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Bureau of Meteorology

Experience applying ecosystem service models

Richard Mount, Environmental Accounts Lead,
Environmental Information Services Branch

19th November 2013

Ecosystem accounting initiatives in Australia

Department of Environment and Primary Industries, Victoria

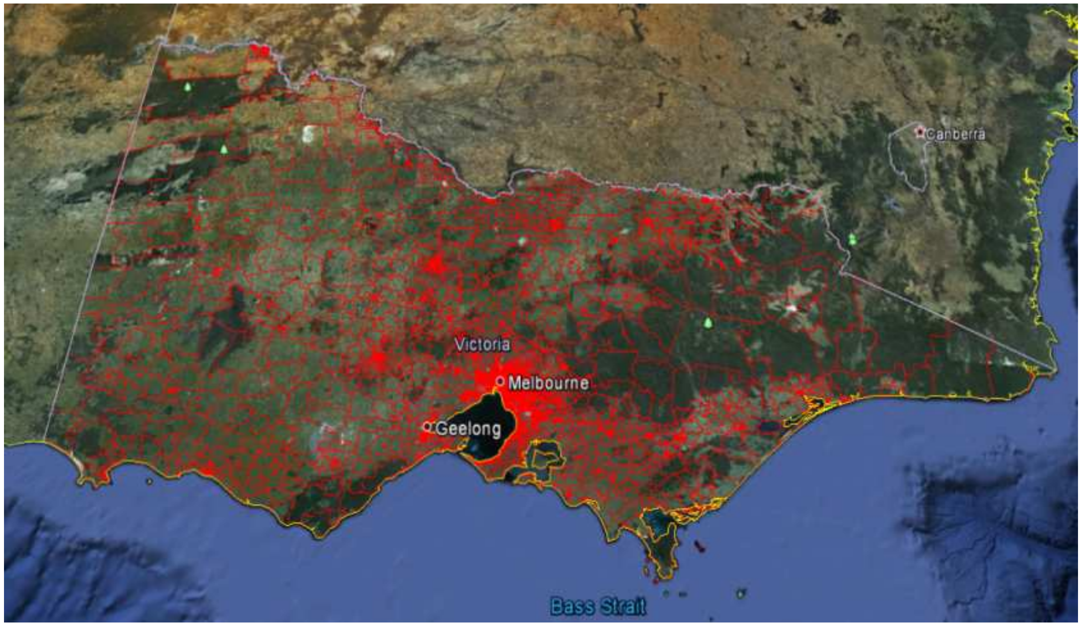
- Victorian Experimental Ecosystem Accounts, 2013

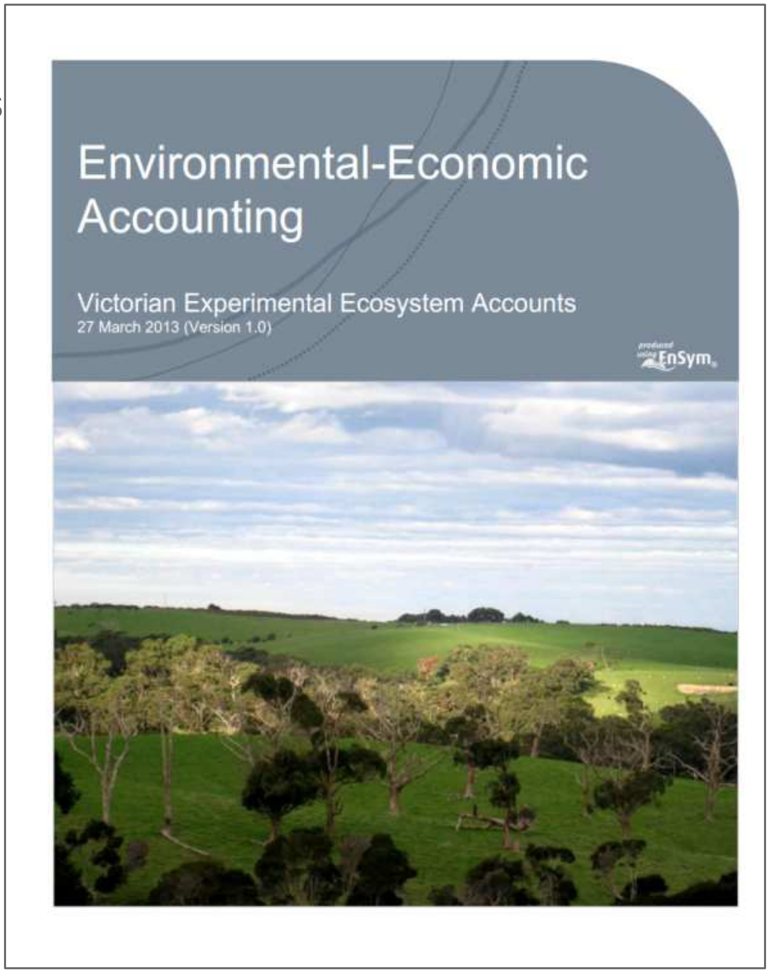
https://ensym.dse.vic.gov.au/docs/Victorian%20Experimental%20Ecosystem%20Accounts,%20March%202013.pdf

Australian Bureau of Statistics

- Land Accounts Victoria, Experimental Estimates

http://www.abs.gov.au/ausstats/abs@.nsf/mf/4609.0.55.002





Ecosystem accounting initiatives in Australia

Australian Bureau of Statistics

•Land Account: Great Barrier Reef Region, Experimental Estimates, 2011
http://www.abs.gov.au/ausstats/abs@.nsf/mf/4609.0.55.002

•Land Accounts Victoria, Experimental Estimates, 2012
http://www.abs.gov.au/ausstats/abs@.nsf/mf/4609.0.55.002

•Land Accounts Queensland, Experimental Estimates, 2013
http://www.abs.gov.au/ausstats/abs@.nsf/mf/4609.0.55.002

•Experimental Land and Ecosystem Account Great Barrier Reef Region, 2014(?)

Ecosystem accounting initiatives in Australia

Bureau of Meteorology

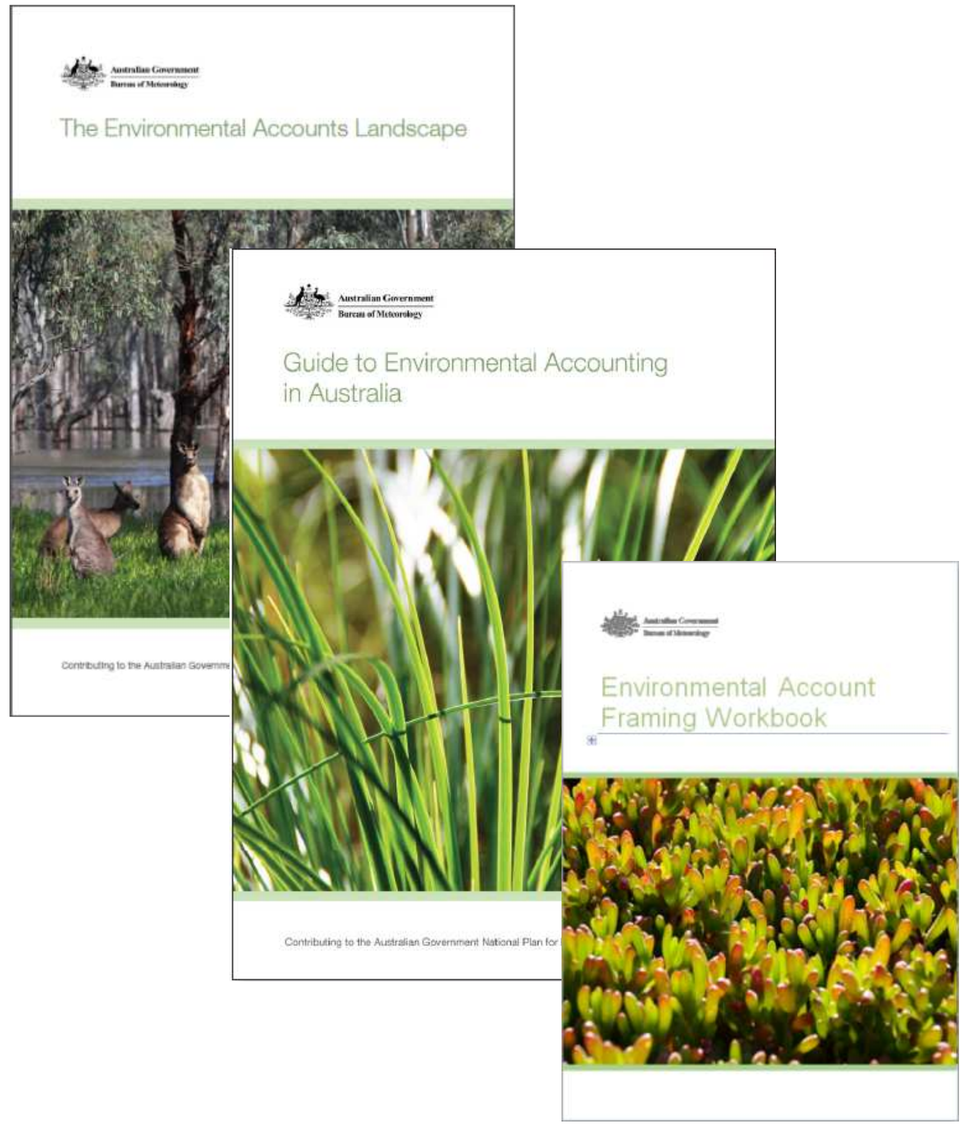
- 2013 The environment accounts landscape (review paper)

http://www.bom.gov.au/environment/doc/environmental_accounts_landscape.pdf

- 2013 Guide to Environmental Accounting in Australia (released 11 December 2013)

http://www.bom.gov.au/environment/activities/accounts.shtmlf

- Trials
  - Carbon Cycle (Mass Balance) trials (report on request)
  - Murray—Darling River trials (soon to be posted on the web)
- Research
  - Carbon, water and biodiversity infrastructure



Other ecosystem accounting initiatives in Australia

Department of Agriculture

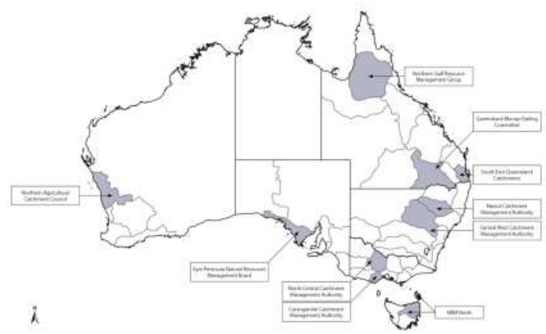
- 2012 Discussion paper on Ecosystem Services

http://www.daff.gov.au/natural-resources/ecosystem-services/ecosystem-services-report

Department of the Environment

- 2010 Ecosystem services: Key concepts and applications

http://www.environment.gov.au/biodiversity/publications/ecosystem-services.html



South East Queensland Catchments

- 2012 Ecosystem Services Framework SEQ

http://www.ecosystemservicesseq.com.au/

Australia 21 Ecosystem Services

- Ecosystem Services discussion papers

http://www.australia21.org.au/research-archive/australians-in-the-landscape-2/ecosystem-services/#.Uor-X9JkPAk

Wentworth Group and Natural Resource Management Regions

- 2008 Accounting for Nature (2012-13 trials to be published soon – assets focus)

http://www.wentworthgroup.org/

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Ecosystem accounting theory

(drawing on the SEEA Experimental Ecosystems Accounting conceptual model)

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Defining an ecosystem

Uses the CBD definition:

- “dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit”*

However, an “ecosystem” *per se* is not a useful construct as it does not exist as a separable, discrete entity

- Not possible to have a single standard map of Australian ecosystems

Approach proposed is to identify

- "ecosystem assets"
- "ecosystem services"

*Source: Article 2 Use of Terms, Convention on Biological Diversity, 2003

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Themes

Taking a 'Building Blocks' approach

- Carbon, water and energy cycles
- Linking into biodiversity-related measures
- Vegetation Accounts
- Asset accounts

Scale issues

- Regional and national accounts have different purposes
- Spatial and data challenges

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Experimental Biodiversity Accounting

Suzi Bond, Jane McDonald & Michael Vardon
suzi.bond@abs.gov.au
j.mcdonald9@uq.edu.au
michael.vardon@abs.gov.au

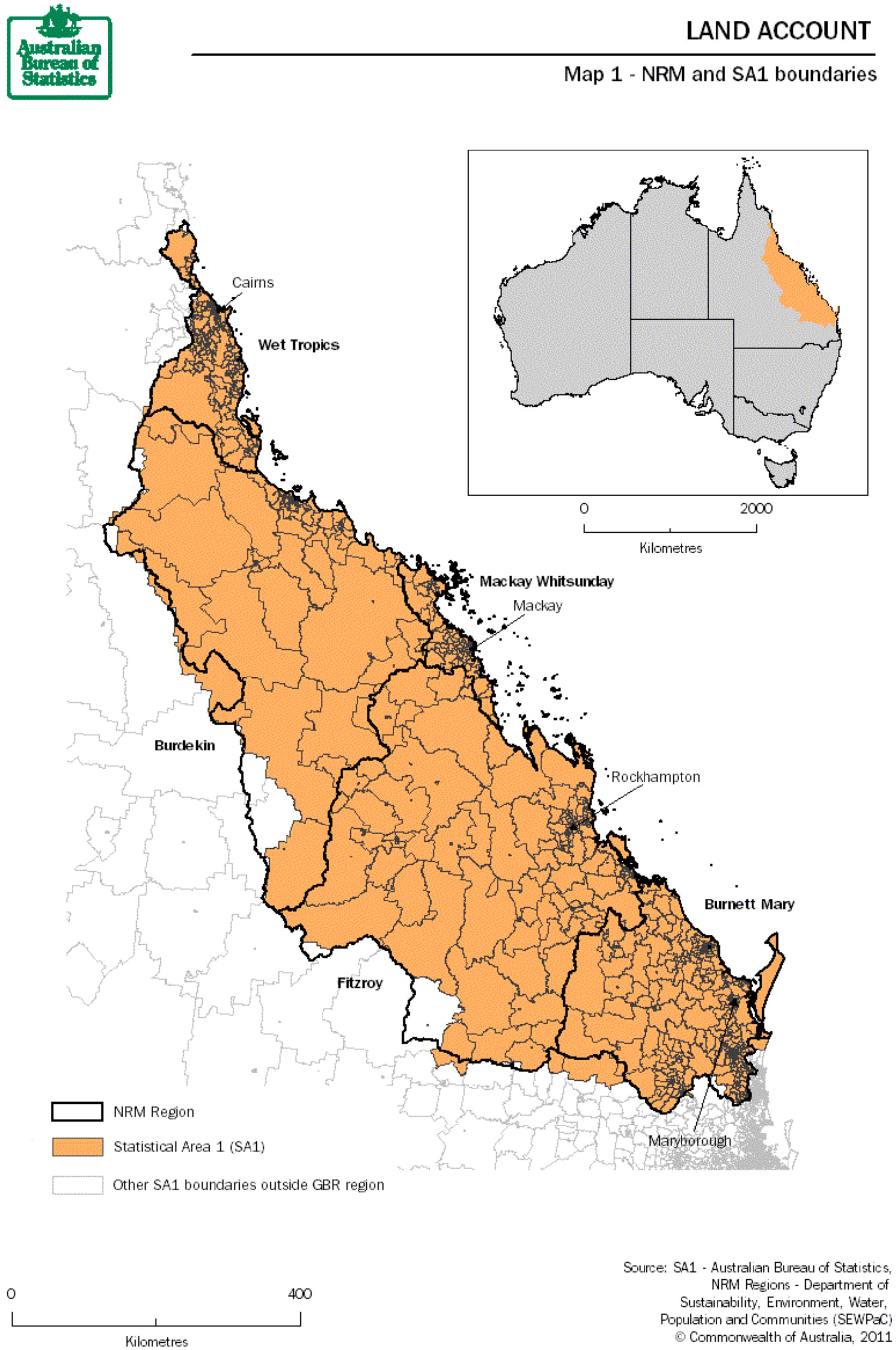
Linking biodiversity to policy and decision–making

Land use and profitability can inform land use planning and conservation planning

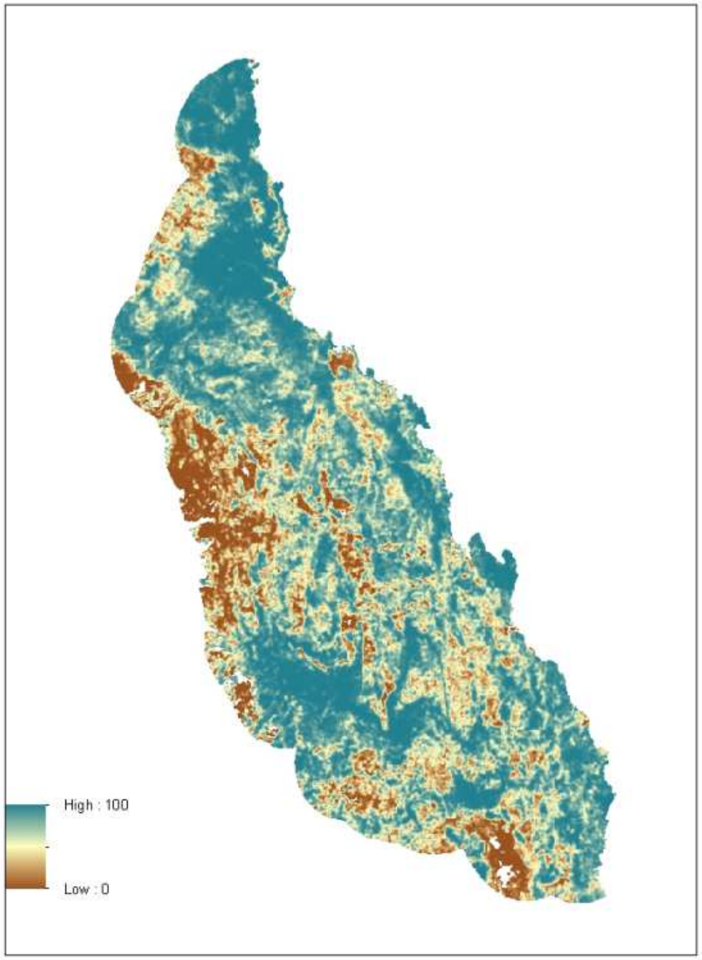
Land use and profitability accounts in conjunction with biodiversity accounts facilitates the analysis of where in the landscape high profits and food can being produced for a given level of biodiversity (Polasky et al. 2008).

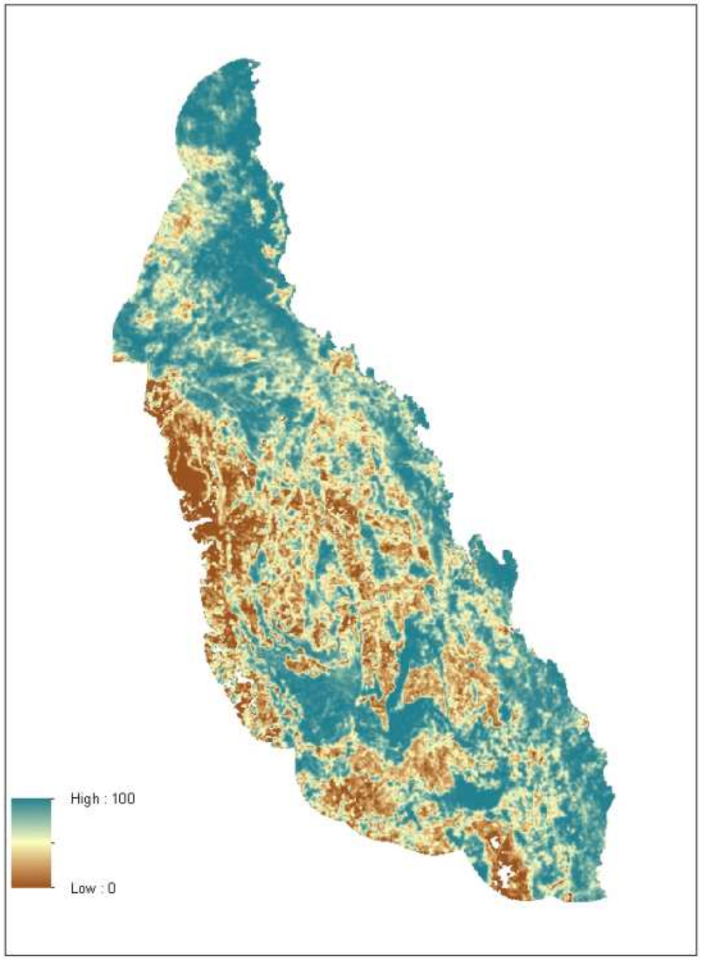
Spatially linking biodiversity accounts to mapped threats can assist in the identifying where to invest in threat management for the greatest return for biodiversity at least cost (Carwardine et al. 2012; Evans et al. 2011).

Region of experimental ecosystem accounts for the Great Barrier Reef Region



Index of bird species richness for the Great Barrier Reef 1972 and 2011 (100 m grid)





Method

Figure: The proportion of species remaining in each 100 m x100 m cell (A) is calculated by estimating the proportion of habitat remaining in the local landscape and applying the species-area curve.

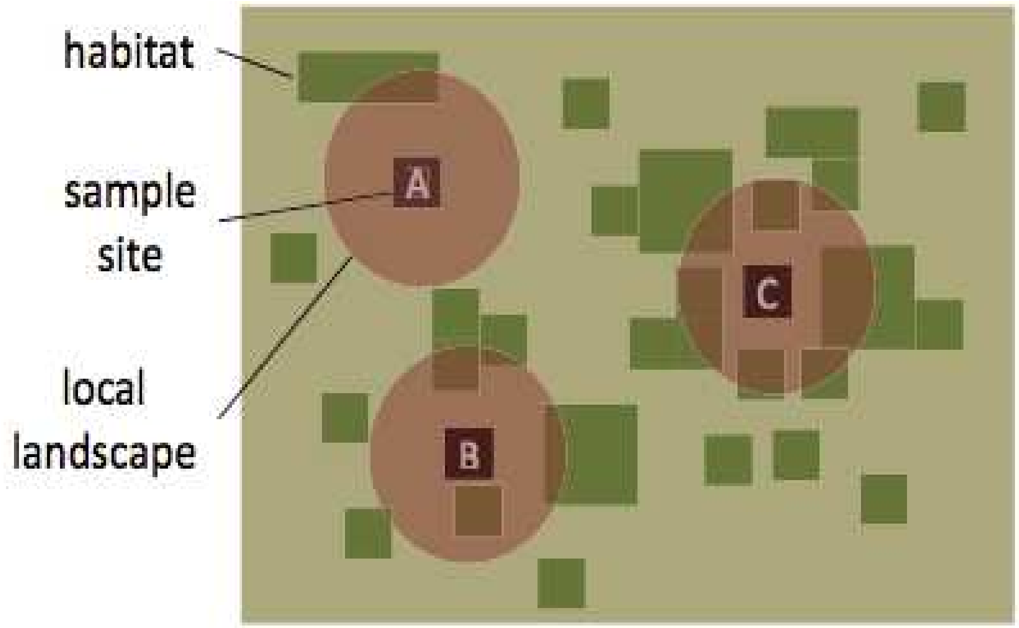


Figure from Fahrig 2013

Brooks et al

$S_{new}/S_{original}=(A_{new}/A_{original})^{z}$

Bird Species Richness Stocks by Agricultural Profit

Table 12: Bird species richness stocks (0-100) compared to agricultural profit by agricultural commodity in the GBR for 2006. (Preliminary results)

Commodities	**Bird species richness per ha (Biodiversity stock per ha)**	**Profit per ha**
Cereals	37	$4,000
Cotton	45	$2,000
Sugar cane	65	$1,100
Grazing	67	$25
Vegetables	70	$11,000

Change in Biodiversity Stocks by Agricultural Profit

Table 13: Change in biodiversity stock between 1998 and 2006 compared to agricultural profit in the GBR for 2006. (Preliminary results

Commodities	Change in Bird species richness 1998 to 2006 per ha (biodiversity stock)	Profit per ha
Cereals	-12.3	$4,000
Cotton	-9.2	$2,000
Sugar cane	-6.4	$1,100
Grazing	-4.3	$25
Vegetables	1.2	$11,000

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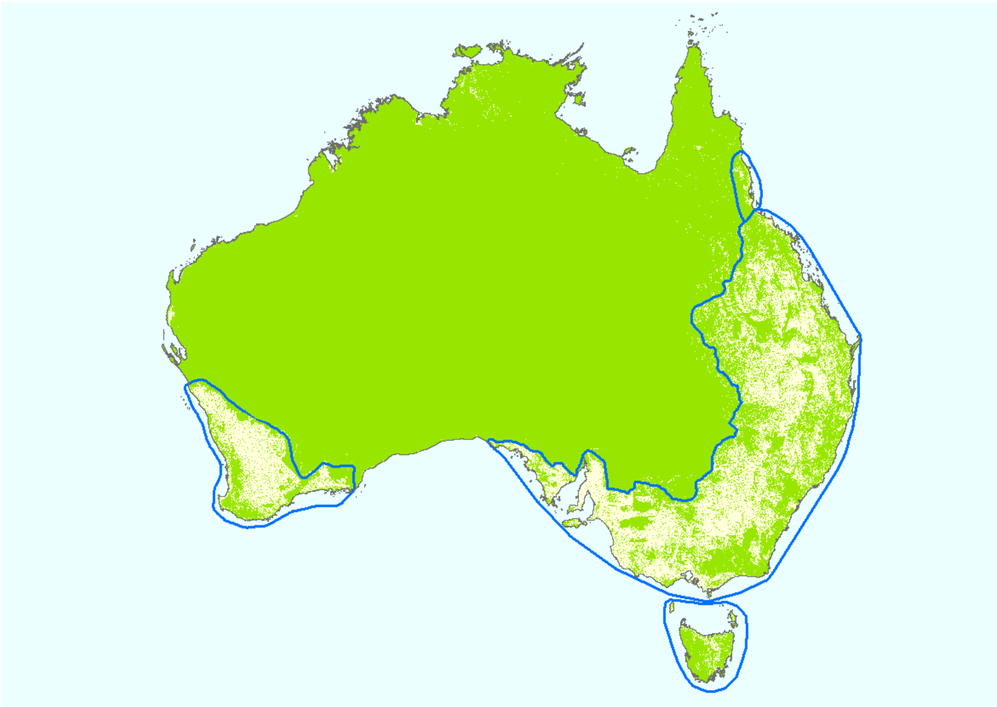
Vegetation Connectivity measures

Need

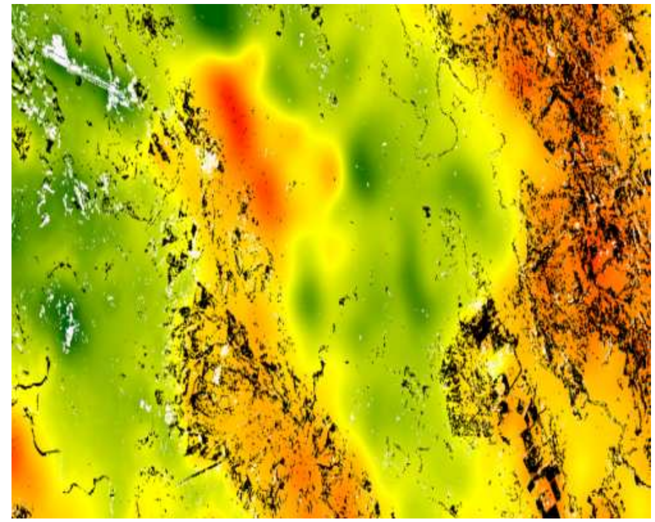
Model of connectivity, suitable for a range of questions, at useful scales and something to tell us how connectivity is changing.

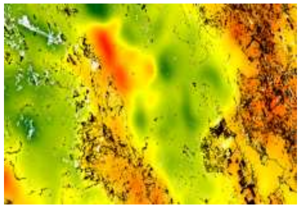


Source: ERIN, DotE

Fragmentation/Connectivity Statistics

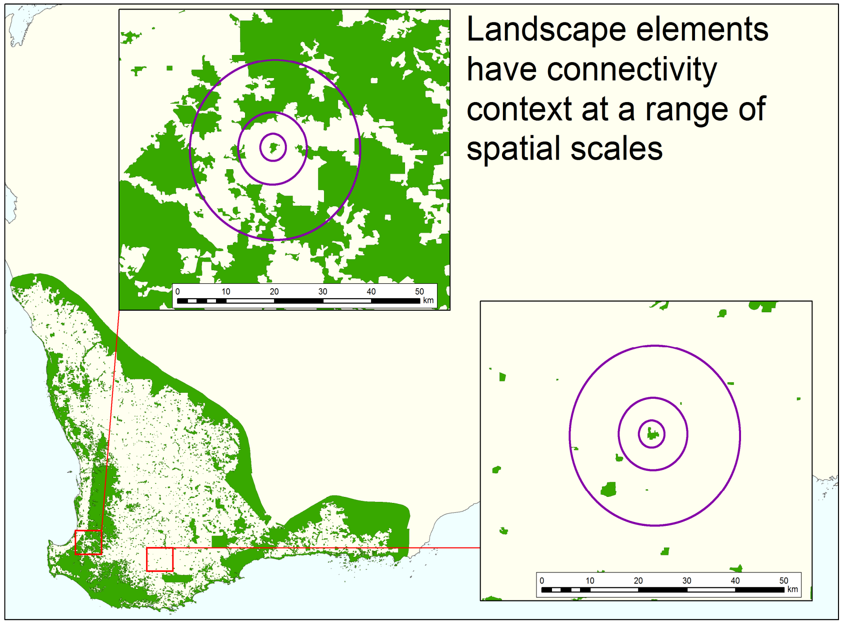
Needed statistics that are ecologically relevant, scientifically robust and suitable for comparing fragmentation/connectivity within and between areas, and through time.

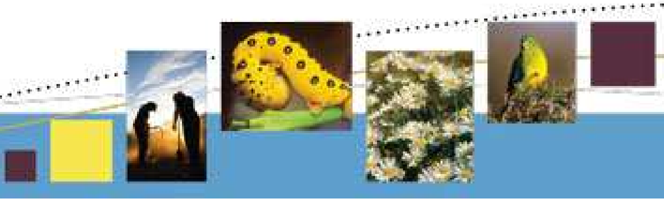


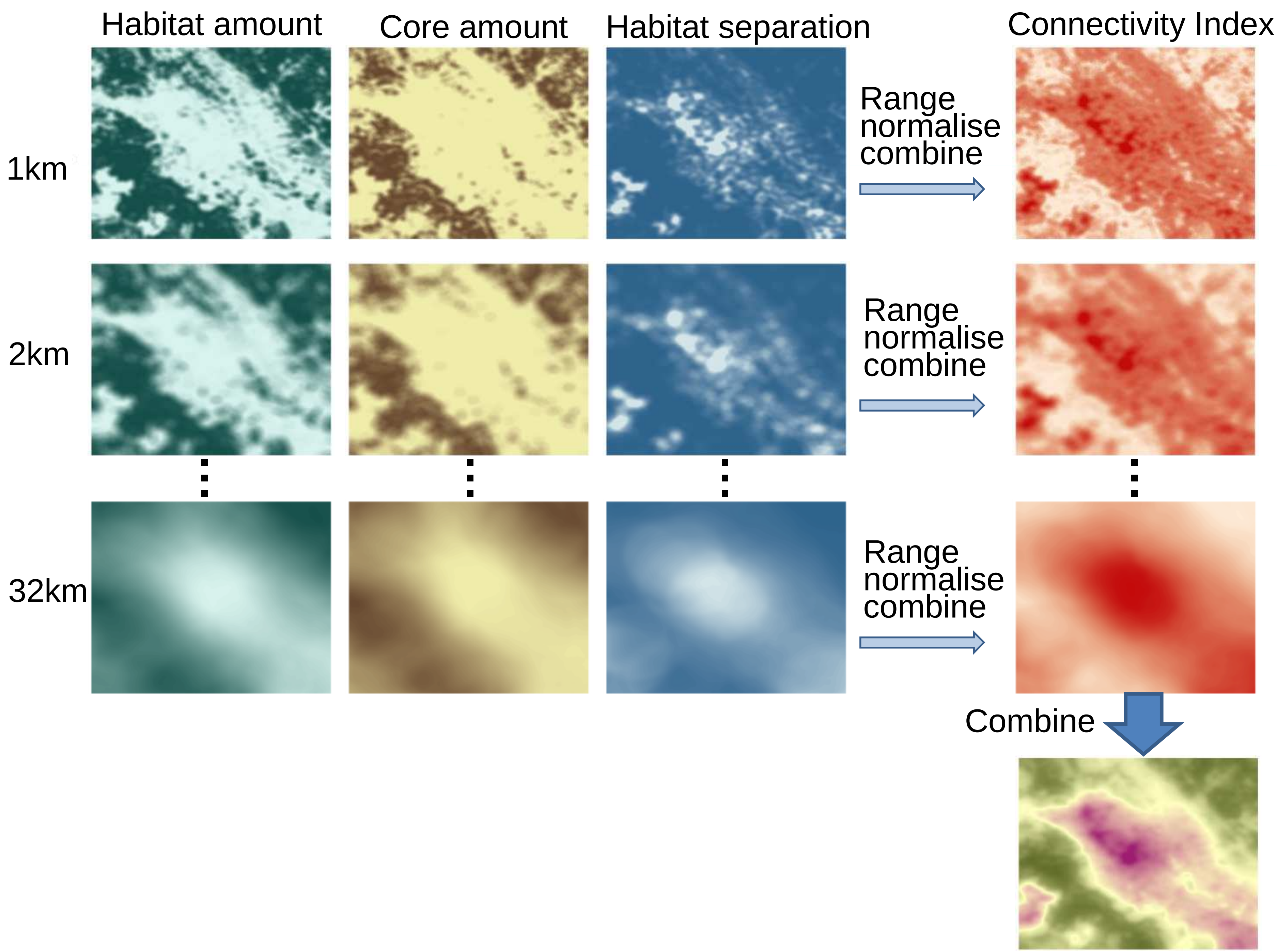


Scale

The index is based on combining available habitat, separation of habitat and habitat condition at different scales i.e. 1km 2km, 4 km ... 32 km. This is to ensure the surrounding landscape context is taken into consideration when measuring fragmentation/connectivity.

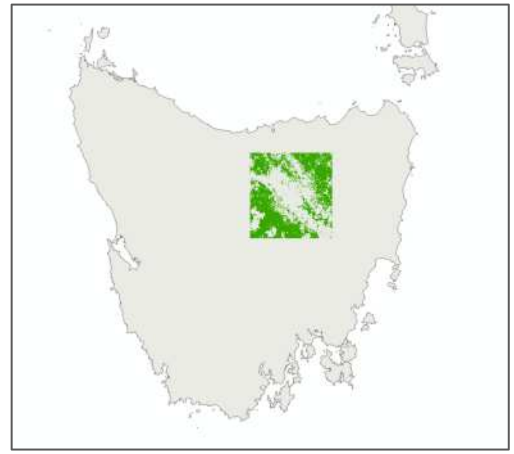


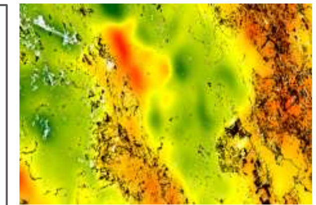



Habitat amount
Core amount
Habitat separation
Connectivity Index
1km
2km
32km
Range normalise combine
Range normalise combine
Range normalise combine
Combine

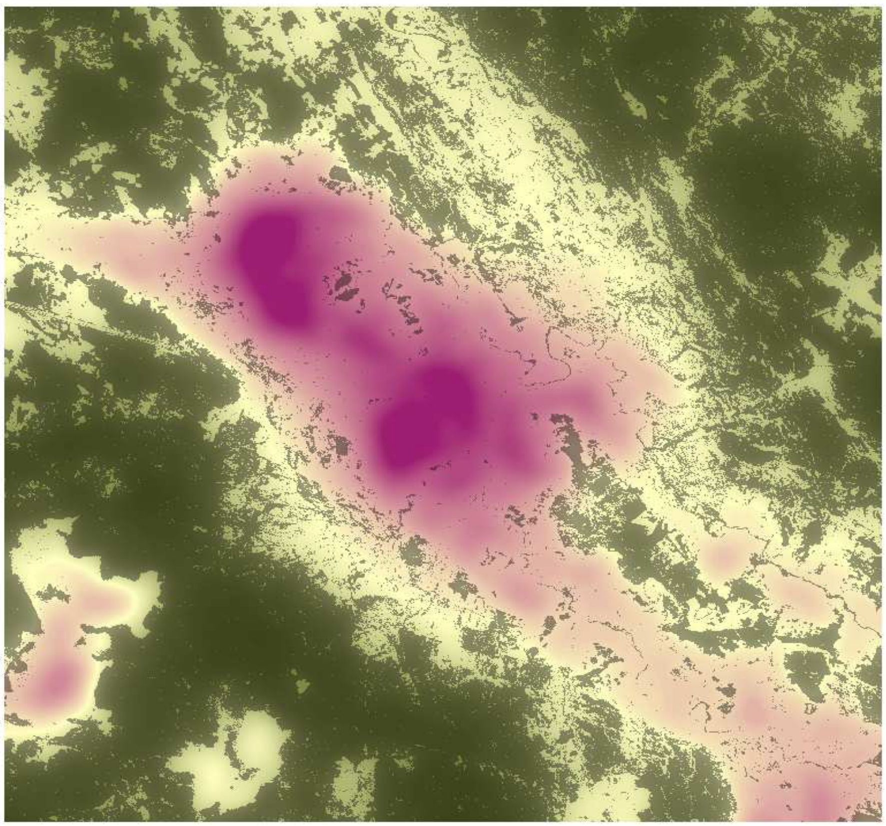
The product – an example

The fragmentation/connectivity statistic shown in two different years (purple to khaki) with the woody habitat overlayed for context (grey).





1980



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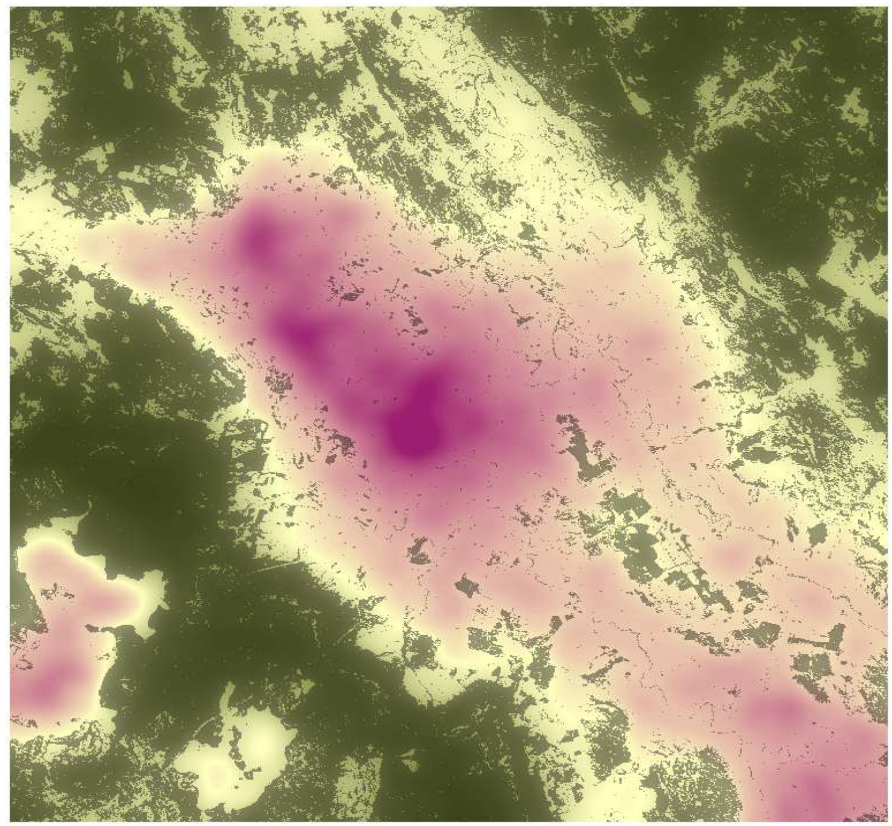
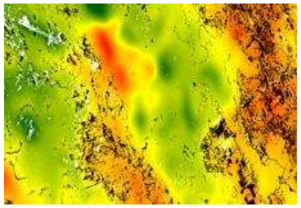
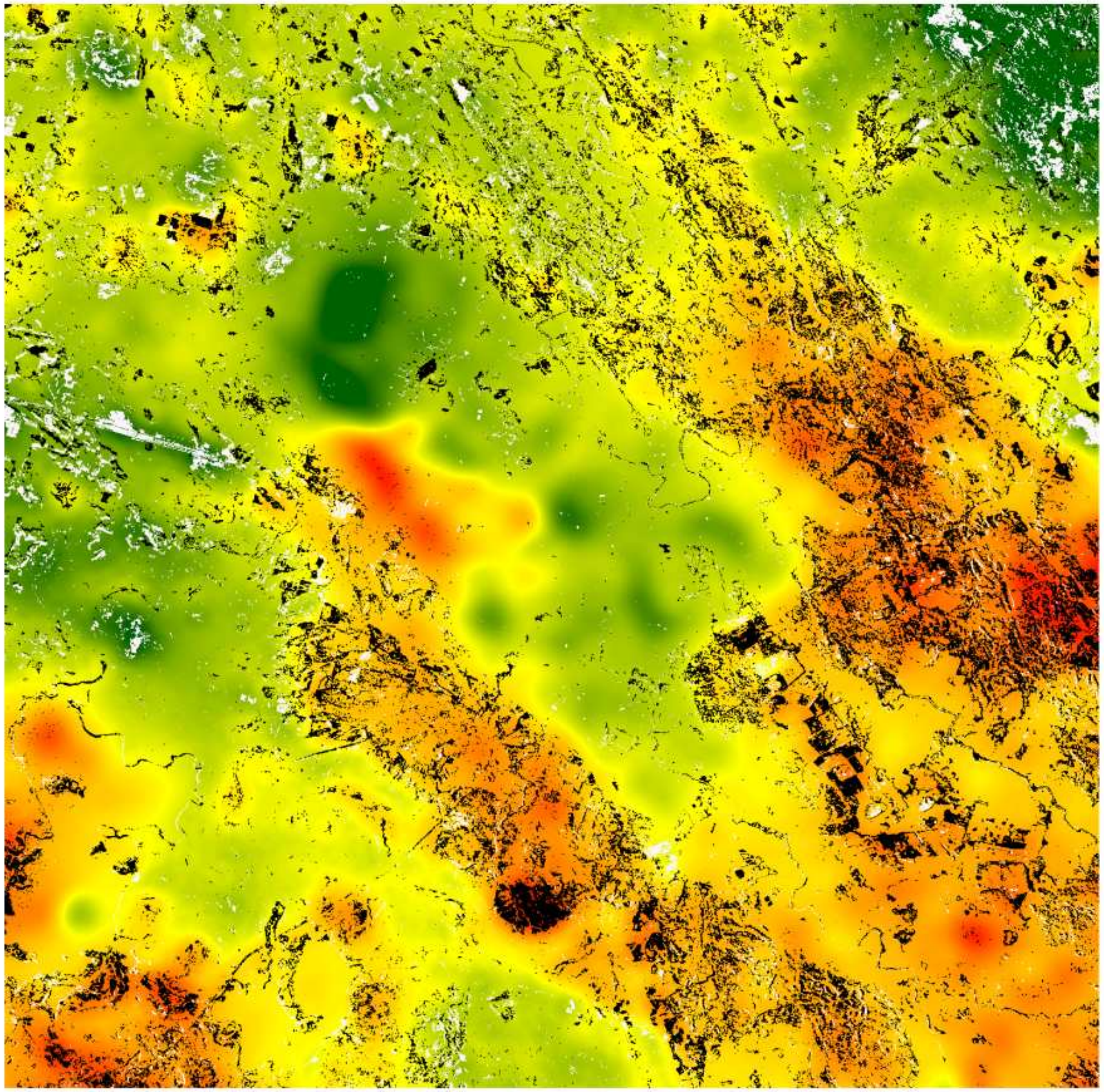


Change over time 1980 - 2011

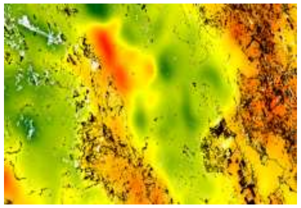




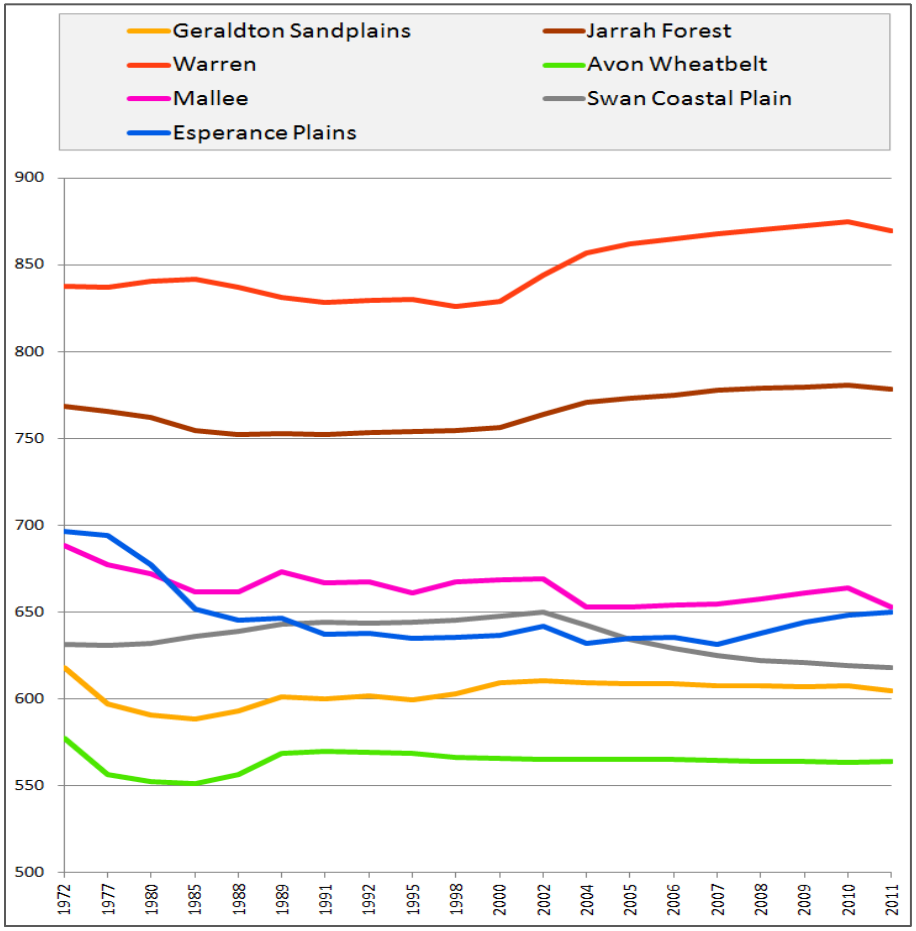
In this region of Tasmania, the black areas are actual losses of woody habitat, and the white areas show gains.

Green areas show an increase in fragmentation/ connectivity while red show decreases.

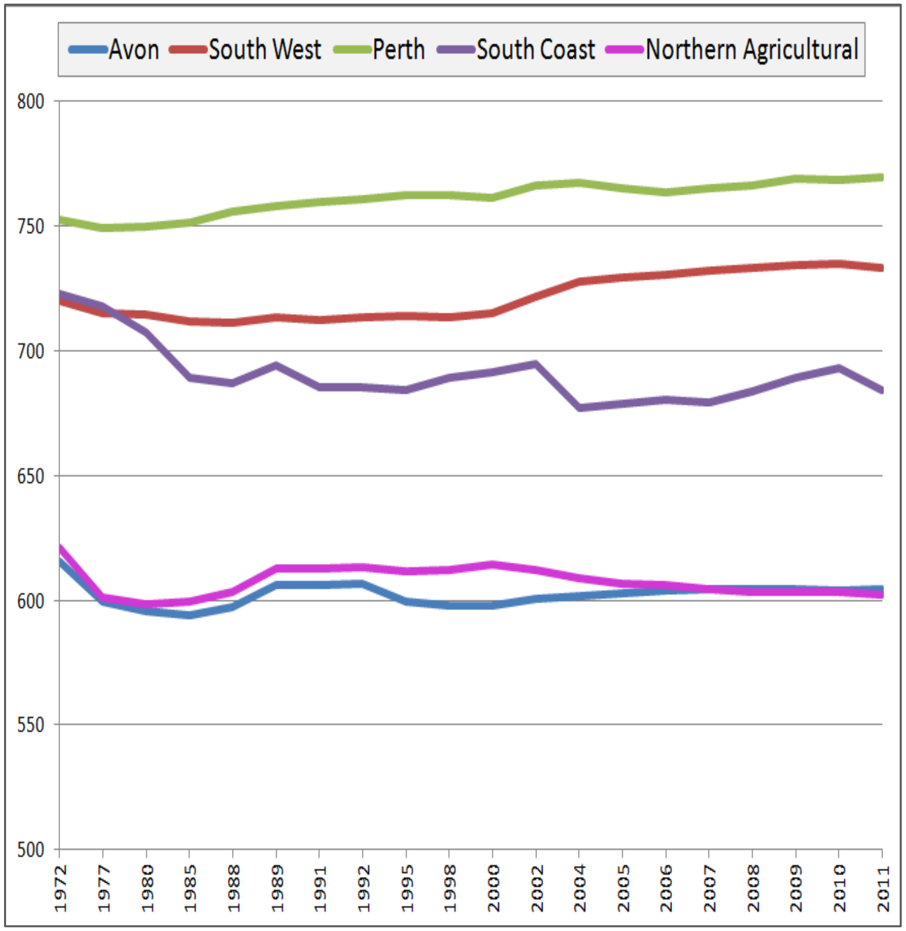
Fragmentation/connectivity by regions 1972 - 2011



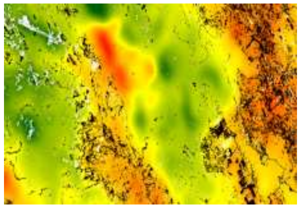
IBRA regions



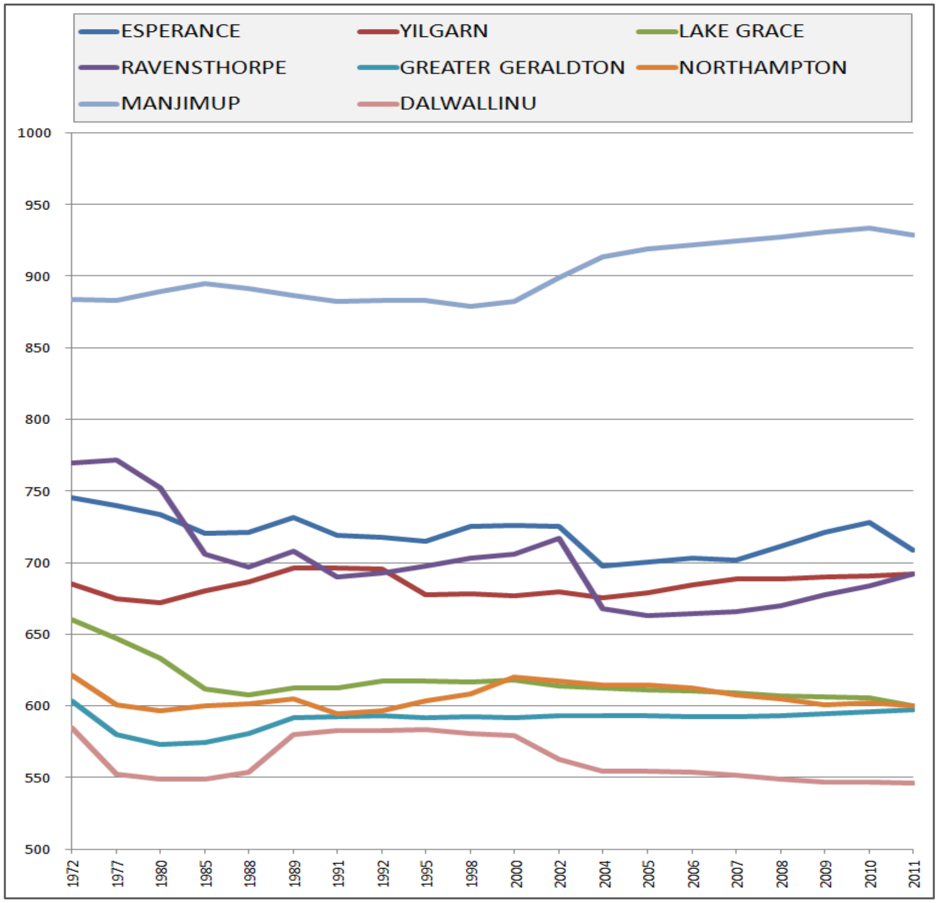
NRM regions



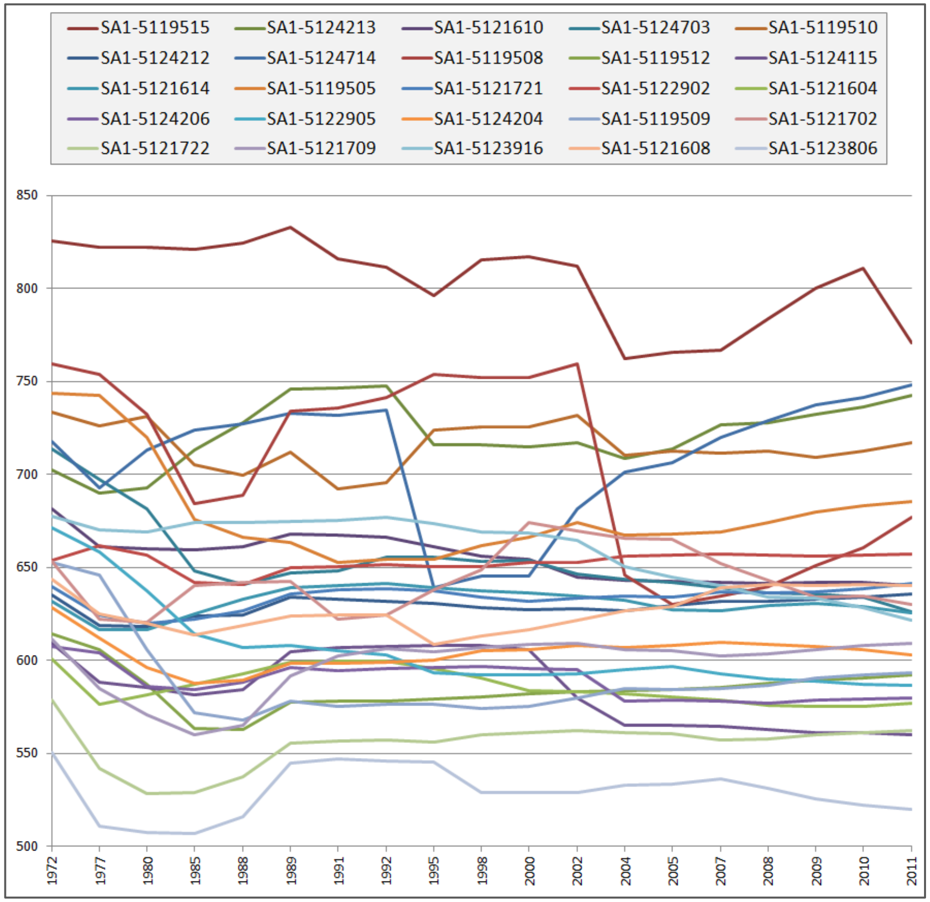
Fragmentation/connectivity by regions 1972 - 2011



Local Government Areas



ABS statistical Areas – Level 1



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Net Ecosystem Productivity Account

Conceptual Model

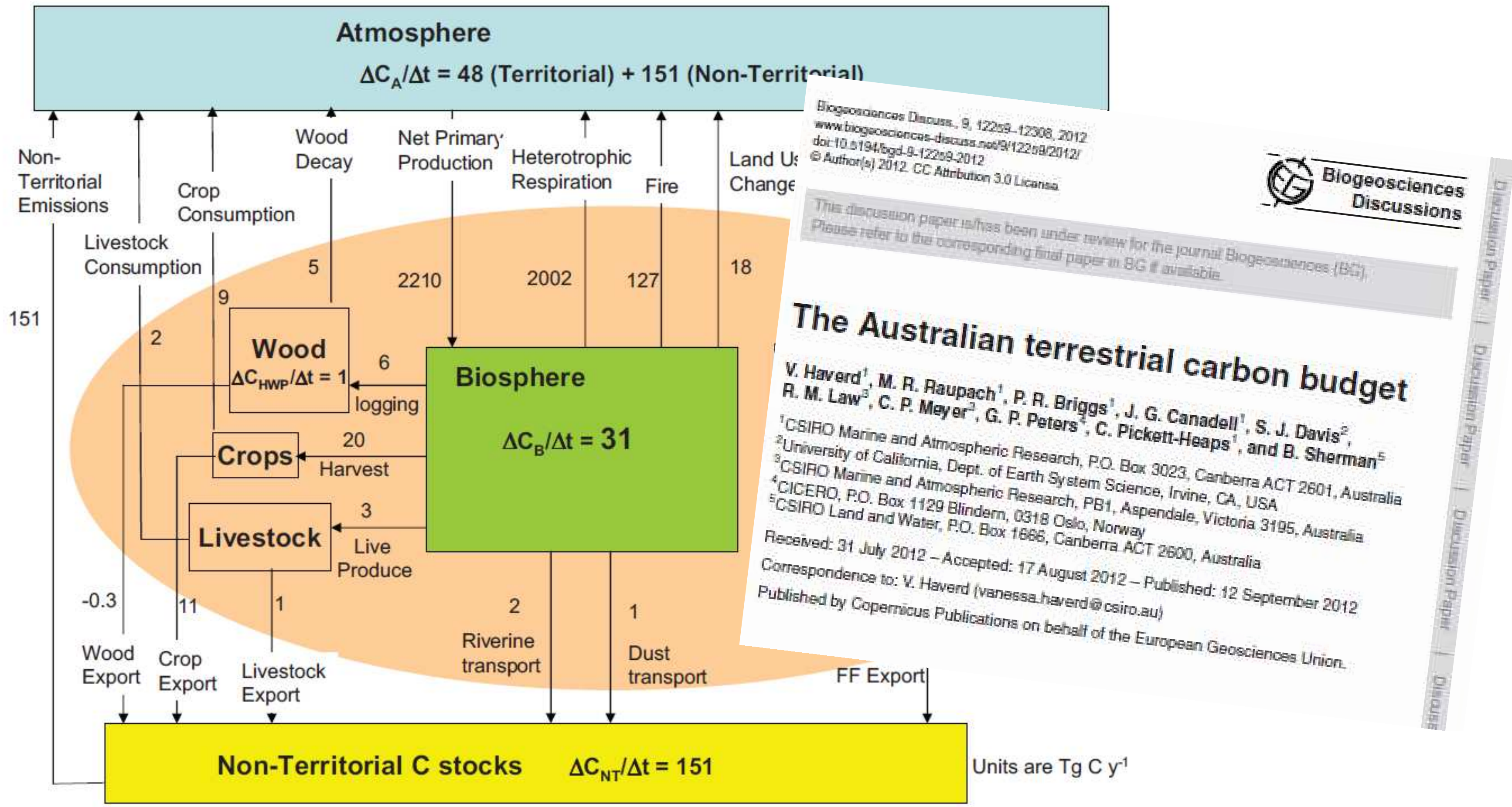
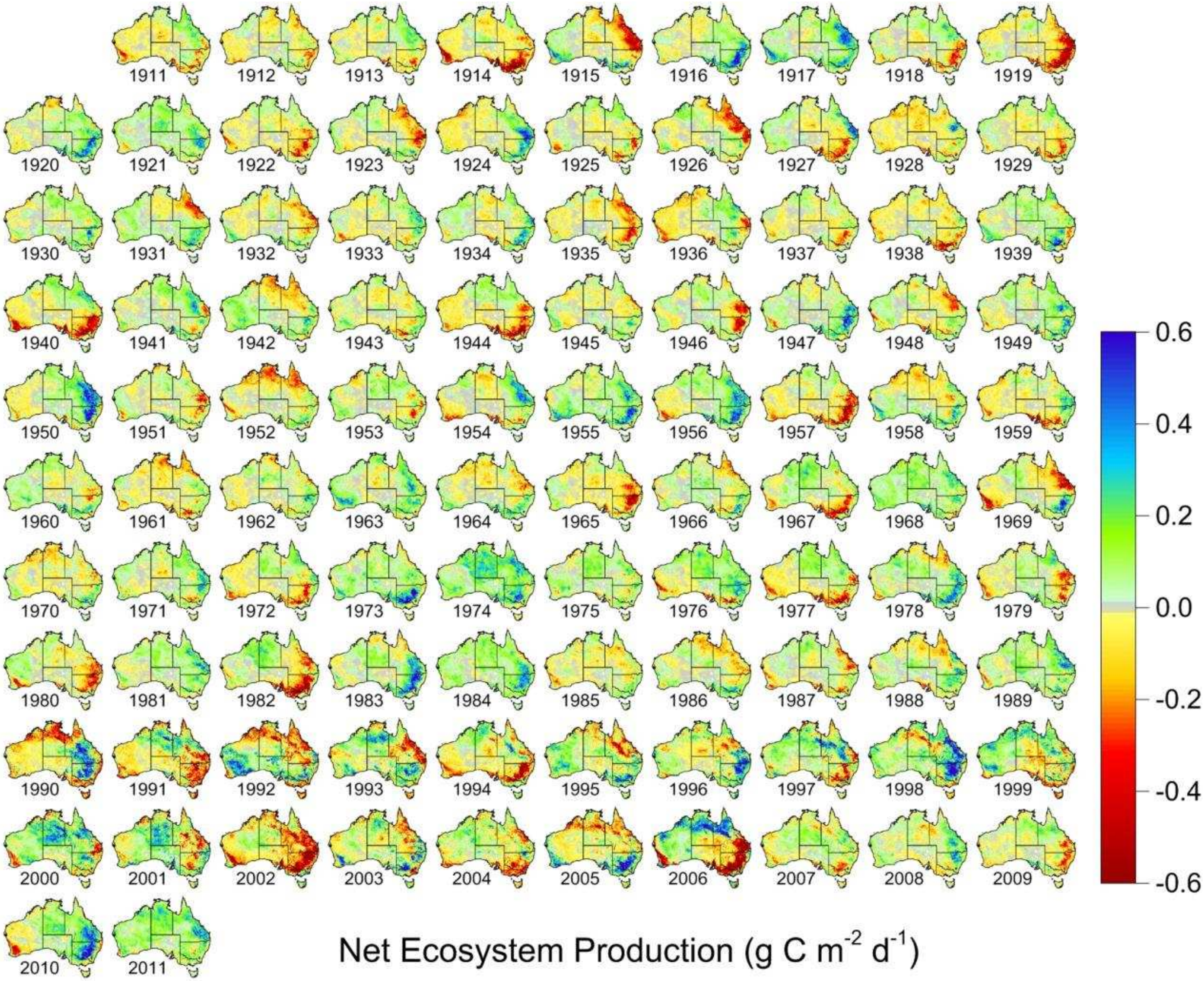


Fig. 1. Summary of the Australian territorial carbon budget, 1990–2011.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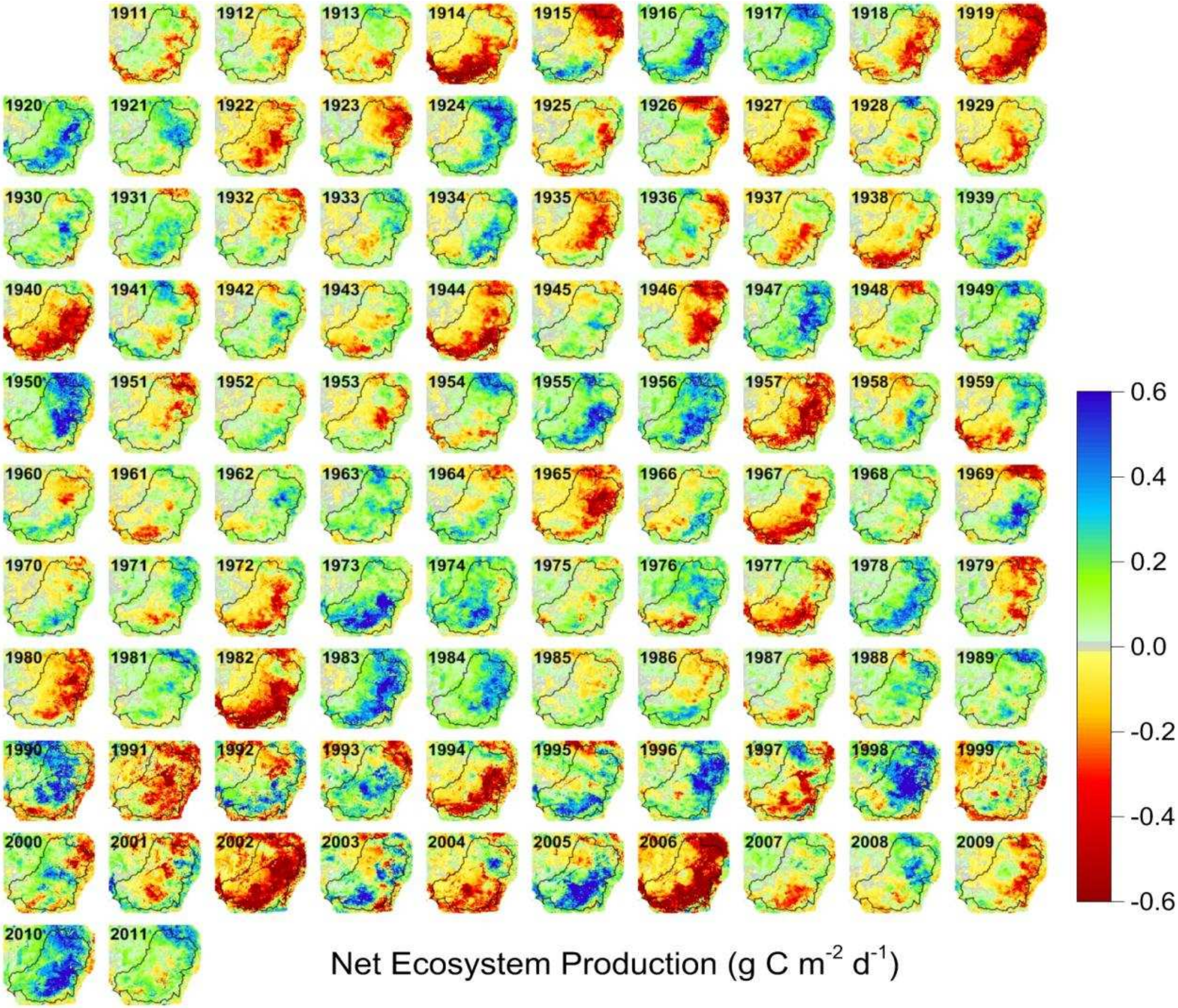
Net Ecosystem Production (g C m-2 d-1)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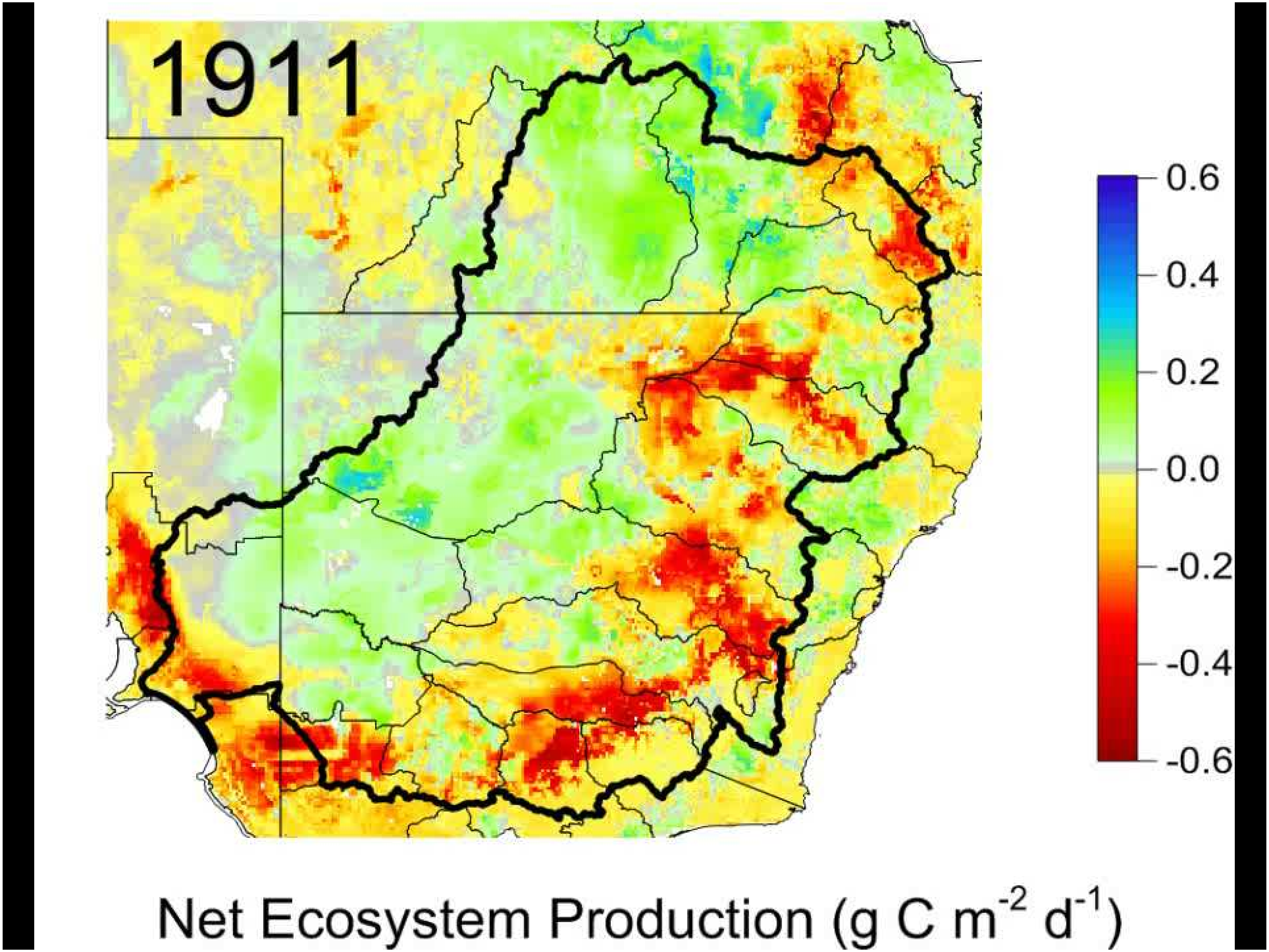
Net Ecosystem Production (g C m-2 d-1)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0.4
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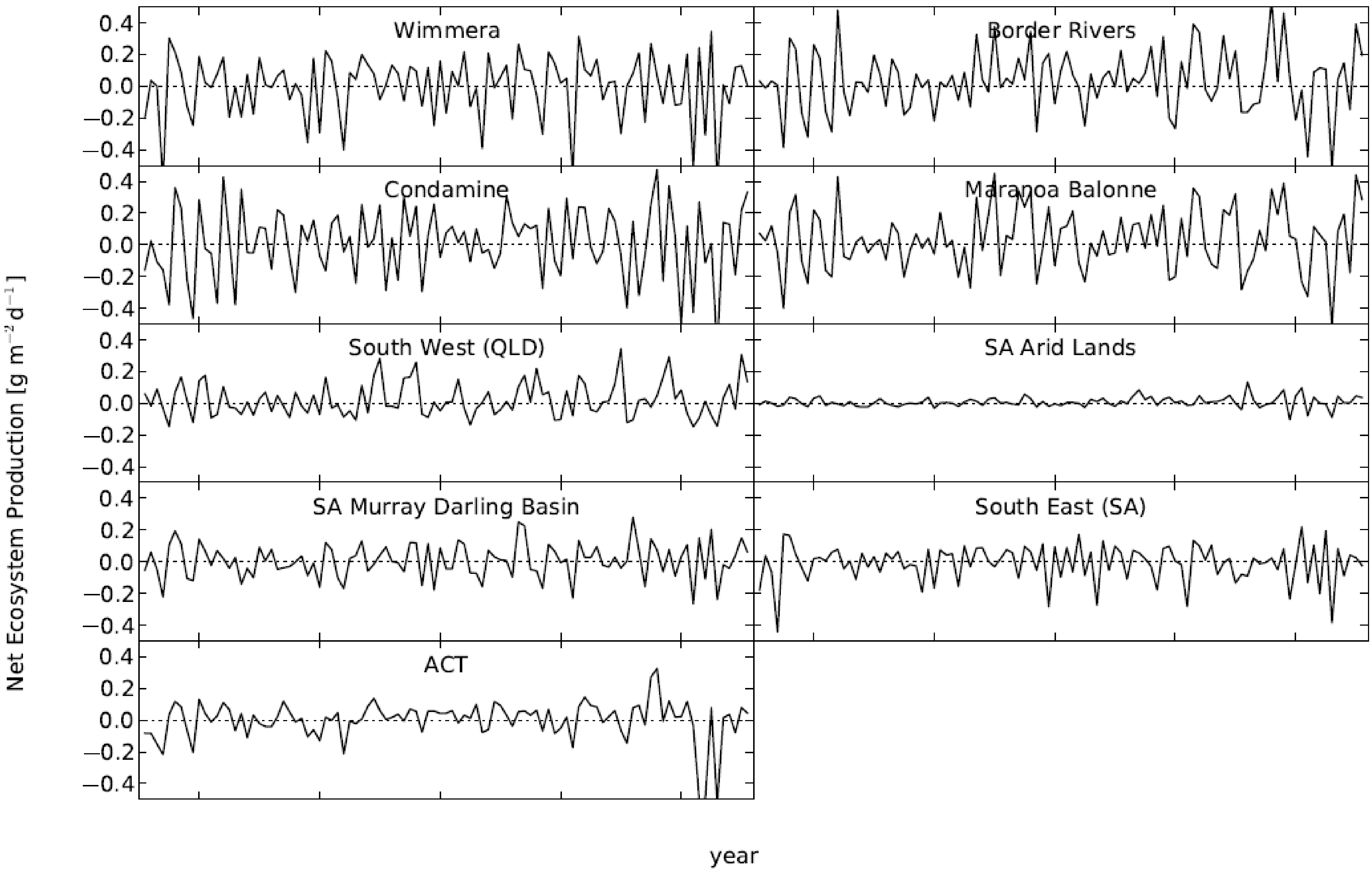
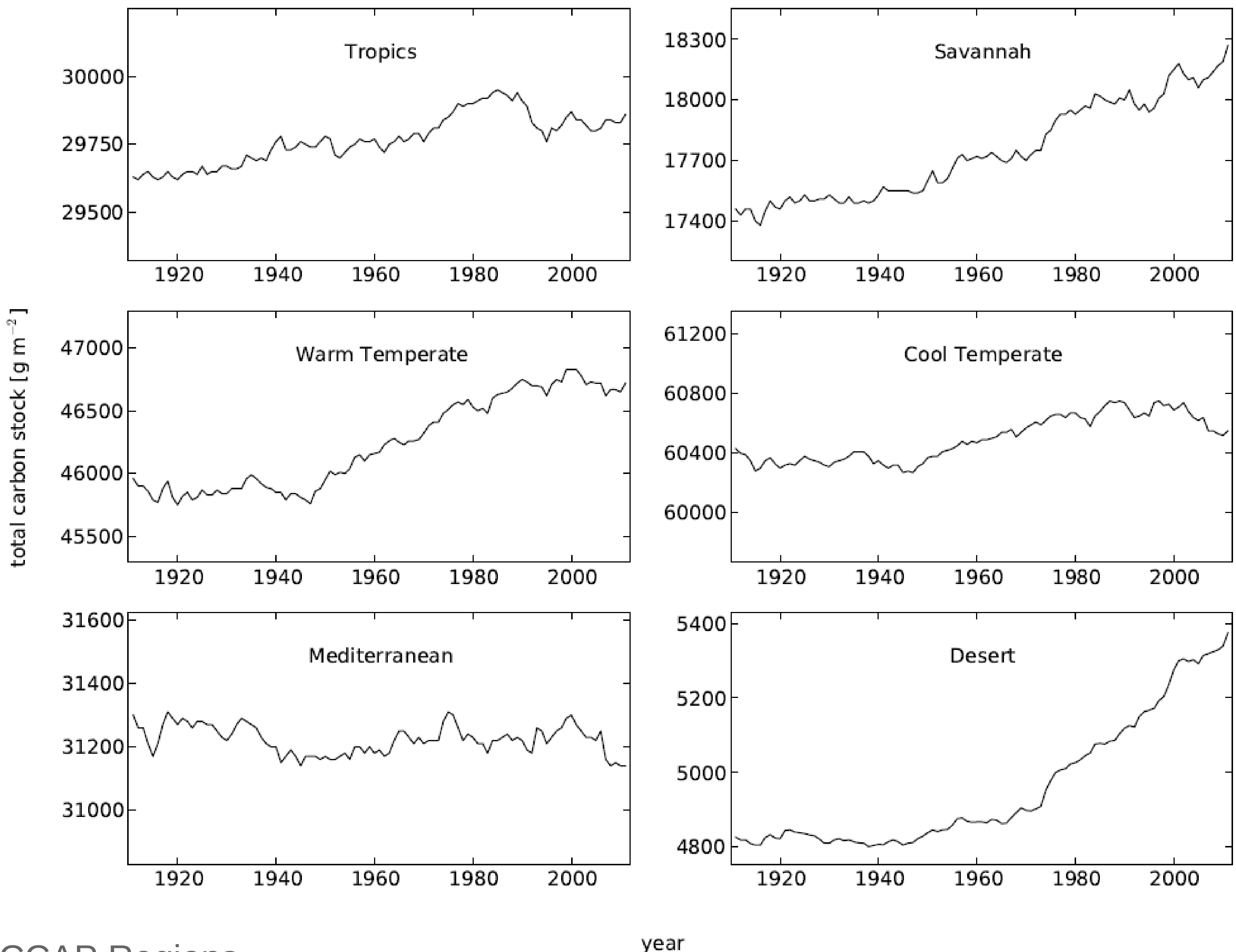
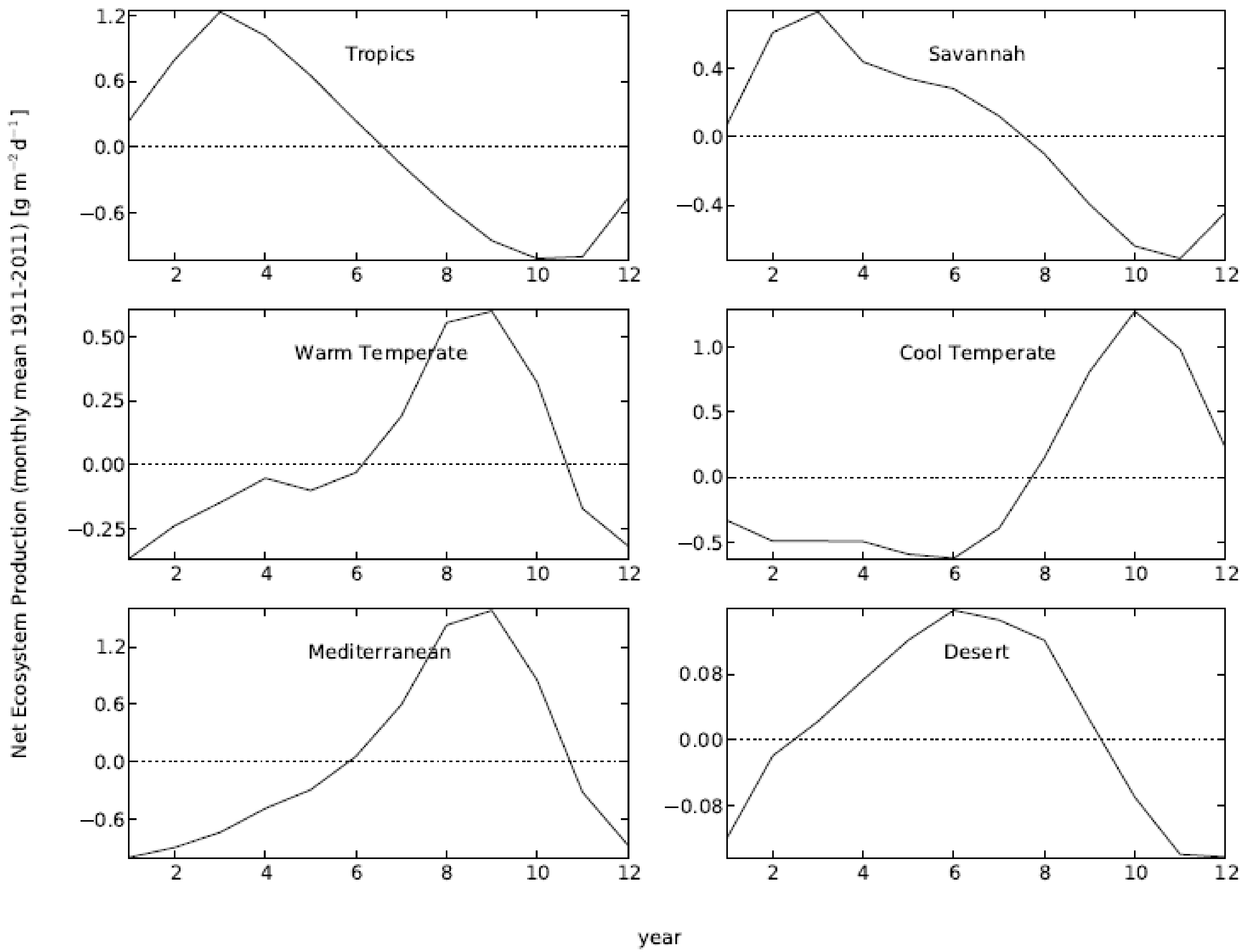
-0.6
Net Ecosystem Production (g C m-2 d-1)


Wimmera
Border Rivers
Condamine
Maranoa Balonne
South West (QLD)
SA Arid Lands
SA Murray Darling Basin
South East (SA)
ACT
0.4
0.2
0.0
−0.2
−0.4
Net Ecosystem Production [g m⁻² d⁻¹]
year



RECCAP Regions



RECCAP Regions

Australian Government
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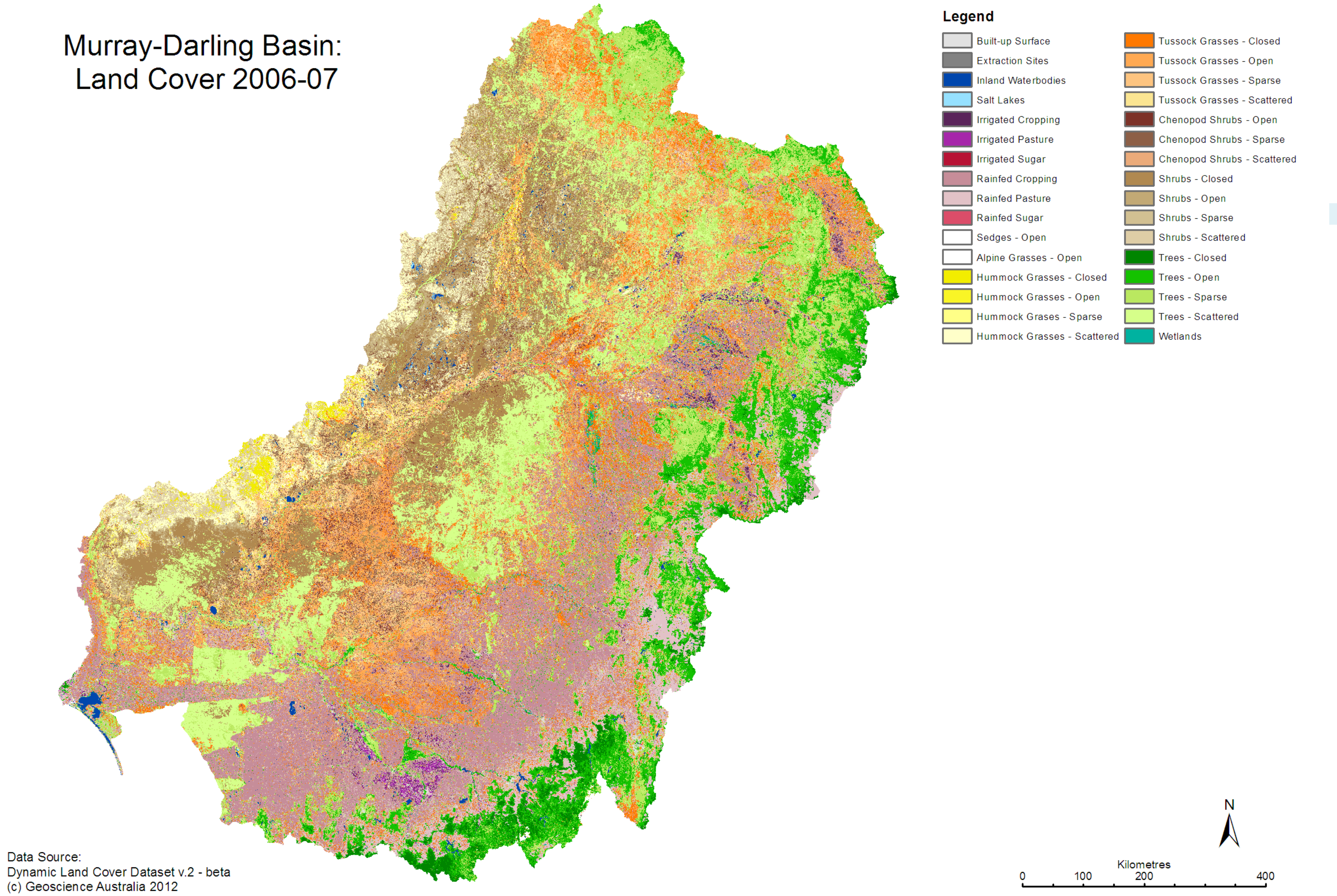
Murray-Darling Basin **Prototype** Ecosystem Land Cover Account

Derived from Dynamic Land Cover Dataset v2 – beta
Sincere thanks to Geoscience Australia

DRAFT May 2013


Murray-Darling Basin:
Land Cover 2006-07
Legend
Built-up Surface
Extraction Sites
Inland Waterbodies
Salt Lakes
Irrigated Cropping
Irrigated Pasture
Irrigated Sugar
Rainfed Cropping
Rainfed Pasture
Rainfed Sugar
Sedges - Open
Alpine Grasses - Open
Hummock Grasses - Closed
Hummock Grasses - Open
Hummock Grases - Sparse
Hummock Grasses - Scattered
Tussock Grasses - Closed
Tussock Grasses - Open
Tussock Grasses - Sparse
Tussock Grasses - Scattered
Chenopod Shrubs - Open
Chenopod Shrubs - Sparse
Chenopod Shrubs - Scattered
Shrubs - Closed
Shrubs - Open
Shrubs - Sparse
Shrubs - Scattered
Trees - Closed
Trees - Open
Trees - Sparse
Trees - Scattered
Wetlands
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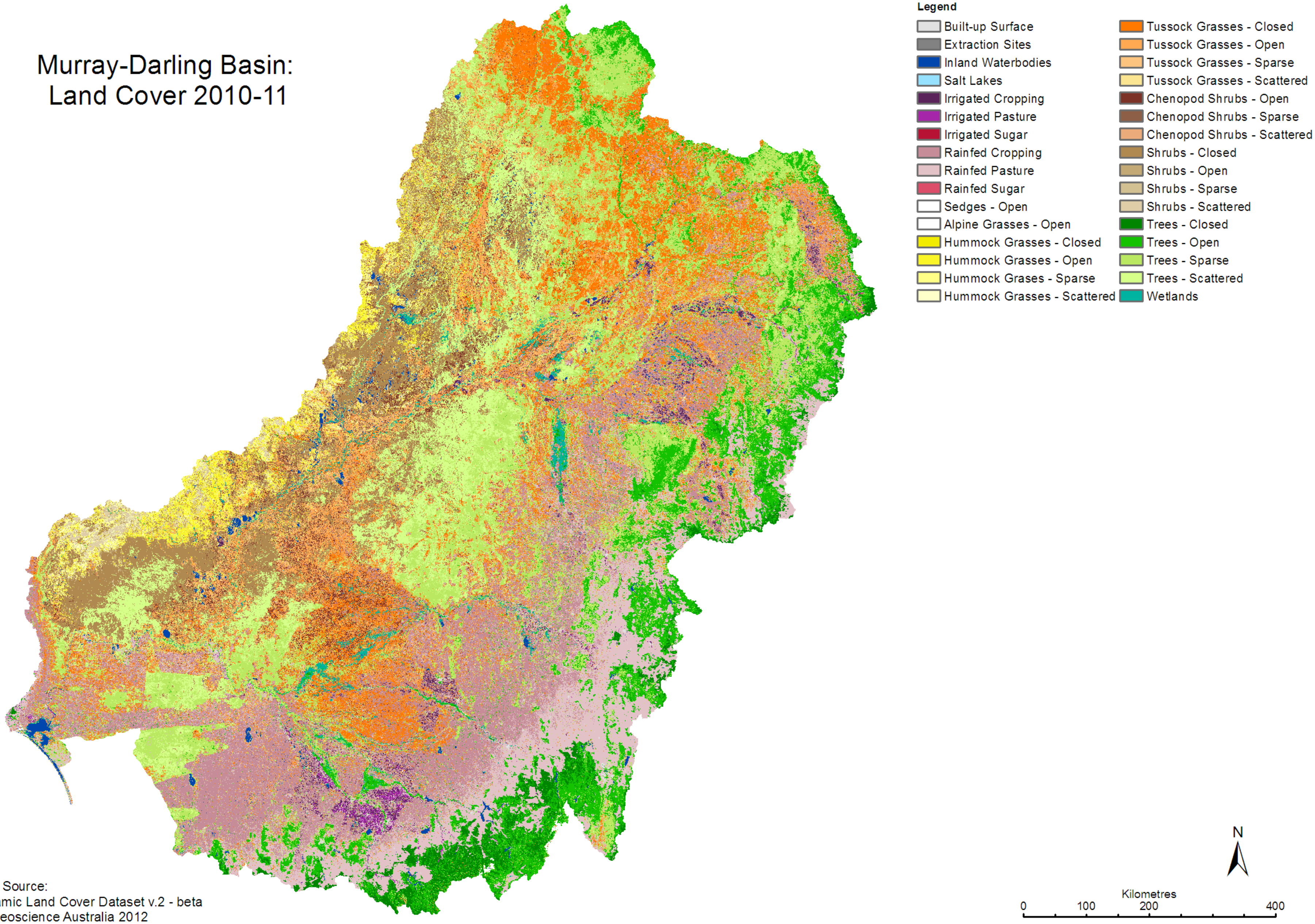
Kilometres
0 100 200 400
Data Source:
Dynamic Land Cover Dataset v.2 - beta
(c) Geoscience Australia 2012

Murray-Darling Basin: Land Cover 2010-11



Data Source:
Dynamic Land Cover Dataset v.2 - beta

Land Cover Stocks – Murray Darling Basin

Dynamic Land Cover by ISO Class: Murray-Darling Basin					
	Area (ha)				
	2002-2003	2004-2005	2006-2007	2008-2009	2010-11
Coastal waters	6,763	6,763	6,763	6,763	6,763
Built-up Surface	122,838	122,838	122,838	122,838	122,838
Extraction Sites	16,631	16,631	16,631	16,631	16,631
Bare Areas	0	0	0	0	0
Inland Waterbodies	636,556	615,919	603,844	616,650	795,031
Salt Lakes	59,900	41,069	36,638	28,281	13,300
Irrigated Cropping	745,231	743,119	536,275	466,006	861,544
Irrigated Pasture	277,538	319,894	250,281	153,325	280,456
Irrigated Sugar	1,669	1,669	1,669	1,669	1,669
Rainfed Cropping	15,638,994	17,224,506	17,450,400	16,996,606	14,191,663
Rainfed Pasture	10,363,519	8,689,675	8,224,950	8,459,838	12,251,288
Rainfed Sugar	275	275	275	275	275
Sedges - Open	40,394	40,263	40,763	40,875	38,469
Alpine Grasses - Open	9,944	10,069	9,563	9,456	11,844
Hummock Grasses - Closed	138,263	369,938	581,675	446,800	58,788
Hummock Grasses - Open	1,026,075	479,006	353,519	367,469	1,827,038
Hummock Grasses - Sparse	943,544	567,650	361,388	433,031	1,030,631
Hummock Grasses - Scattered	3,830,869	2,809,238	2,905,531	2,633,813	384,331
Tussock Grasses - Closed	4,410,425	7,290,488	7,617,813	9,355,638	11,829,619
Tussock Grasses - Open	4,602,775	6,691,381	9,027,613	8,285,131	7,959,088
Tussock Grasses - Sparse	1,485,006	2,263,206	3,605,081	2,895,356	1,010,400
Tussock Grasses - Scattered	1,482,069	1,021,631	1,302,206	1,929,750	240,938
Chenopod Shrubs - Open	1,059,731	1,179,444	1,151,919	1,157,300	2,304,144
Chenopod Shrubs - Sparse	1,729,200	1,720,888	1,661,181	1,465,125	684,894
Chenopod Shrubs - Scattered	514,513	403,113	490,344	681,019	314,406
Shrubs - Closed	10,020,606	10,675,775	9,673,038	8,793,063	8,079,013
Shrubs - Open	3,014,425	2,987,544	2,609,375	2,216,813	232,444
Shrubs - Sparse	3,205,369	2,681,925	2,294,125	2,197,569	456,188
Shrubs - Scattered	1,134,500	1,114,781	1,012,881	1,167,425	504,650
Trees - Closed	1,690,331	2,083,663	1,372,319	1,474,988	1,969,381
Trees - Open	6,648,750	8,063,931	7,687,025	6,911,238	8,593,313
Trees - Sparse	13,565,906	12,454,925	11,984,919	14,206,900	18,057,275
Trees - Scattered	17,137,238	12,819,713	12,605,300	11,906,475	10,536,663
Wetlands	297,888	346,806	259,594	413,619	1,192,763
Total	**105,857,731**	**105,857,731**	**105,857,731**	**105,857,731**	**105,857,731**

Change to MDB Land Cover: Summary Class 2006-07 to 2010-11

Land Cover Class	Opening Stock 2006-07 (ha)	Additions to stock (ha)	Reductions in stock (ha)	Closing Stock 2010-11 (ha)
Coastal waters	6,763	0	0	6,763
Built-up Surface	122,838	0	0	122,838
Extraction Sites	16,631	0	0	16,631
Salt lakes and inland waterbodies	640,482	225,144	57,294	808,332
Total Managed land	26,463,851	5,874,389	4,751,349	27,586,890
Total Grasses	25,805,155	15,789,145	17,203,152	24,391,148
Total Shrubs	18,892,867	6,609,330	12,926,452	12,575,744
Total Trees	33,649,568	19,287,138	13,780,068	39,156,638
Wetlands	259,594	1,022,138	88,969	1,192,763
Total	**105,857,748**	**48,807,284**	**48,807,284**	**105,857,748**

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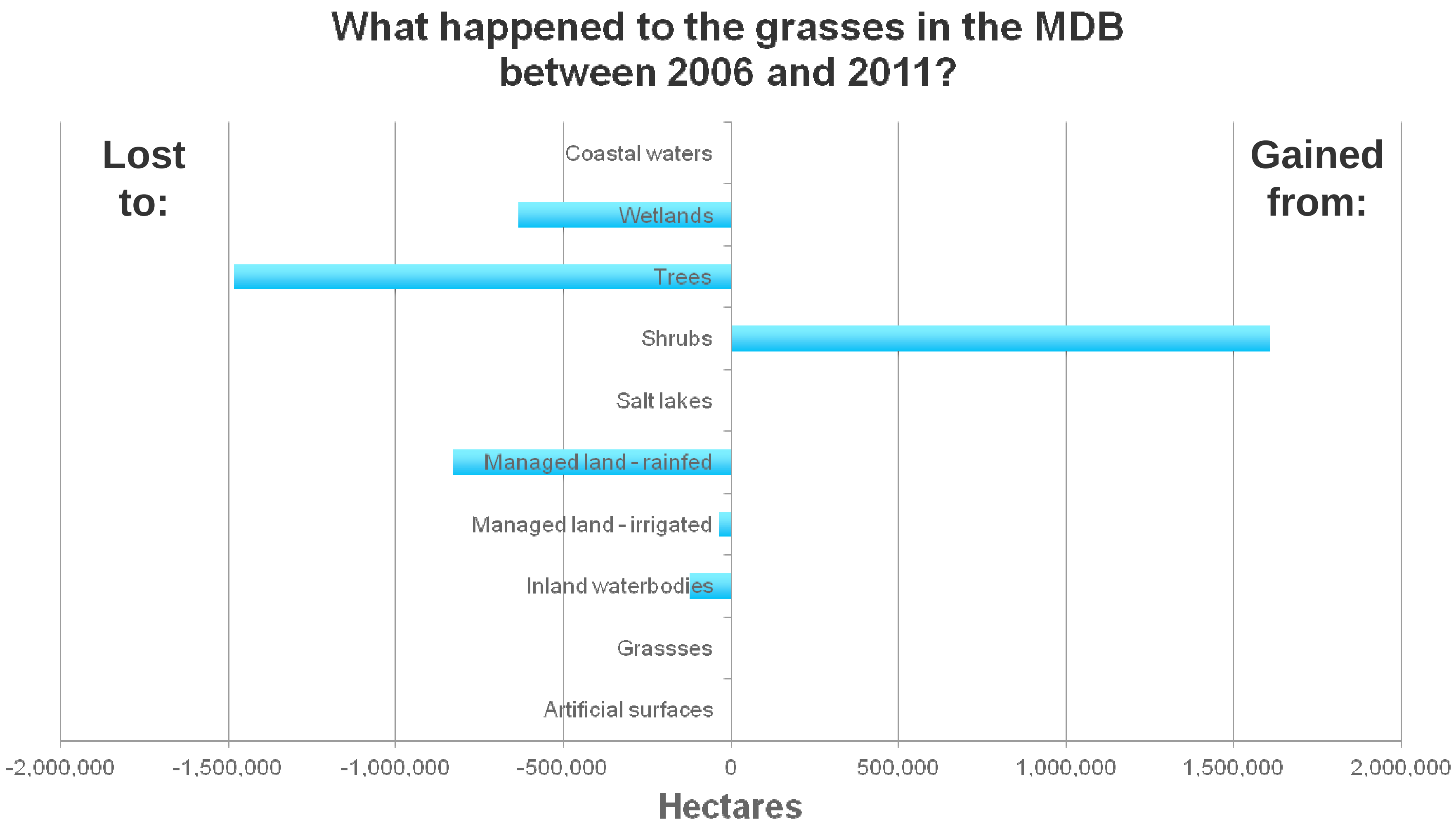
SEEA Land Cover Matrix table

Table 1. Land Cover Change Matrix (ha) for Murray-Darling Basin

Land Cover Group	Opening area, 2006-07	Net Increases (+ve) and Decreases (-ve) from 2006-07 to 2010-11											Closing Area, 2010-111
		Artificial Surfaces	Grasses	Inland Waterbodies	Managed Land - Irrigated	Managed Land - Rainfed	Salt Lakes	Shrubs	Trees	Wetlands	Coastal Waters	Net change (increase - decrease)	
Artificial Surfaces	139,469	-	0	0	0	0	0	0	0	0	0		139,469
Grasses	25,805,144	0	-	-123,625	-34,788	-831,013	0	1,690,075	-1,480,838	-633,819	0	-1,414,006	24,391,138
Inland Waterbodies	603,844	0	123,625	-	0	0	23,325	44,075	3,056	-2,894	0	191,188	795,031
Managed Land - Irrigated	788,225	0	34,788	0	-	320,656	0	0	0	0	0	355,444	1,143,669
Managed Land - Rainfed	25,675,625	0	831,013	0	-320,656	-	0	-8,131	265,375	0	0	767,600	26,443,225
Salt Lakes	36,638	0	0	-23,325	0	0	-	0	0	-13	0	-23,338	13,300
Shrubs	18,892,863	0	-1,690,075	-44,075	0	8,131	0	-	-4,469,869	-121,238	0	-6,317,125	12,575,738
Trees	33,649,563	0	1,480,838	-3,056	0	-265,375	0	4,469,869	-	-175,206	0	5,507,069	39,156,631
Wetlands	259,594	0	633,819	2,894	0	0	13	121,238	175,206	-	0	933,169	1,192,763
Coastal Waters	6,763	0	0	0	0	0	0	0	0	0	-	0	6,763

Account matrix



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Spatial accounts: capacity to splice and dice

Table 3. Stock account for land cover group for 2010-11, MDB Water Resource Plan Areas (Surface Water)

Water Resource Plan Area (Surface Water)	Land Cover Group										
	Artificial Surfaces	Grasses	Inland Waterbodies	Managed Land - Irrigated	Managed Land - Rainfed	Salt Lakes	Shrubs	Trees	Wetlands	Coastal Waters	Total
Australian Capital Territory (surface water)	15,963	2,106	1,969	188	45,819		206	170,325			236,575
Barwon-Darling	494	124,900	5,444	244	15,863	6	56,706	93,550	44,975		342,181
Condamine-Balonne	14,181	3,254,475	24,819	102,381	807,381		85,850	4,526,869	28,113		8,844,069
Eastern Mount Lofty	2,194	41,875	525	15,188	256,425		306	40,944	2,800	756	361,013
Gwydir	2,206	519,363	43,675	62,719	1,167,769		20,238	1,058,288	25,469		2,899,725
Intersecting Streams	2,206	2,958,725	153,056	7,369	244,269	8,250	3,738,938	4,581,300	295,038		11,989,150
Lachlan	8,356	1,638,163	24,900	46,200	3,803,625	50	456,563	2,462,944	214,531		8,655,331
Macquarie-Castlereagh	14,031	1,340,231	17,431	51,369	3,702,956		115,344	3,784,119	173,119		9,198,600
Moonie	13	714,338	1,331	2,069	155,519		25,356	540,581	2,969		1,442,175
Murrumbidgee	15,819	1,592,156	32,556	142,544	4,543,913	6	90,119	1,973,481	152,538		8,543,131
Namoi	6,444	475,588	27,988	81,644	1,431,444	19	14,163	2,131,469	16,719		4,185,475
New South Wales Border	3,531	304,819	14,069	34,363	698,131		10,769	1,079,694	16,581		2,161,956
New South Wales Murray	8,706	3,933,456	128,338	100,269	1,223,119	288	3,409,750	2,877,413	132,575		11,813,913
Northern Victoria	24,213	113,731	39,569	294,813	2,527,838		2,513	1,716,794	10,588		4,730,056
Queensland Border Rivers	1,425	523,825	11,288	34,994	333,606	6	10,400	1,480,438	9,606		2,405,588
South Australian Murray	4,119	1,552,288	31,200	8,763	1,329,863	63	1,932,125	1,462,556	18,488	2,644	6,342,106
South Australian River	100	28,613	91,294	4,019	12,881		18,288	47,119	13,906	3,363	219,581
Victorian Murray	8,531	46,925	24,513	147,250	493,444		4,356	1,028,944	10,338		1,764,300
Warrego-Paroo-Nebine	531	4,591,425	73,275	463	28,550	4,513	2,454,856	6,067,813	17,013		13,238,438
Wimmera-Mallee (surface	6,406	634,138	47,794	6,825	3,620,813	100	128,894	2,031,994	7,400		6,484,363
Total	**139,469**	**24,391,138**	**795,031**	**1,143,669**	**26,443,225**	**13,300**	**12,575,738**	**39,156,631**	**1,192,763**	**6,763**	**105,857,725**

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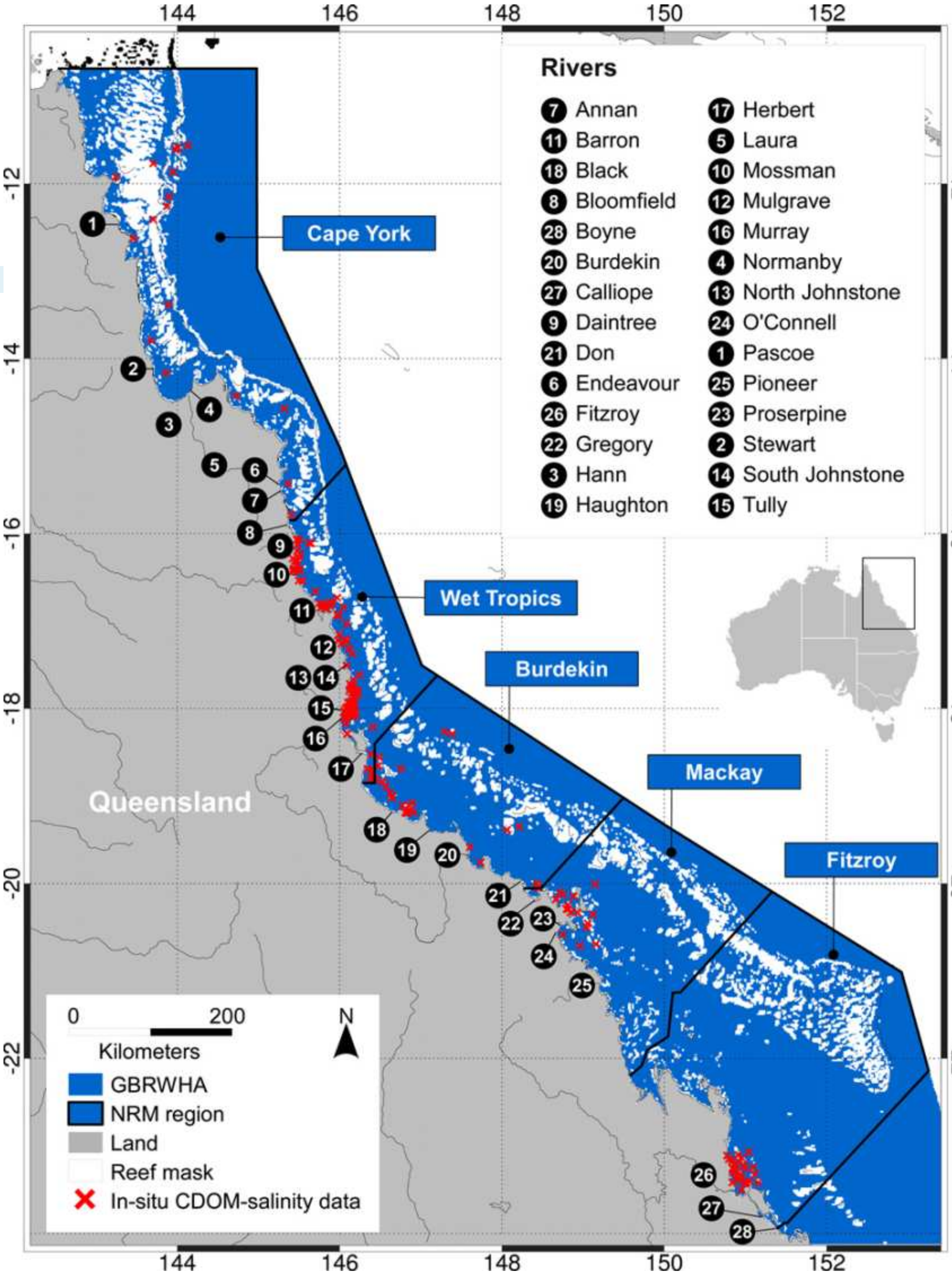
GBR Marine Water Quality Account

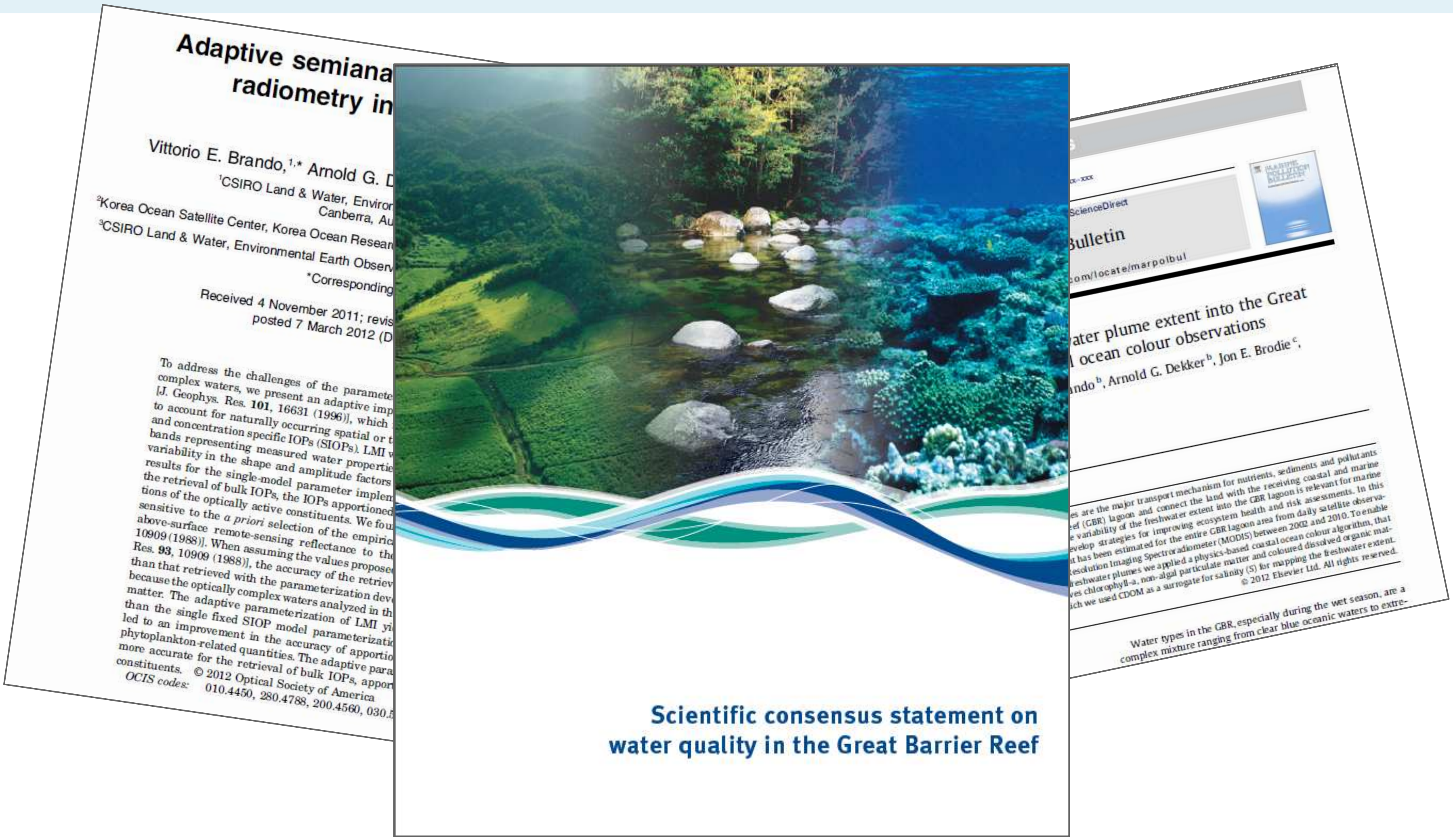
GBR NRM Marine Water Quality Account

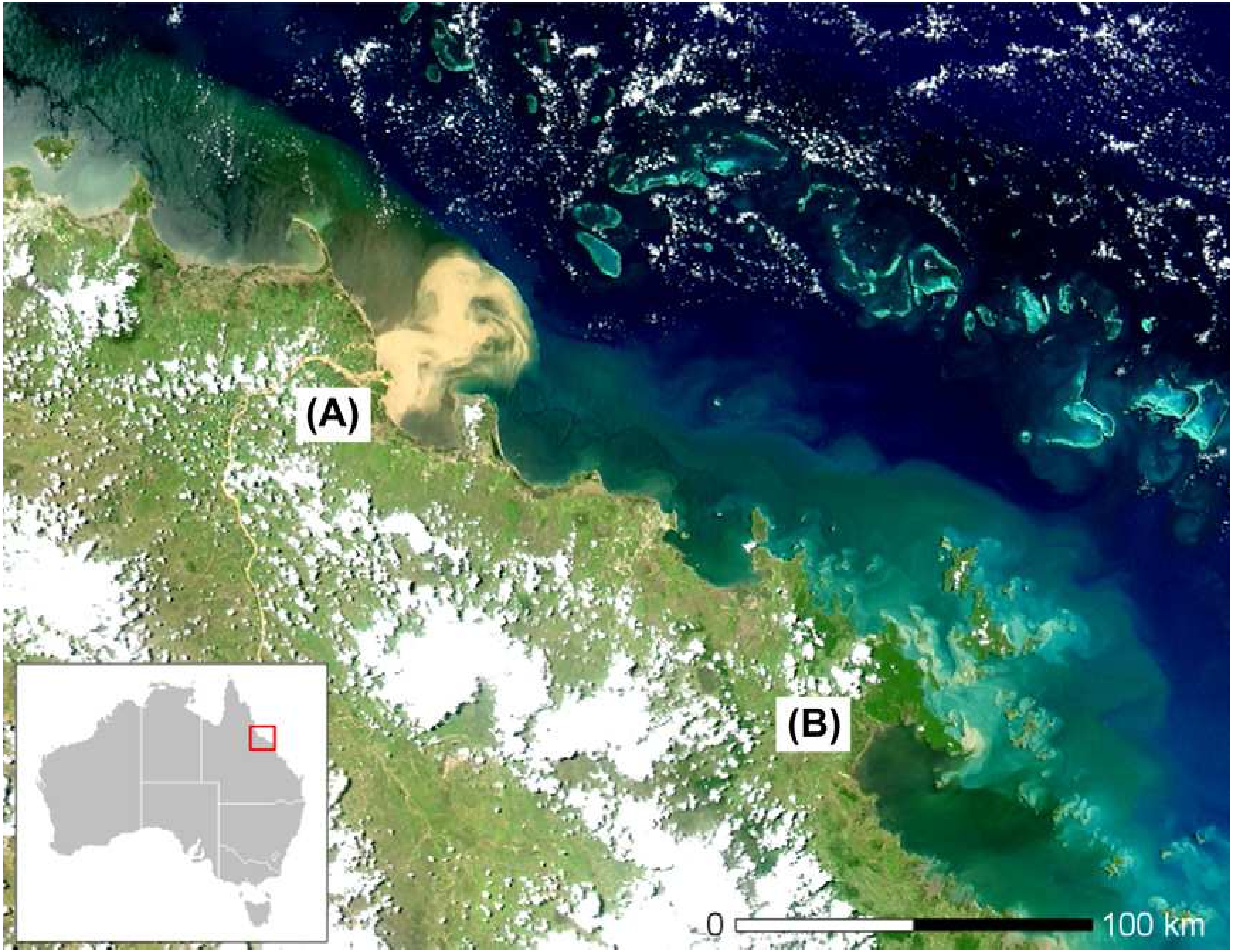
Marine NRM boundaries

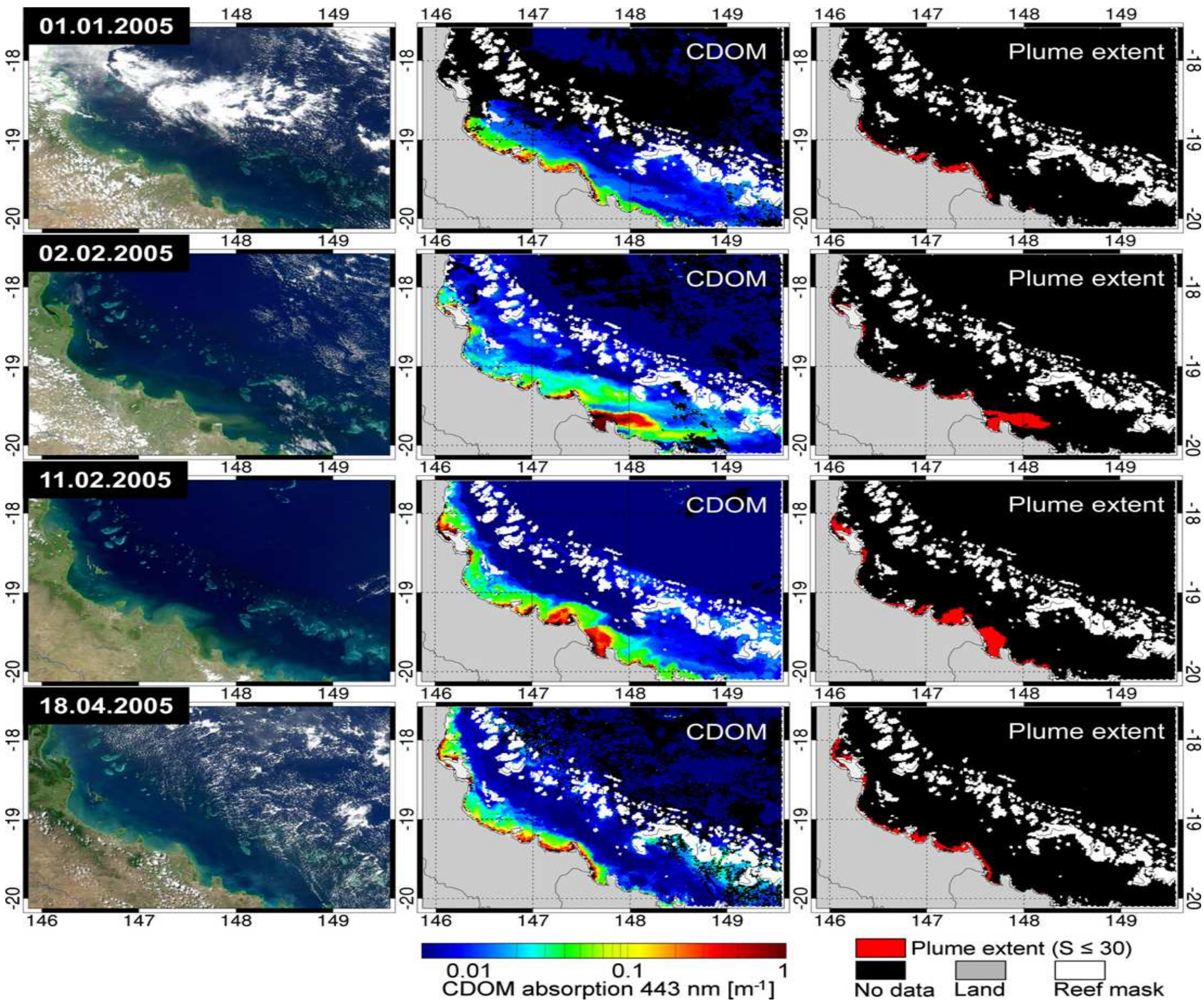


Source: Schroeder et al., 2012

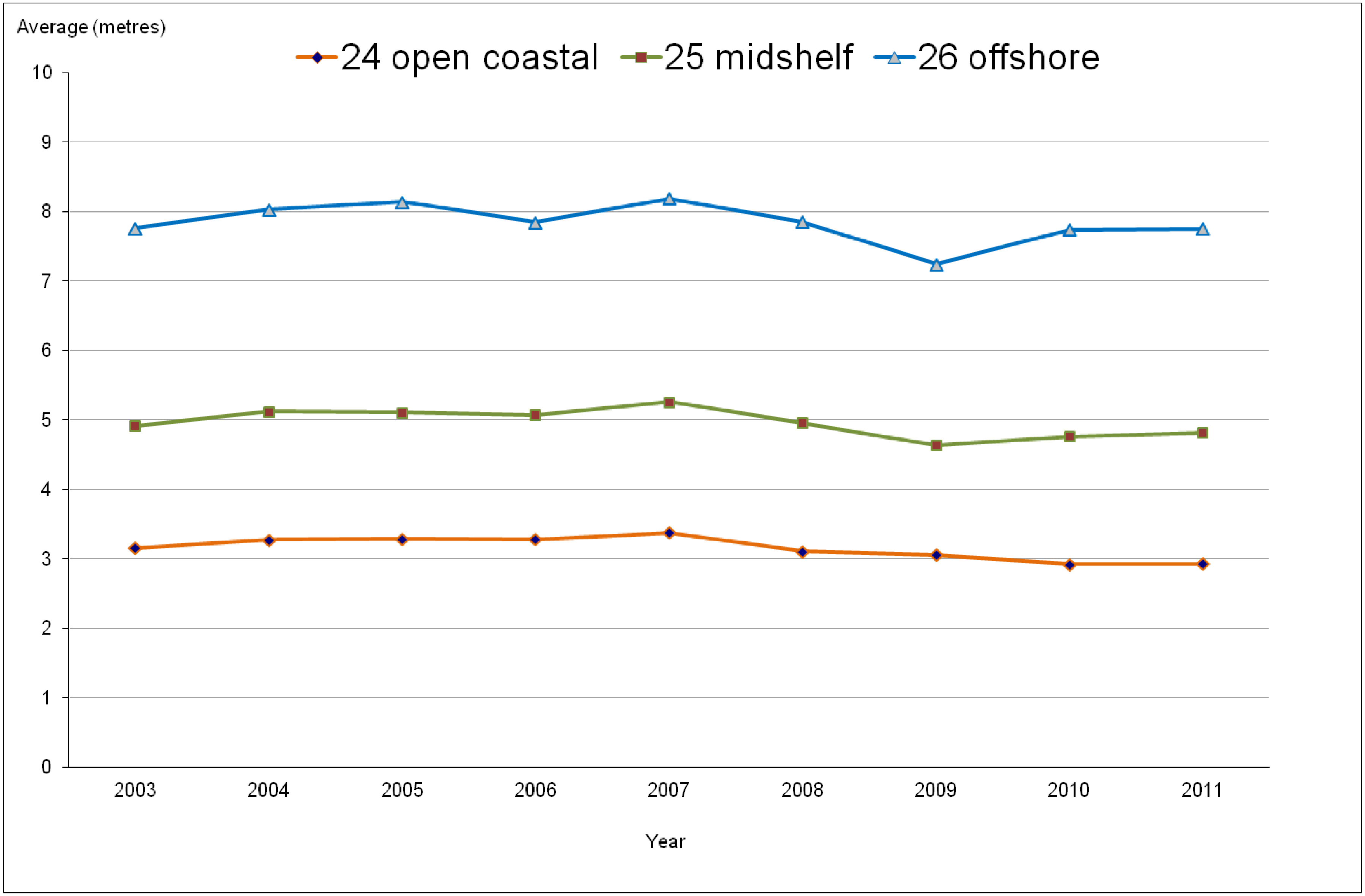
Conceptual Model



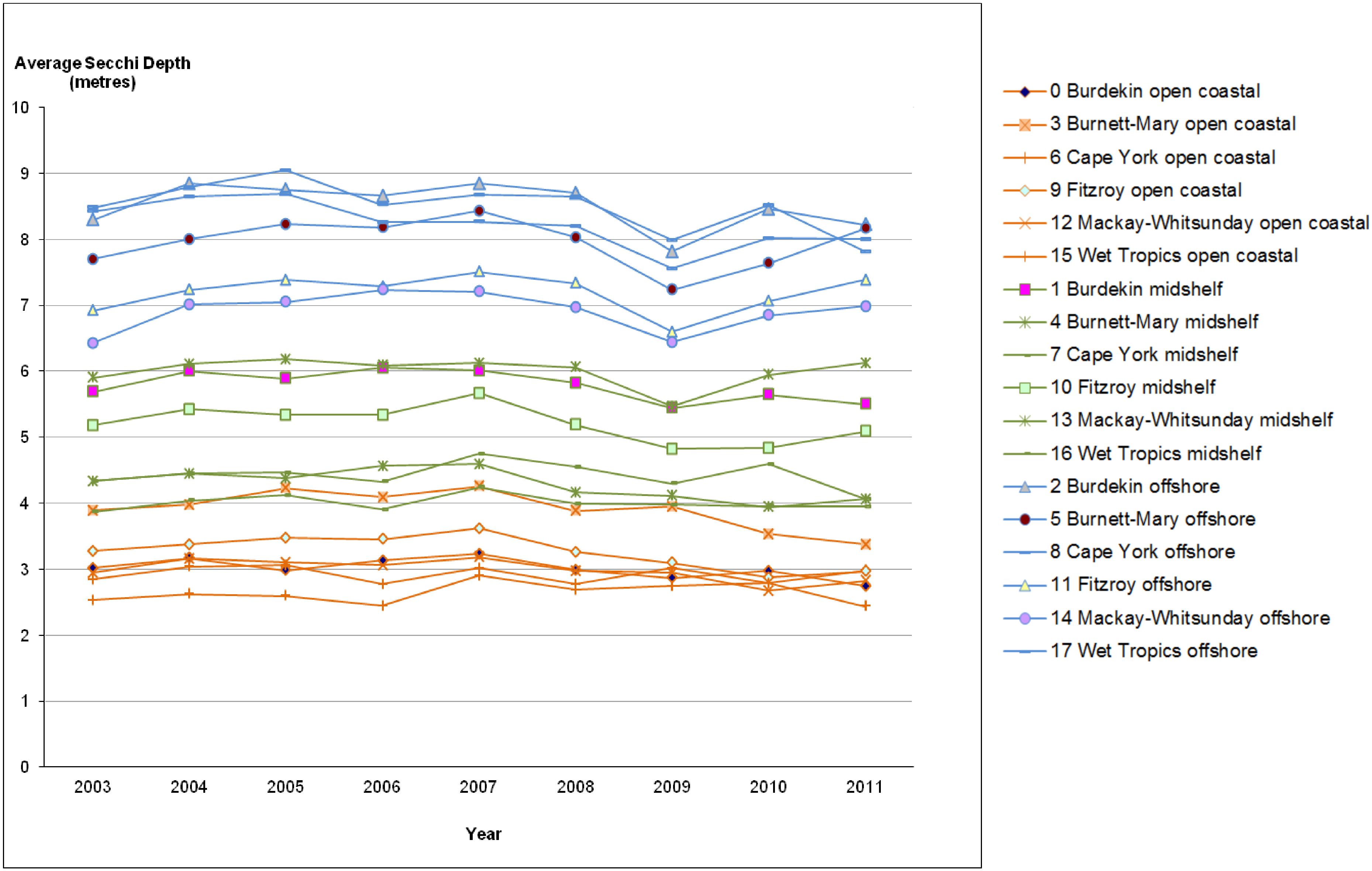

(A)
(B)
0
100 km


01.01.2005
02.02.2005
11.02.2005
18.04.2005
CDOM
Plume extent
146
147
148
149
-18
-19
-20
0.01
0.1
1
CDOM absorption 443 nm [m-1]
Plume extent (S ≤ 30)
No data
Land
Reef mask

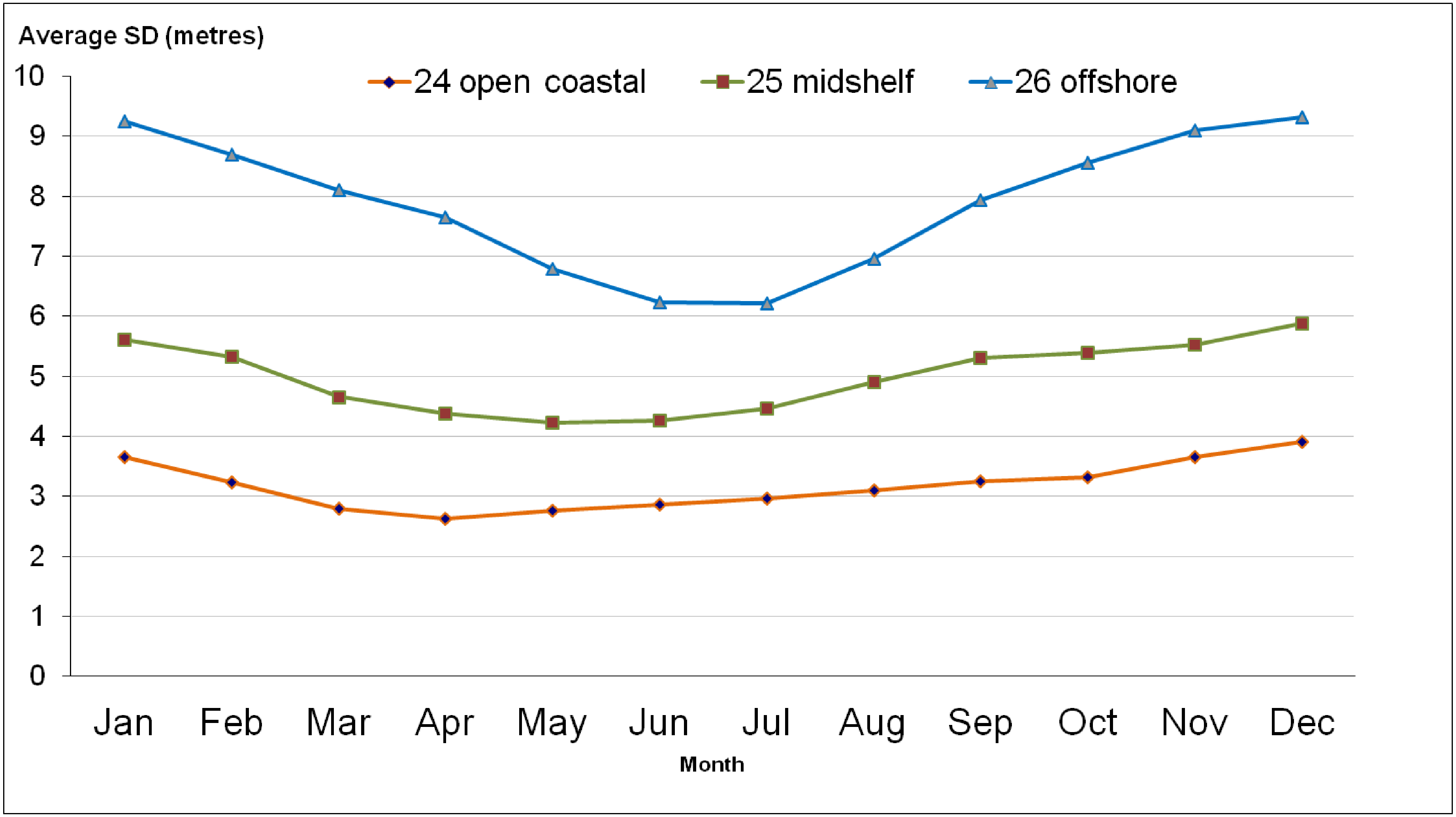
MWQ – Water Clarity (Secchi Depth) – ecological regions



MWQ – Water Clarity (Secchi Depth) – multiple regions



MWQ – Water Clarity (Secchi Depth) – Monthly Climatology



THANK YOU FOR LISTENING

Questions?

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