major
Non-perennial	25 m	75 m
Perennial	50 m	100 m



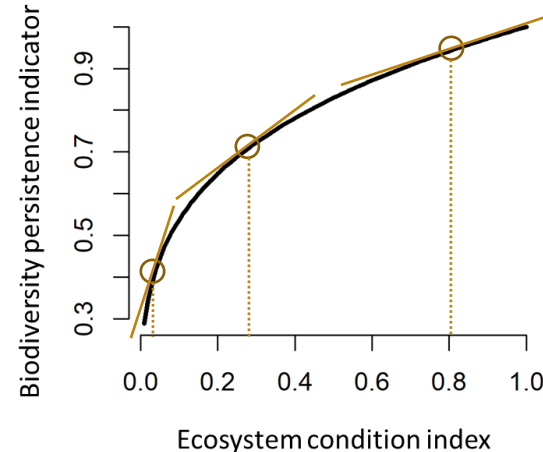
# Priority surfaces

- How much will adding an intact hectare of each asset type improve the relevant regional biodiversity persistence indicator?
- Regional biodiversity persistence indicators are related to the condition score of each of ecosystem/species/catchment through the species area relationship

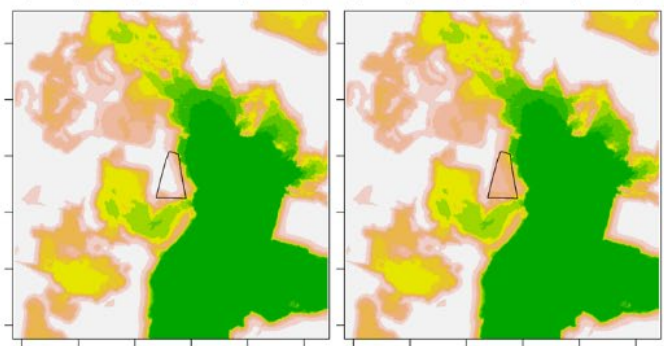
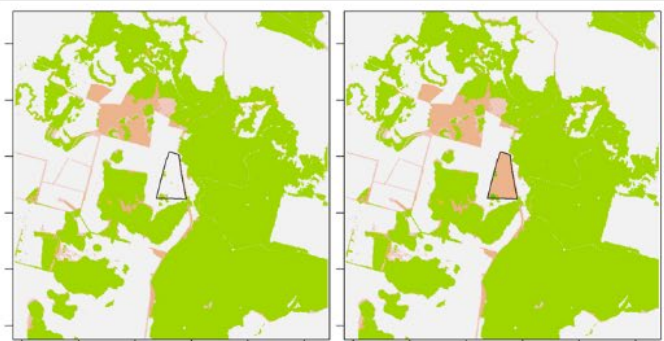
$$B = \frac{\sum_{k=1}^n C_k^{0.27} \cdot H_k}{\sum_{k=1}^n H_k}$$

Where:

- $B$  is an index of biodiversity persistence for a given asset class (e.g. ecosystems, riparian buffers or threatened species habitats)
- $n$  is the number of classes within the asset
- $k$  is an indexing variable ranging from 1 to  $n$
- $C_k$  is the condition (on a scale of 0-1) of the  $k$ th class (from the accounts prepared as described above)
- $H_k$  is the area of the  $k$ th class



Current local condition    Future local condition

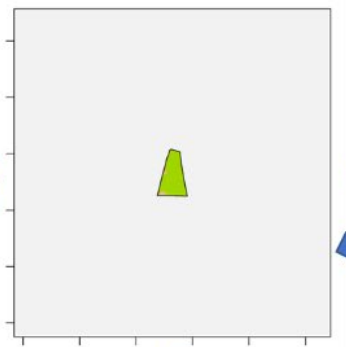


Current landscape context

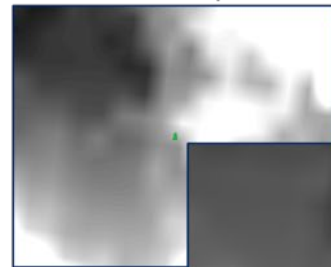
Future landscape context

high  
low

Change in condition for biodiversity



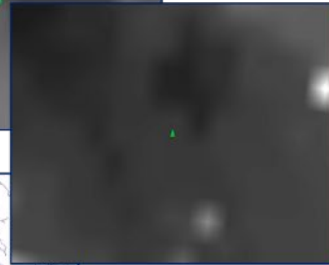
Threatened species 1



Species 2



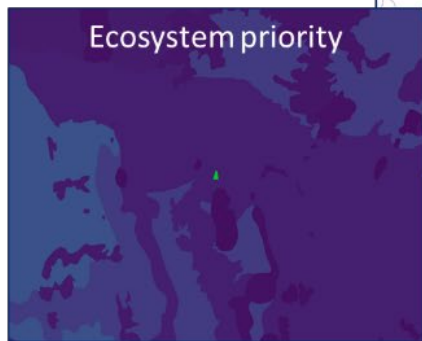
Species 3



Stream priority



Ecosystem priority

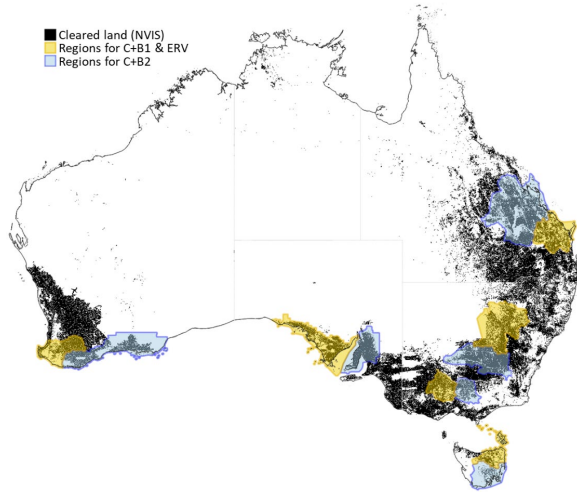


Benefit



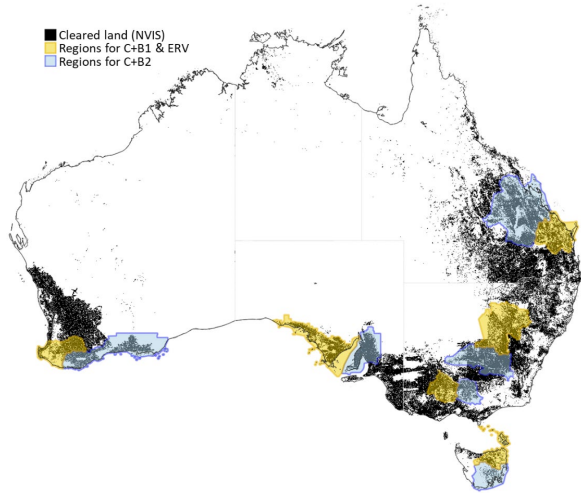
# Carbon plus biodiversity

2 rounds, 159 applications



- 2 planting options offered
  - a) Simple mixed native plantings
  - b) Local vegetation community plantings
- Guidelines and planting protocol detailed regionally specific planting requirements, beyond those of ERF native plantings method (Minimum numbers of species and lifeforms, minimum dimensions, exclusion of native grasslands and treeless wetlands etc.)
- Applications via national stewardship trading platform (detail costs plus spatial data)
- Assessment remote only
- Local condition gain ~ planting type and starting condition

# Enhancing remnant native vegetation

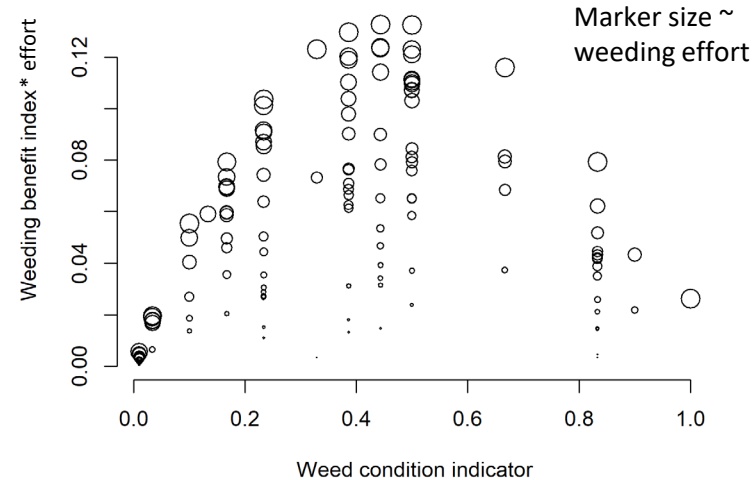
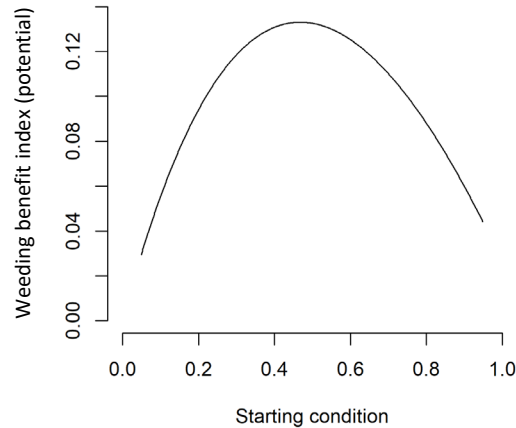
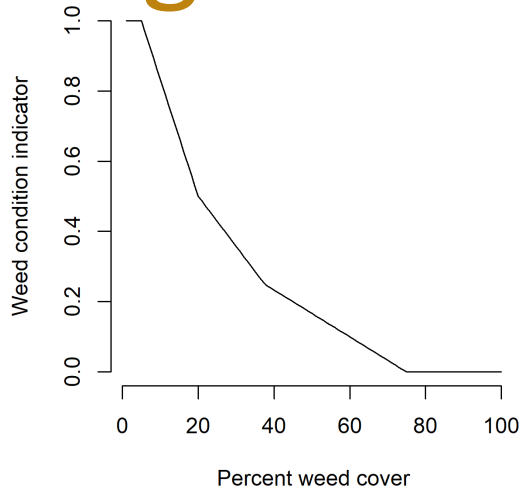


- Biodiversity payments for management to improve condition of native vegetation in agricultural landscapes
- Management options in 4 themes:
  - Infill planting/revegetation
  - Improved grazing management
  - Enhanced weed control
  - Enhanced pest control
- 2 stage assessment (↑risk and complexity)
  1. Initial prioritisation then field assessment of priorities
  2. Project plan agreement followed by final assessment
- 180 application, 115 field assessed

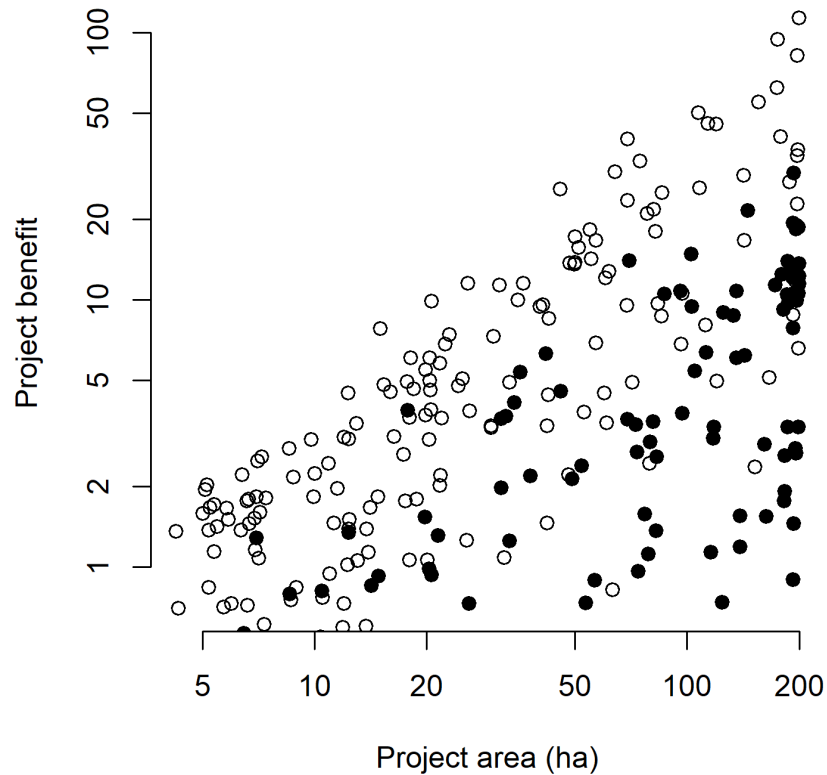
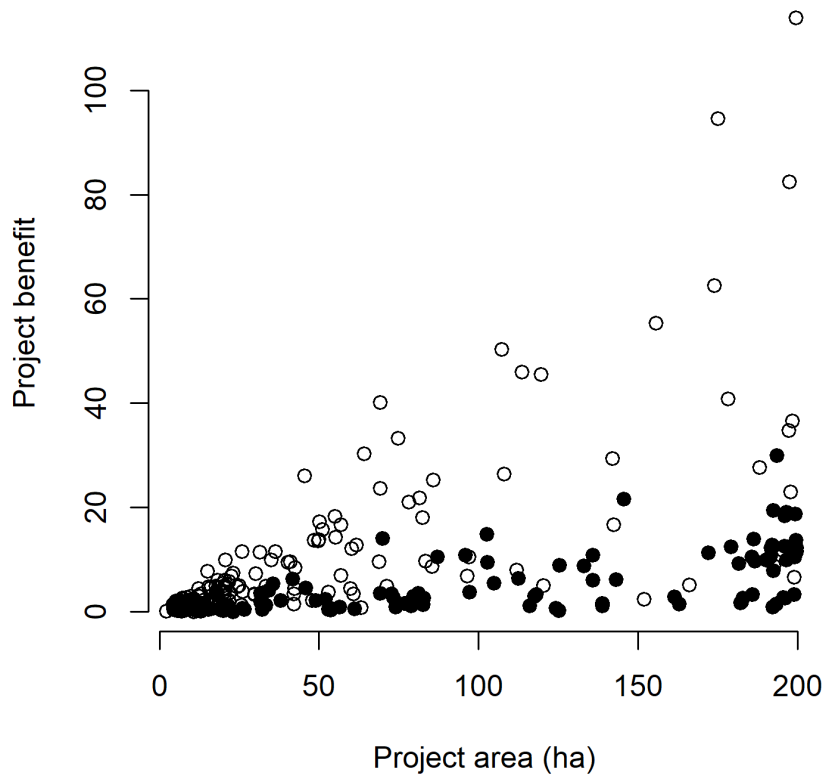


# Enhancing remnant native vegetation

- Local condition gain estimated as a function of starting condition and proposed effort for each management theme
- E.g. Condition gain from weeding  $\sim$  weeding benefit index \* effort \* starting condition



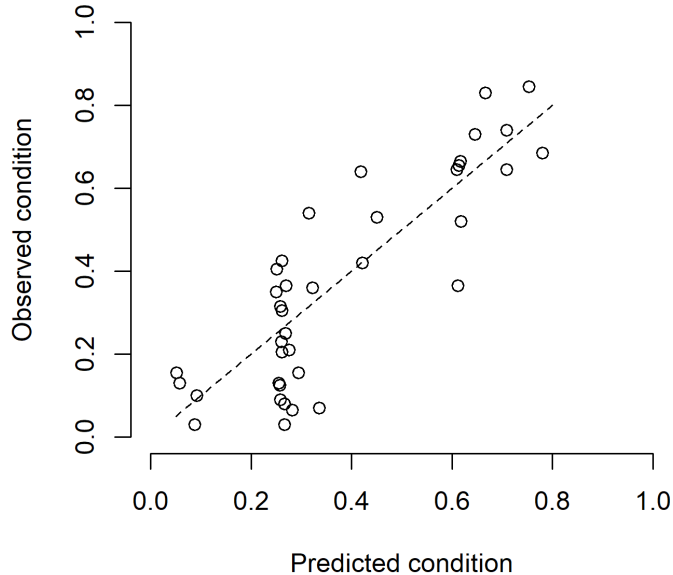
○ C+B  
● ERV



# Evaluation

- Combination of local condition change with priority for specific values is useful and enables consistent scaling for assessment of benefits

- Adequacy of available data is patchy
- Errors always an issue – any system needs processes to correct errors. Using classes enables efficient error correction
- Representation of biodiversity (for priority layers) can be improved



# Evaluation



- Pilot approaches well suited to agricultural landscapes and government grants
- Habitat condition dimension can be less informative in relatively intact landscapes, where habitat destruction may not be the main driver of biodiversity decline
- Appropriate balance between complexity/effort and risks varies between activities, but consistent concepts can still be applied
- Making use of ‘best available’ data will highlight benefits from improvement



# THANK YOU

- ANU team: Andrew Macintosh, Dean Ansell and Marie Waschka
- DAWE/DCCEEW teams
- Regional NRM bodies
- Landholders involved in the pilots

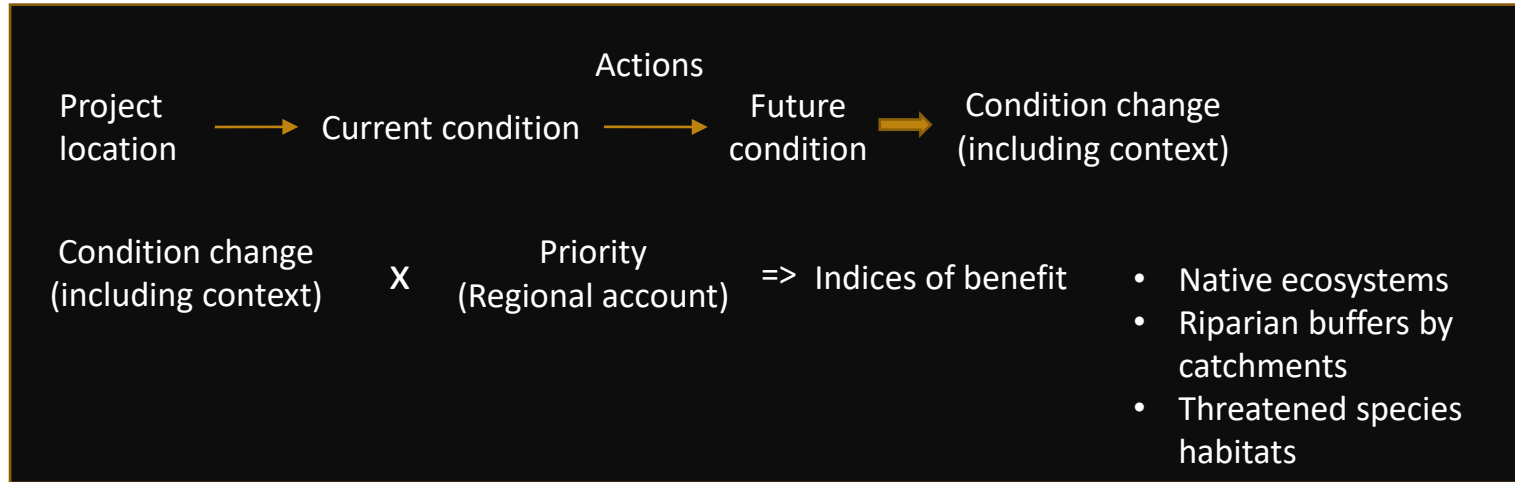
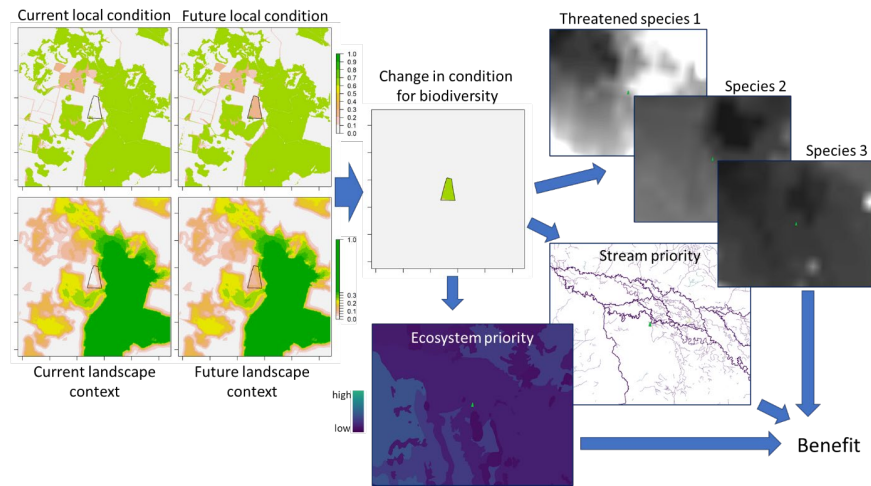
## Contact



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# Recap



# Data sources for land use and vegetation extent in pilots

State	Regions	Land use	Native vegetation extent
Western Australia	South West, South Coast	Catchment Scale Land Use Mapping for Western Australia 2018 (2008-2018) <a href="https://data.gov.au/dataset/d897e165-46a3-4f3b-a2f2-b348ac06ddfe">https://data.gov.au/dataset/d897e165-46a3-4f3b-a2f2-b348ac06ddfe</a>	National Vegetation Information System (NVIS) Version 6.0 - AUSTRALIA - Extant Vegetation [MVG not 25 or 99 or 0] <a href="https://www.dcceew.gov.au/environment/land/native-vegetation/national-vegetation-information-system/data-products#detailed60">https://www.dcceew.gov.au/environment/land/native-vegetation/national-vegetation-information-system/data-products#detailed60</a>
South Australia	Eyre Peninsula, Northern and Yorke Northern and Yorke	Land Use (ACLUMP) 2008-2016 <a href="https://data.sa.gov.au/data/dataset/land-use-aclump">https://data.sa.gov.au/data/dataset/land-use-aclump</a>	National Vegetation Information System (NVIS) Version 6.0 - AUSTRALIA - Extant Vegetation [MVG not 25 or 99 or 0]
Victoria	North Central, Goulburn Broken	Victorian Land Use Information System 2016-2017 <a href="https://discover.data.vic.gov.au/dataset/victorian-land-use-information-system-2016-20171">https://discover.data.vic.gov.au/dataset/victorian-land-use-information-system-2016-20171</a>	National Vegetation Information System (NVIS) Version 6.0 - AUSTRALIA - Extant Vegetation [MVG not 25 or 99 or 0]
Tasmania	NRM North, NRM South	Tasmanian Land Use 2019 <a href="https://www.thelist.tas.gov.au/app/content/data/geo-meta-data-record?detailRecordUID=ed2bc55a-6e61-4f9a-b292-4c0d0549ee59">https://www.thelist.tas.gov.au/app/content/data/geo-meta-data-record?detailRecordUID=ed2bc55a-6e61-4f9a-b292-4c0d0549ee59</a>	TASVEG 4.0 (released 2020) <a href="https://www.thelist.tas.gov.au/app/content/data/geo-meta-data-record?detailRecordUID=b5c7a079-14bc-4b3c-af73-db7585d34cdd">https://www.thelist.tas.gov.au/app/content/data/geo-meta-data-record?detailRecordUID=b5c7a079-14bc-4b3c-af73-db7585d34cdd</a>
New South Wales	Central West, Riverina	NSW Landuse 2017 v1.2 <a href="https://datasets.seed.nsw.gov.au/dataset/nsw-landuse-2017-v1p2-f0ed">https://datasets.seed.nsw.gov.au/dataset/nsw-landuse-2017-v1p2-f0ed</a>	Mainly Plant Community Type (PCT) mapping. Central West - Central West / Lachlan Regional Native Vegetation PCT Map Version 1.0. VIS_ID 4468; Riverina - NSW State Vegetation Type Map (SVTM) Riverina Version v1.2. Supplemented by NVIS for areas not covered by PCT mapping, including ACT and Victoria (within buffers)
Queensland	Burnett Mary, Fitzroy Basin	QLD Land Use 2019 (BMRG and Fitzroy both 2017)	National Vegetation Information System (NVIS) Version 6.0 - AUSTRALIA - Extant Vegetation [MVG not 25 or 99 or 0]

Landcover from Geoscience Australia's landcover data (LCCS), with NCAS overlay to reduce commission for woody cover in grazing & cropping lands



State	Regions	Ecosystem classes	Notes
Western Australia	South West, South Coast	Combinations of pre-1750 Major Vegetation Subgroups (NVIS) and bioregions (IBRA).	NVIS data in south-west WA has polygons containing up to 6 MVS. Condition pixels in heterogeneous polygons contributed to class averages via weightings for standardised proportions based on the number of MVS listed. For example, polygons with 2 MVS were weighted 70% for the first listed class and 30% for the second.
South Australia	Eyre Peninsula, Northern and Yorke Northern and Yorke	Combinations of pre-1750 Major Vegetation Groups (NVIS) and bioregions (IBRA).	Used MVG's rather than MVS in South Australia because of inconsistent pre-1750 classification approaches between areas that are now cleared and areas of remnant vegetation in the modern landscape. NVIS data in SA has polygons containing up to 3 MVS. Condition pixels centred in heterogeneous polygons contributed to class averages via weightings from proportions fields in the NVIS data.
Victoria	North Central, Goulburn Broken	Combinations of pre-1750 Major Vegetation Subgroups (NVIS) and bioregions (IBRA).	NVIS data were the same as the latest pre-1750 EVC release. Polygons are assigned to a single MVS, so no weighting was needed.
Tasmania	NRM North, NRM South	Land Systems for NRM south (second round of C+B), for C+B1 and ERV combined classifications of geology, landform and IBRA regions.	There is no pre-clearing or pre-1750 data in NVIS for Tasmania. Land systems were selected as the best available spatial data describing ecosystem level variation in biodiversity in the State.
New South Wales	Central West, Riverina	Mitchell Landscapes (similar to land systems).	There is no pre-clearing or pre-1750 data in NVIS for New South Wales. Mitchell Landscapes were selected as the best available spatial data describing ecosystem level variation for biodiversity in the State.
Queensland	Burnett Mary, Fitzroy Basin	Combinations of pre-1750 Major Vegetation Subgroups (NVIS) and bioregions (IBRA).	NVIS data for QLD has polygons containing up to 5 MVS. Condition pixels centred in heterogeneous polygons contributed to class averages via weightings from proportions fields in the NVIS data.

<sup>[1]</sup> National Vegetation Information System (NVIS) Version 6.0 - AUSTRALIA - Estimated Pre-1750 Vegetation <http://environment.gov.au/fed/catalog/search/resource/details.page?uuid=%7BB26A2C5D-5964-4EE4-BA29-8DAA7C90ABA2%7D>

<sup>[2]</sup> Interim Biogeographic Regionalisation for Australia (IBRA), Version 7 (Regions) <https://data.gov.au/dataset/ds-dga-d44dd392-ebea-4f1a-b30e-4a2da154aae4/details?q=IBRA%20regions>

<sup>[3]</sup> Land Systems of Tasmania. <https://www.thelist.tas.gov.au/app/content/data/geo-meta-data-record?detailRecordUID=a6edb2f-f8ad-4232-8a89-2c7d4c4fd003>

<sup>[4]</sup> NSW (Mitchell) Landscapes - version 3.1. <https://datasets.seed.nsw.gov.au/dataset/nsw-mitchell-landscapes-version-3-1>



Species	EPBC	Habitat remnant (%)	WA	SA	TAS	VIC	NSW	QLD
Australasian bittern	E	48.7						
Baudin's black cockatoo	V	37.4						
Black-breasted button-quail	V	49.4						
Forest Red-tailed black cockatoo	V	80.1						
Forty-spotted pardalotte	E	42.5						
Grey falcon	V	88.0						
Mallee fowl	V	56.6						
Mallee western whipbird	V	23.8						
Masked owl (Tasmania)	V	60.8						
Night parrot	E	90.0						
Painted honeyeater	V	62.3						
Painted snipe	E	67.2						
Plains wanderer	CE	59.7						
Red goshawk	V	75.9						
Regent honeyeater	CE	48.4						
Eastern regent parrot	V	40.0						
Southern emu-wren	V	27.1						
Squatter pigeon	V	60.2						
Superb parrot	V	45.8						
Swift parrot	CE	47.5						
Thick-billed grass-wren	V	96.3						
Wedge-tailed eagle (Tasmania)	E	60.9						
White-throated needletail	V	51.2						

## Threatened species selections for C+B (left) and ERV (all) pilots

Species	EPBC	Habitat remnant (%)	WA	SA	TAS	VIC	NSW	QLD
Black-tipped Spider-orchid	CE	52.7						
Chuditch	V	72.0						
Corben's Long-eared Bat	V	58.2						
Greater glider	E	58.0						
Grey-headed Flying-fox	V	60.9						
Koala (Qld, NSW, ACT)	E	40.0						
Large Pied Bat	V	46.2						
Northern quoll	E	86.8						
Numbat	E	93.4						
Pilliga Mouse	V	96.3						
Red-tailed phascogale	V	60.8						
Sandhill Dunnart	E	37.4						
Spotted-tail Quoll (SE mainland population)	E	52.9						
Spotted-tail Quoll (Tasmanian population)	V	78.1						
Tasmanian devil	E	23.8						
Western Ringtail Possum	CE	27.1						
Wopilkara	V	97.1						
Woylie	E	73.0						



# ERV – management gain factors

	Theme condition indicators	Effort measure	Condition gain
Grazing management	Bare ground, regeneration, erosion, signs of grazing impact	Grazing intensity change (dse.ha.months, new:now)	Benefit index * effort * assessor confidence in gains
Infill	Signs of past clearing, current condition	% of area to be planted	Benefit index * effort * starting condition
Weeding	Weed cover	~ hours/ha/yr	Benefit index * effort * starting condition
Pest control	Field evidence of pests, large tree abundance	~ hours/ha/yr	Benefit index * effort * starting condition



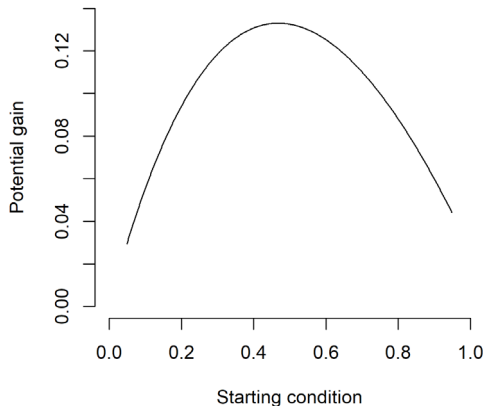
# Condition model

Assessment Unit code	Extent (ha x 1000)	Description	HCAS 2.1 mean	NSW condition mean	Assigned condition value
1	5700	Mapped native vegetation (outside reserves)	0.66	0.46	0.65
2	225	Modified woody vegetation in grazing land	0.60	0.49	0.5
3	930	Herbaceous vegetation in grazing land	0.53	0.42	0.3
4	802	Bare areas in grazing land	0.52	0.41	0.2
5	63	Modified woody vegetation in dryland crop land	0.35	0.17	0.2
6	426	Herbaceous or cultivated woody cover in dryland crop land	0.38	0.16	0.05
7	5367	Bare areas in dryland crop land	0.30	0.12	0.01
8	55	Modified woody vegetation in improved grazing land	0.44	0.24	0.25
9	656	Herbaceous or sparse cover in improved grazing land	0.40	0.17	0.1
10	794	Cultivated herbaceous cover or bare areas in improved grazing land	0.41	0.17	0.05
19	721	Mapped native vegetation conservation lands	0.85	0.71	0.8
11	10	Modified woody vegetation in conservation land	0.76	0.71	0.7
12	16	Herbaceous vegetation or bare in conservation land	0.57	0.59	0.6
22	1030	Mapped native vegetation resource protection or native forestry	0.81	0.57	0.4
13	44	Modified woody vegetation in resource protection land	0.74	0.59	0.6
14	59	Herbaceous or sparse cover in resource protection land	0.61	0.46	0.4
15	14	Modified woody in native forestry land	0.48	0.63	0.6
16	5	Herbaceous cover in native forestry land	0.62	0.47	0.5
17	7	Modified woody in irrigated crop land	0.26	0.17	0.2
18	387	Herbaceous or bare irrigated crop land	0.29	0.12	0.01
20	36	Modified woody river/marsh/wetland	0.47	0.40	0.5
21	10	Non-woody river/marsh/wetland	0.35	0.34	0.3
23	33	Modified woody all other land uses	0.46	0.28	0.3
24	213	Non-woody all other land uses	0.40	0.20	0.01
25	12	Water >3 months	0.28	0.43	0.4

## Central West NSW condition assignments



# Enhancing remnant native vegetation



- Local condition gain estimated as a function of starting condition and proposed effort for each management theme

$$V = \frac{C \cdot e^{r \cdot t}}{1 + C \cdot e^{r \cdot t} - 1}$$

Where:

- $V$  is the future value for a management specific condition indicator as a proportion of benchmark (i.e. scaled 0-1)
- $C$  is the current value of the indicator (scale 0-1)
- $e$  is Euler's number (a mathematical constant)
- $r$  is a constant akin to an 'intrinsic rate of increase' in the indicator –  $r$  was held at 0.05
- $t$  is the time frame (10 years for ERV)

See equation 31 in <https://legislation.nsw.gov.au/view/pdf/asmade/sl-2020-621>, and Oliver, I. Dorrrough, J. and Seidel, J. (2021) A new Vegetation Integrity metric for trading losses and gains in terrestrial biodiversity value, *Ecological Indicators*, 124, 107341 <https://doi.org/10.1016/j.ecolind.2021.107341>.



## PERMEABILITY (COST) GRID

Cell permeability values for window centred on focal cell

	0.9	0.9	0.1	0.9	0.9	0.9	0.1	
1.2	0.1	0.9	0.9	0.7	0.2	0.1	0.9	0.1
1.2	0.8	0.8	0.5	0.9	0.2	0.8	0.8	0.2
1.9	0.9	0.9	0.2	0.9	0.9	0.9	0.9	0
1	0.9	0.9	0.2	0.2	0.1	0.9	0.9	0
0.9	0.9	0.9	0.1	0.9	0.9	0.9	0.9	0
0.1	0.9	0.9	0.1	0.9	0.9	0.9	0.9	0

## HABITAT (BENEFIT) GRID

Habitat quality values ( $H$ ) for window centred on focal cell

	70	60	50	40	30	80	70	
100	100	90	50	30	10	10		
90	90	50	100	20	70	50	80	
70	90	50	100	100	100	20	0	
40	90	20	20	10	100	50	0	
90	90	10	90	90	90	100	0	
90	90	10	50	10	40	40	0	

# Context modelling approach – in brief

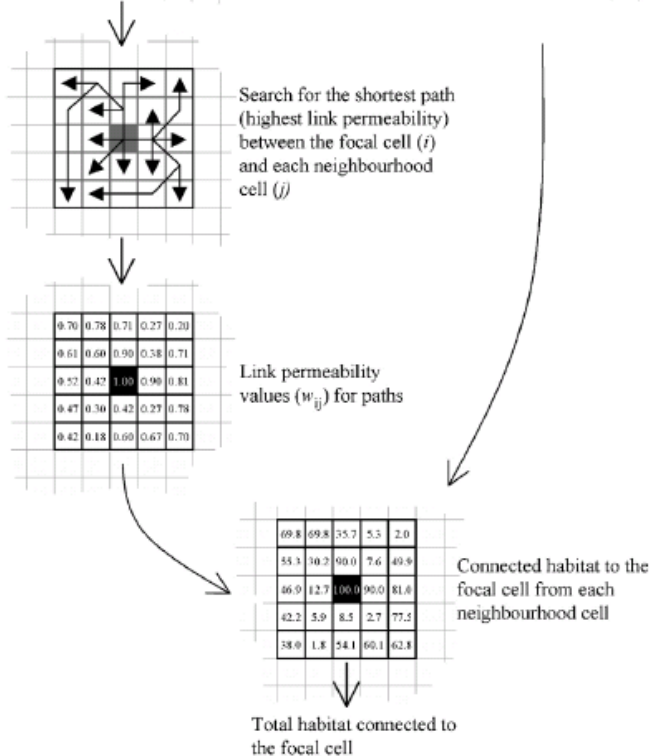
Using “neighbourhood habitat value” metric described by Drielsma, Ferrier & Manion, 2007 Ecological Modelling

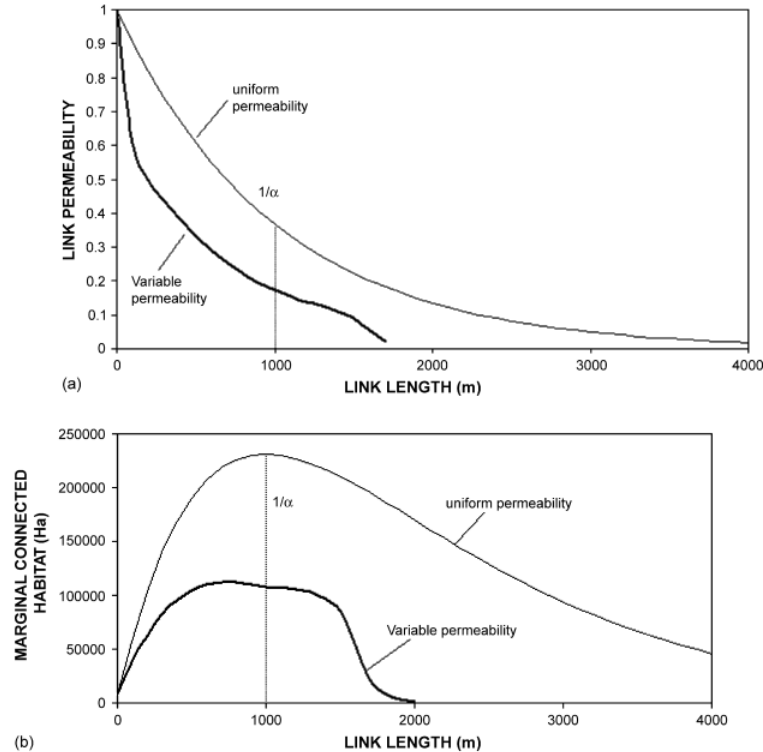
Neighbourhood habitat value is a measure of habitat value connected to focal cells

Evaluates connection using ‘least cost paths’ within a search window

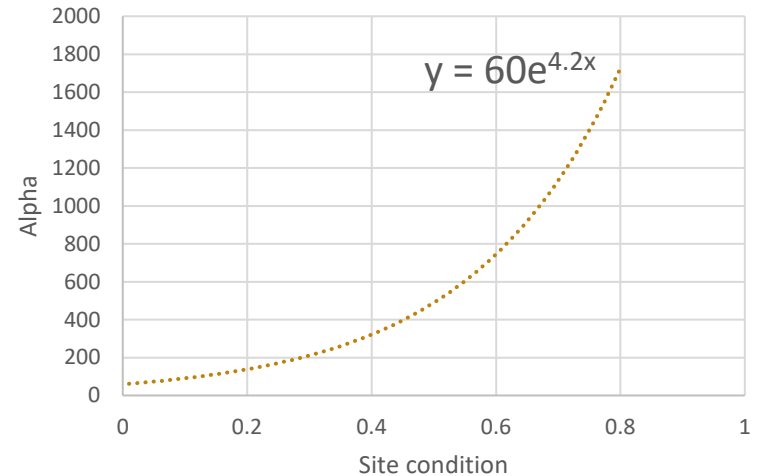
Habitat value and permeability are both based on land condition classes

Context contributes 20% of the ‘condition’ score change, areas outside the proposal are assumed to not change in base condition apart from the context change effected by the project



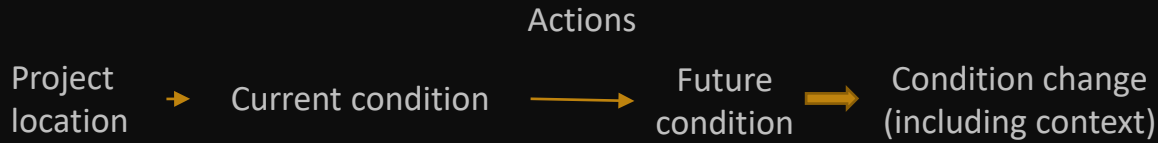


Permeability is modelled as a function of site condition



**Fig. 1 – The decay in link permeability as link length increases. Hypothetical decay curves are shown for a link through homogenous conditions (effective distance per metre is constant) and for a link through a mosaic where the effective distance per metre is influenced by the variable conditions (effective distance is greater than or equal to geographic distance) (panel a). Corresponding potential and actual marginal connected habitat accumulation as radius increases. The disproportionately high increase in area as radius increases means that for radii less than  $1/\alpha$  the rate of habitat connectivity can potentially increase despite diminishing link permeabilities; but must then fall (panel b). Link length is measured in geographic distance units.  $1/\alpha = 1000$  m.**





Condition change (including context) × Priority (Regional environmental account) = Index of benefit

- Riparian
- Threatened species
- Native vegetation

