

## Supplementary Information

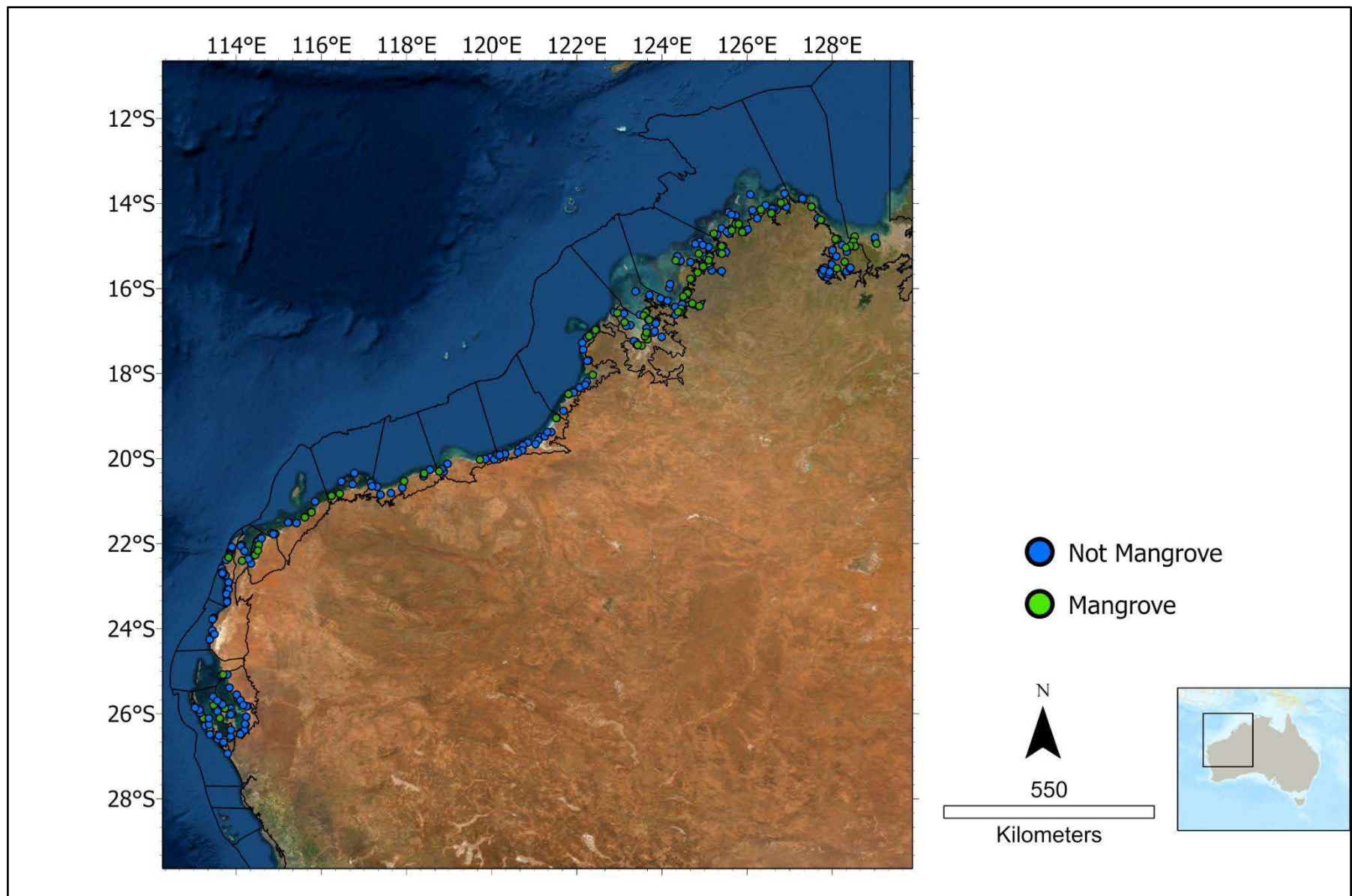


Figure S1: Training points ( $n = 346$ ) used to build the WA mangrove models. Blue circle indicates the location is not mangrove, green represents a mangrove location. Imagery as discussed in the method section was used to determine mangrove validation. Black outline refers to zones as defined by primary sedimentary processes (source: Geoscience Australia soil layer - see methods).

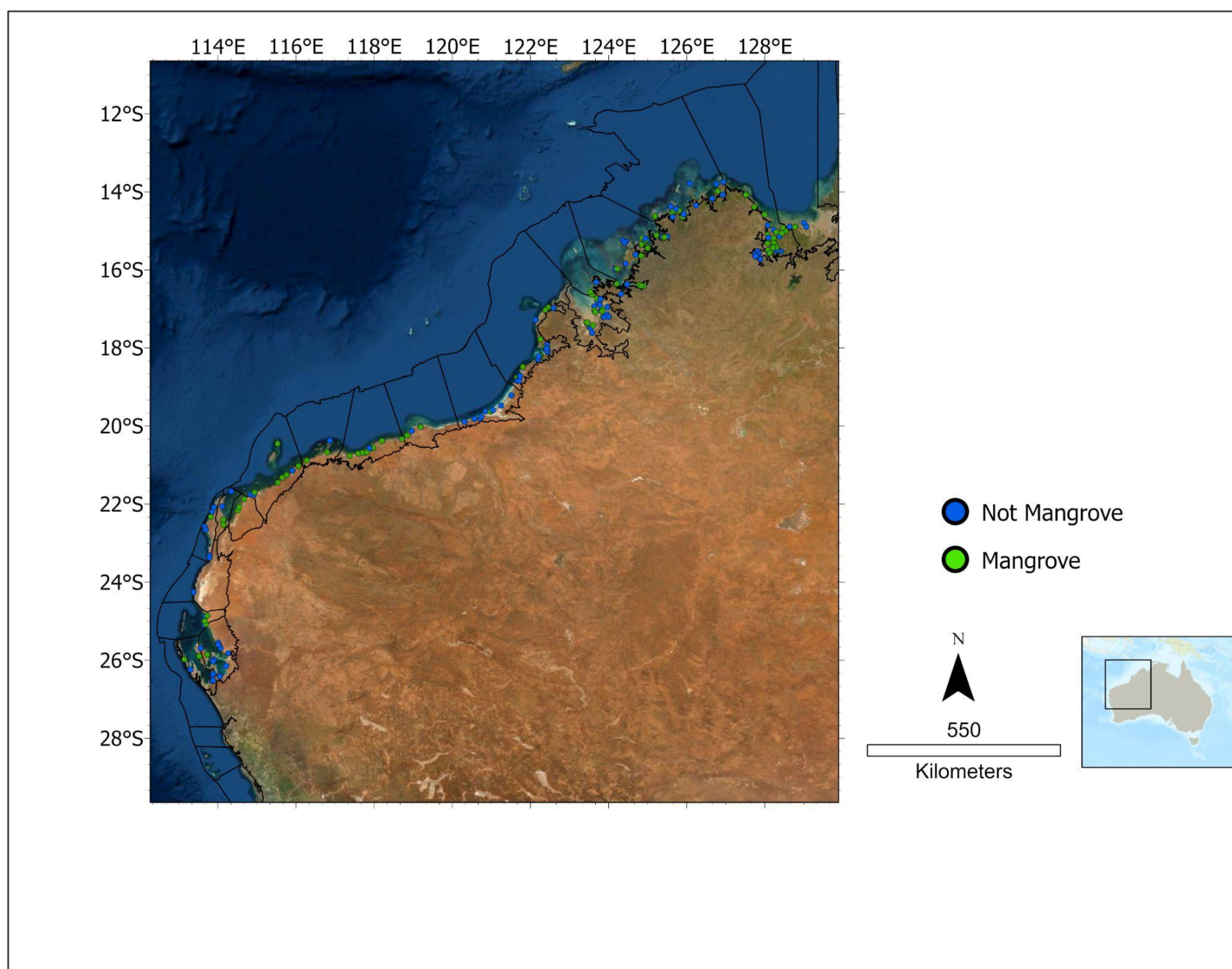


Figure S2: Test points (n = 229, 109 mangrove; 120 not mangrove) used to validate the WA mangrove models. Blue circle indicates non-mangrove locations, green circles represents a mangrove location. Imagery as discussed in the method section was used to determine mangrove validation. Black outline refers to zones as defined by primary sedimentary processes (source: Geoscience Australia soil layer - see methods).

Table S1: Cumulative accuracy statistics for mangrove model based on combining satellite information from 1 to up to 7 years and also for each individual year form 2014 to 2021. See methods for information on model development and validation methods. The validation points were used to assess the performance of the optimal mangrove layer to existing datasets (Giri et al., 2011; Worthington et al., 2021, Lymburner et al., 2020 - note: validation points were not checked against the time point of the dataset for these comparisons).

Method	Model	Class Statistics						Overall Model Statistics	
			Not Mangrove	Mangrove	Precision	Recall	F1-Score	Kappa	Accuracy (%)
Cumulative Frequency of Pixel	$\geq 1$	Not Mangrove	54	66	0.92	0.45	0.60	0.39	69
		Mangrove	5	104	0.61	0.95	0.75		
	$\geq 2$	Not Mangrove	57	63	0.90	0.47	0.62	0.41	10
		Mangrove	6	103	0.62	0.94	0.75		
	$\geq 3$	Not Mangrove	60	60	0.90	0.50	0.64	0.43	71
		Mangrove	7	102	0.62	0.94	0.75		
	$\geq 4$	Not Mangrove	96	24	0.82	0.80	0.81	0.61	80
		Mangrove	21	88	0.79	0.81	0.80		
	$\geq 5$	Not Mangrove	100	20	0.78	0.83	0.81	0.58	79
		Mangrove	28	81	0.80	0.74	0.77		
	$\geq 6$	Not Mangrove	104	16	0.76	0.87	0.81	0.57	79
		Mangrove	33	76	0.83	0.70	0.76		
	$\geq 7$	Not Mangrove	109	11	0.73	0.91	0.81	0.54	77
		Mangrove	41	68	0.86	0.62	0.72		
Annual Mangrove Model	2014 Mangroves	Not Mangrove	89	31	0.82	0.74	0.78	0.56	78
		Mangrove	20	89	0.74	0.82	0.78		
	2015 Mangroves	Not Mangrove	93	27	0.78	0.78	0.78	0.53	76
		Mangrove	27	82	0.75	0.75	0.75		
	2016 Mangroves	Not Mangrove	80	40	0.78	0.67	0.72	0.45	72
		Mangrove	23	86	0.68	0.79	0.73		
	2017 Mangroves	Not Mangrove	76	44	0.78	0.63	0.70	0.44	72
		Mangrove	21	88	0.67	0.81	0.73		
	2018 Mangroves	Not Mangrove	81	39	0.78	0.68	0.72	0.46	73
		Mangrove	23	86	0.69	0.79	0.74		
	2019 Mangroves	Not Mangrove	88	32	0.81	0.73	0.77	0.54	77
		Mangrove	21	88	0.73	0.81	0.77		
	2020 Mangroves	Not Mangrove	101	19	0.80	0.84	0.82	0.60	80
		Mangrove	26	83	0.81	0.76	0.79		

Comparison Layer	2021 Mangroves	<b>Not Mangrove</b>	85	35	0.76	0.71	0.73	0.46	73
		<b>Mangrove</b>	27	82	0.70	0.75	0.73		
	Giri et al.	<b>Not Mangrove</b>	120	0	0.63	1.00	0.77	0.37	69
		<b>Mangrove</b>	70	39	1.00	0.36	0.53		
	Worthington et al.	<b>Not Mangrove</b>	119	1	0.65	0.99	0.78	0.41	71
		<b>Mangrove</b>	65	44	0.98	0.40	0.57		
	Lymburner et al.	<b>Not Mangrove</b>	120	0	0.68	1.00	0.81	0.49	75
		<b>Mangrove</b>	57	52	1.00	0.48	0.65		



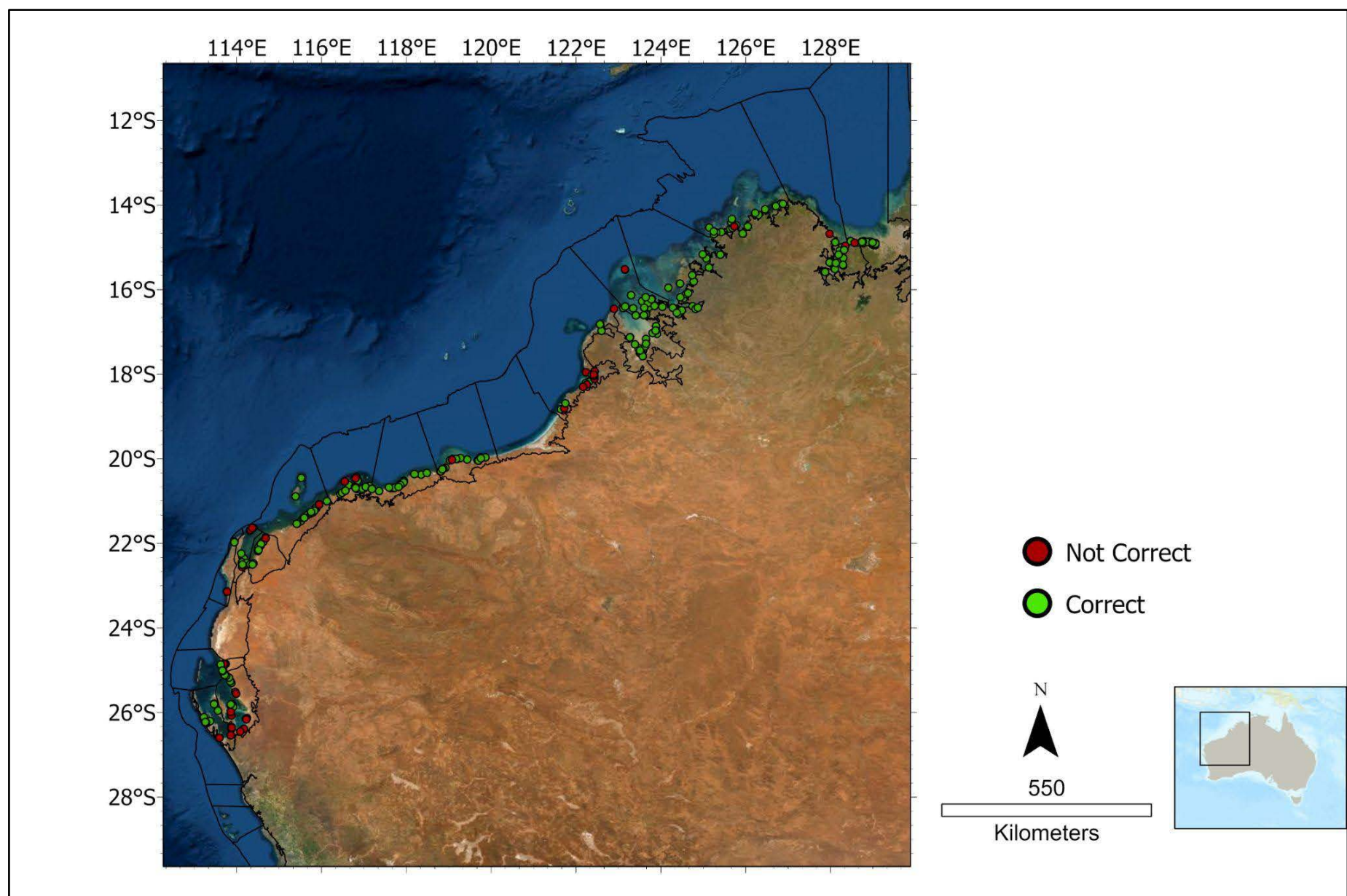


Figure S3: Model Test points ( $n = 20$  per zone, 340 total points) used to assess accuracy at zonal level for optimal WA mangrove model. Red circle indicates the location is not correctly labelled, green represents a correct model classification. Imagery as discussed in the method section was used to determine mangrove validation. Black outline refers to zones as defined by primary sedimentary processes (source: Geoscience Australia soil layer - see methods), 20 points were created in each zone within the new mangrove category devised from the Giri to Optimal WA mangrove model change analysis (see methods).

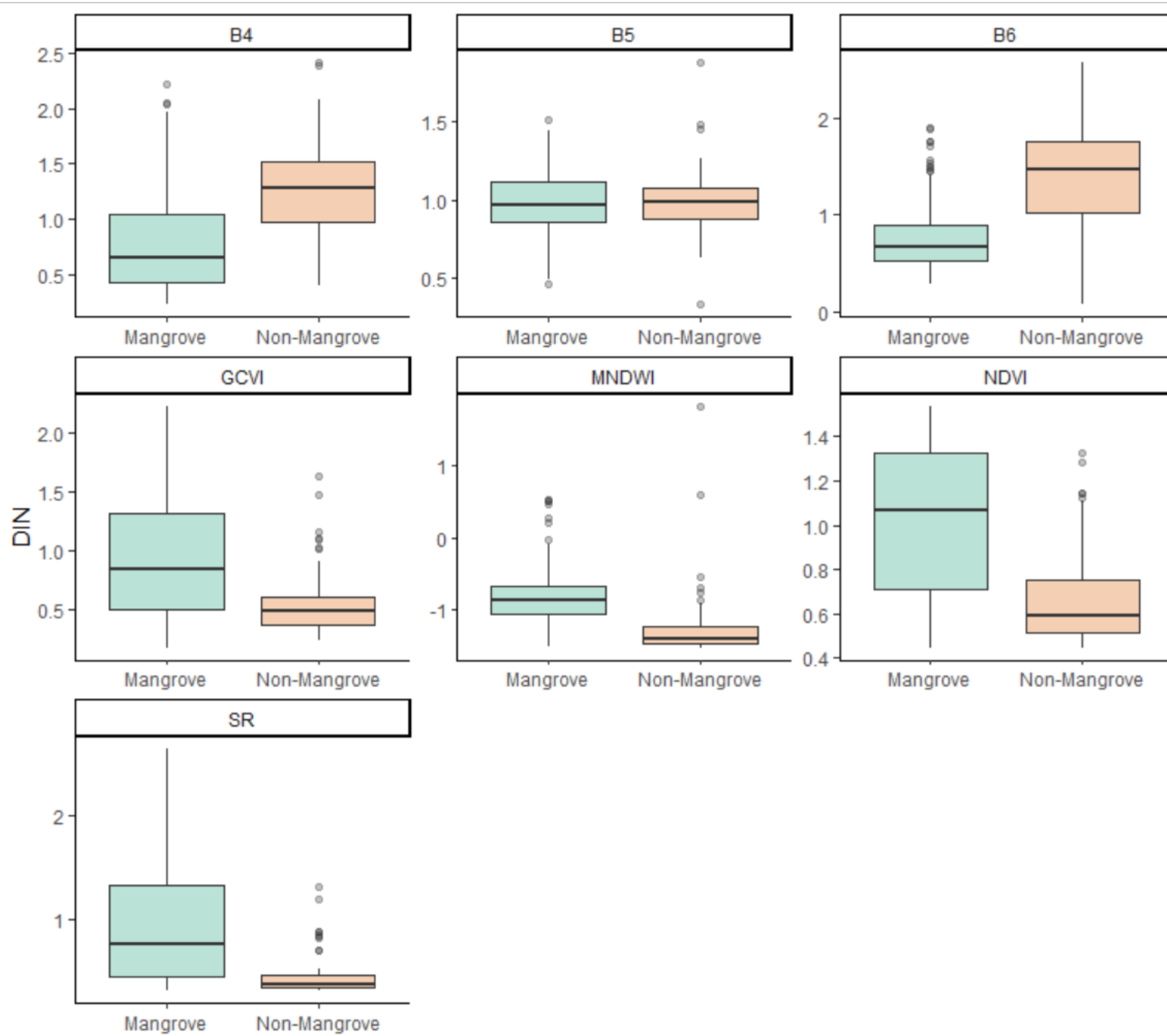
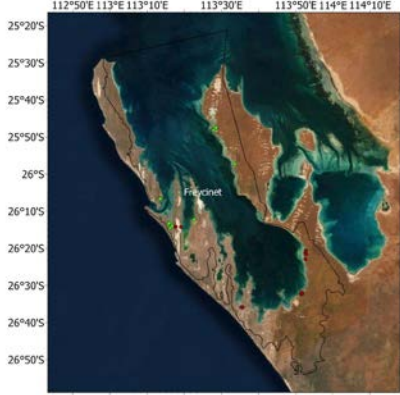
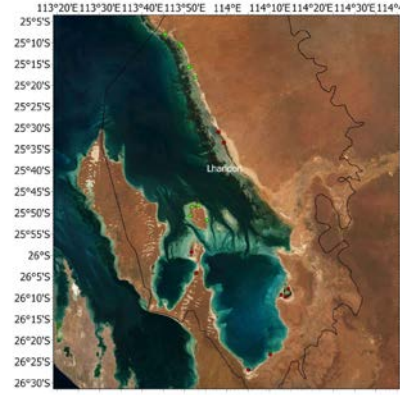
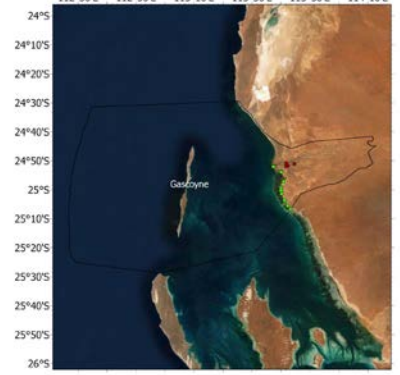
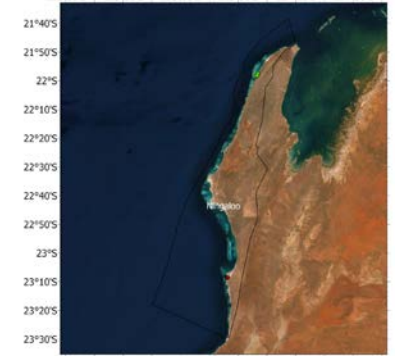




Figure S4: Box and whisker plot showing the relative band values of mangrove (Blue) ground control points versus non-mangrove (Pink) ground control points for Landsat 8 remote sensing bands 4,5 and 6 and band composites GCVI, NDVI, MNDWI and SR from a 5 year median composite. The solid central line is the median value, lower and upper hinges correspond to the first and third quartiles. The upper whisker extends from the hinge by 1.5 multiplied by the inter quartile range. The lower whisker extends from the hinge to 1.5 multiplied by the inter quartile range. Data beyond the end of the whiskers "outlying" points and are plotted individually.


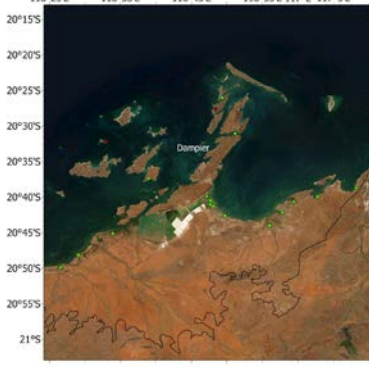



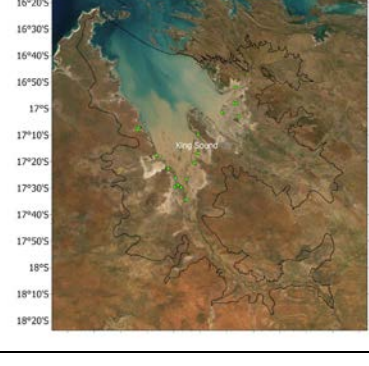
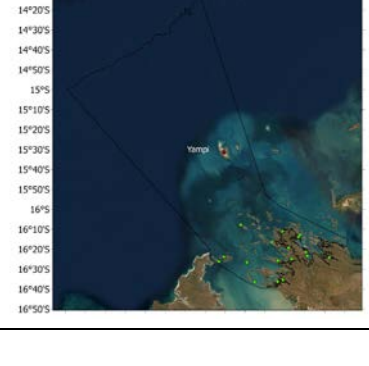
Table S2: Total area of mangroves as derived from each mangrove habitat model. Note: due to geometric changes between polygons and rasters area may differ slightly if derived from pixel counts (ratio between layers is the same).

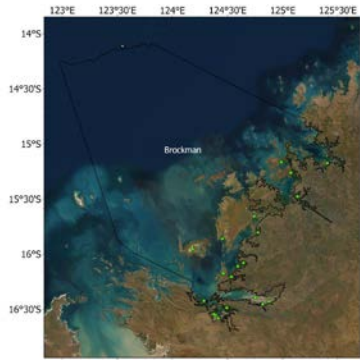
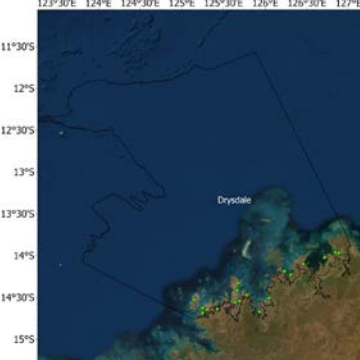


Method	Model	Area (ha)
Cumulative Frequency of Pixel Models	≥ 1	358211
	≥ 2	312699
	≥ 3	290968
	≥ 4	276538
	≥ 5	263136
	≥ 6	251757
	≥ 7	238031
Annual Mangrove Models	2014 Mangroves	288854
	2015 Mangroves	265868
	2016 Mangroves	293735
	2017 Mangroves	283839
	2018 Mangroves	283839
	2019 Mangroves	271089
	2020 Mangroves	257205
Comparison Layers	2021 Mangroves	269842
	Giri et al.	200490
	Worthington et al.	183236

Table S3: Zonal Validation of optimal WA habitat model in zones that overlapped Giri et al., 2011, Worthington et al., 2020 and Lymburner et al., 2020.

Zone	Not Correct	Correct	Percentage Correct	Validation Points (red not correct; green correct)
Freycinet	12	8	40%	
Lharidon	10	10	50%	
Gascoyne	4	16	80%	
Ningaloo	6	14	70%	
Exmouth West	8	12	60%	
Exmouth East	1	19	95%	



Barrow	2	18	90%	
Dampier	2	18	90%	
Roebourne		20	100%	
De Grey	1	19	95%	
Pindan	11	9	45%	
King Sound	0	20	100%	
Yampi	3	17	85%	

Brockman		20	100%	
Drysdale	1	19	95%	
Bonaparte West	2	18	90%	
Bonaparte East	1	19	95%	



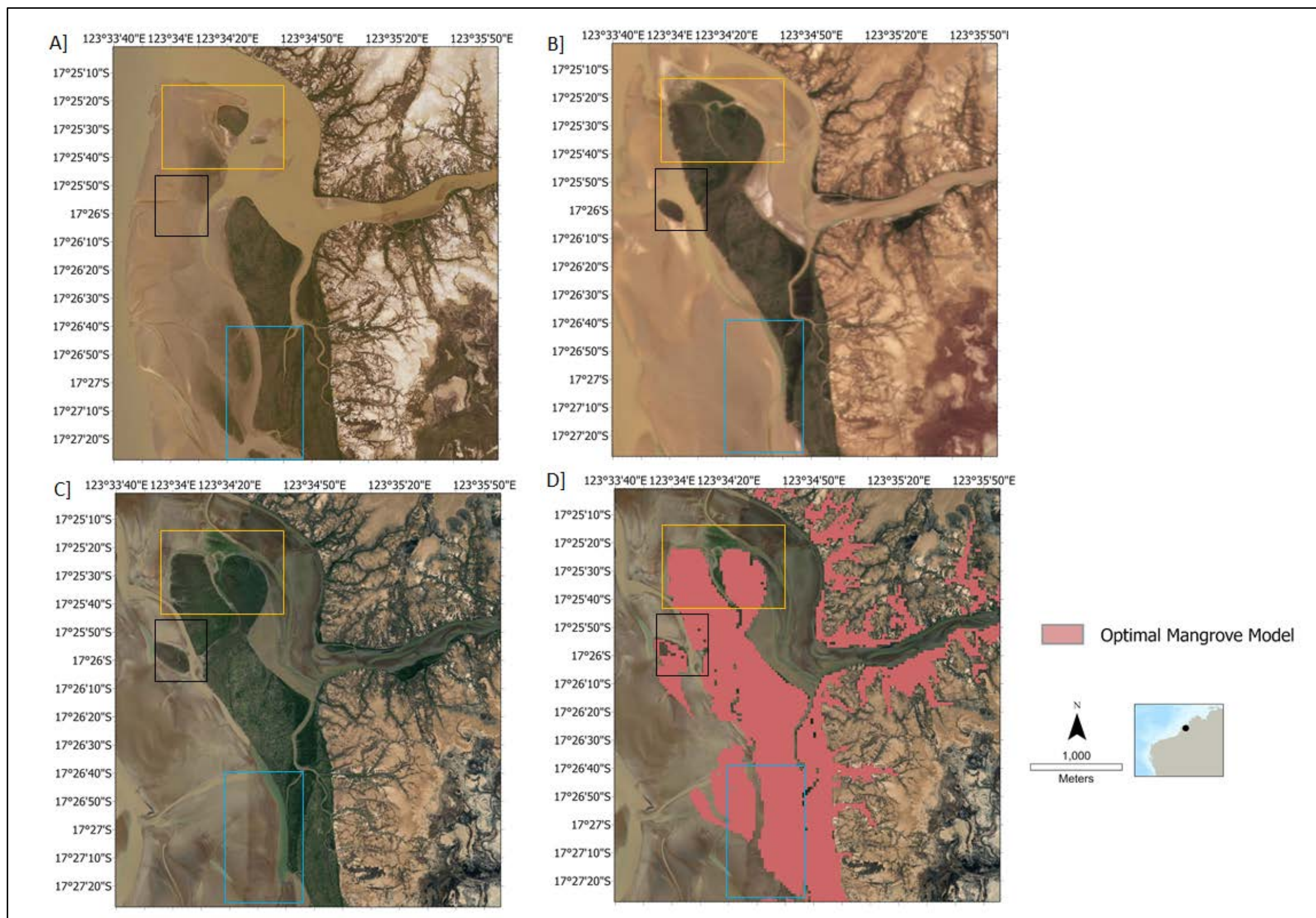


Figure S5a: Areas of mangrove that were identified in the optimal WA mangrove model (red). Boxes refer to areas of change. [A] - [D] Depict mangrove change across time series of images at one location; [A] High resolution orthorectified aerial image in 2013; [B] High resolution Planet Labs satellite image 2021; [C] ESRI basemap image representative recent timescale image collection; and [D] optimal WA mangrove model (red). Boxes refer to areas of change.



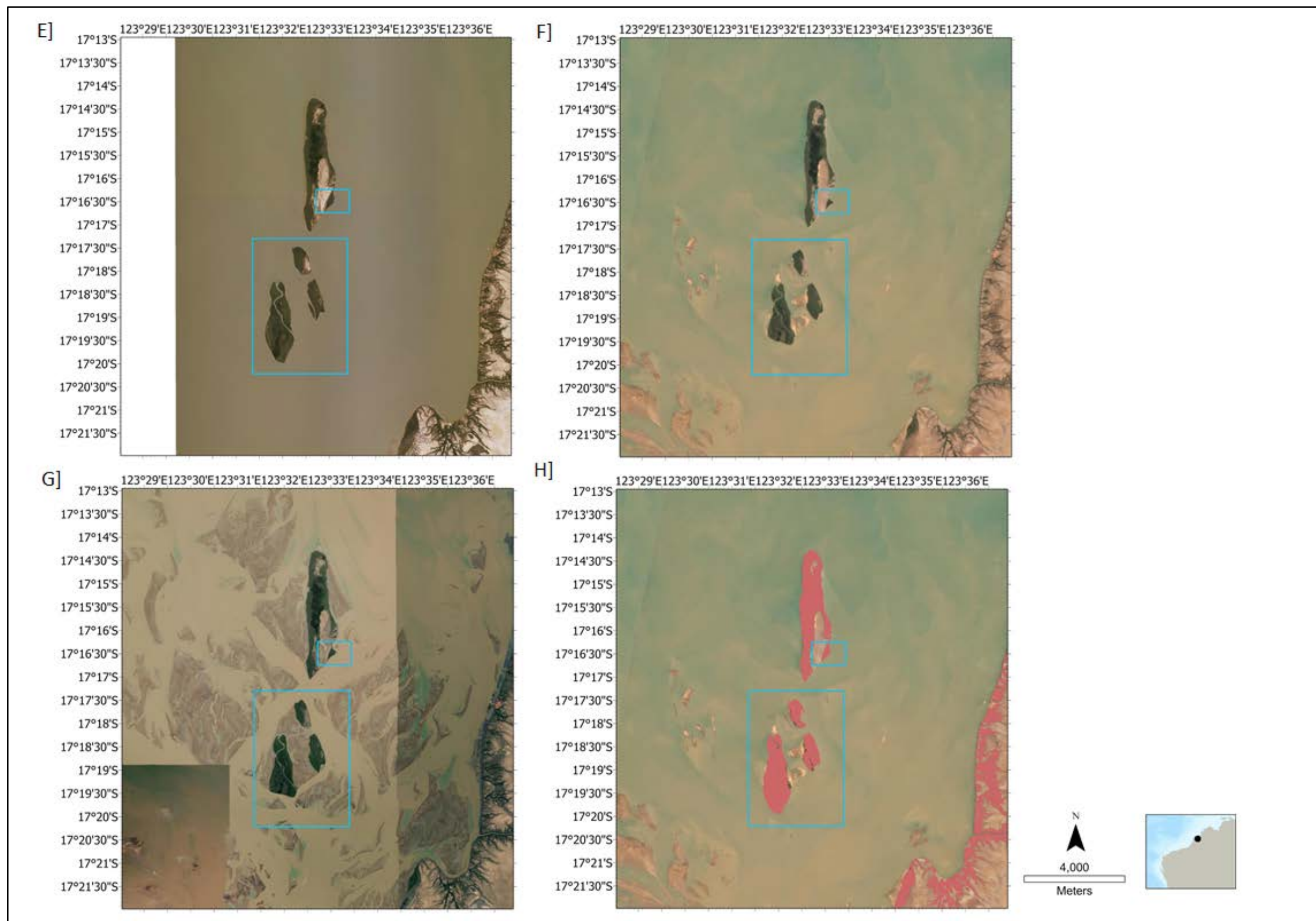


Figure S5b: [E] - [H] Depict mangrove change across time series of images at one location; [E] High resolution orthorectified aerial image in 2013; [F] High resolution Planet Labs satellite image 2021; [G] ESRI basemap image representative recent timescale image collection; and [H] optimal WA mangrove model (red). Boxes refer to areas of change.



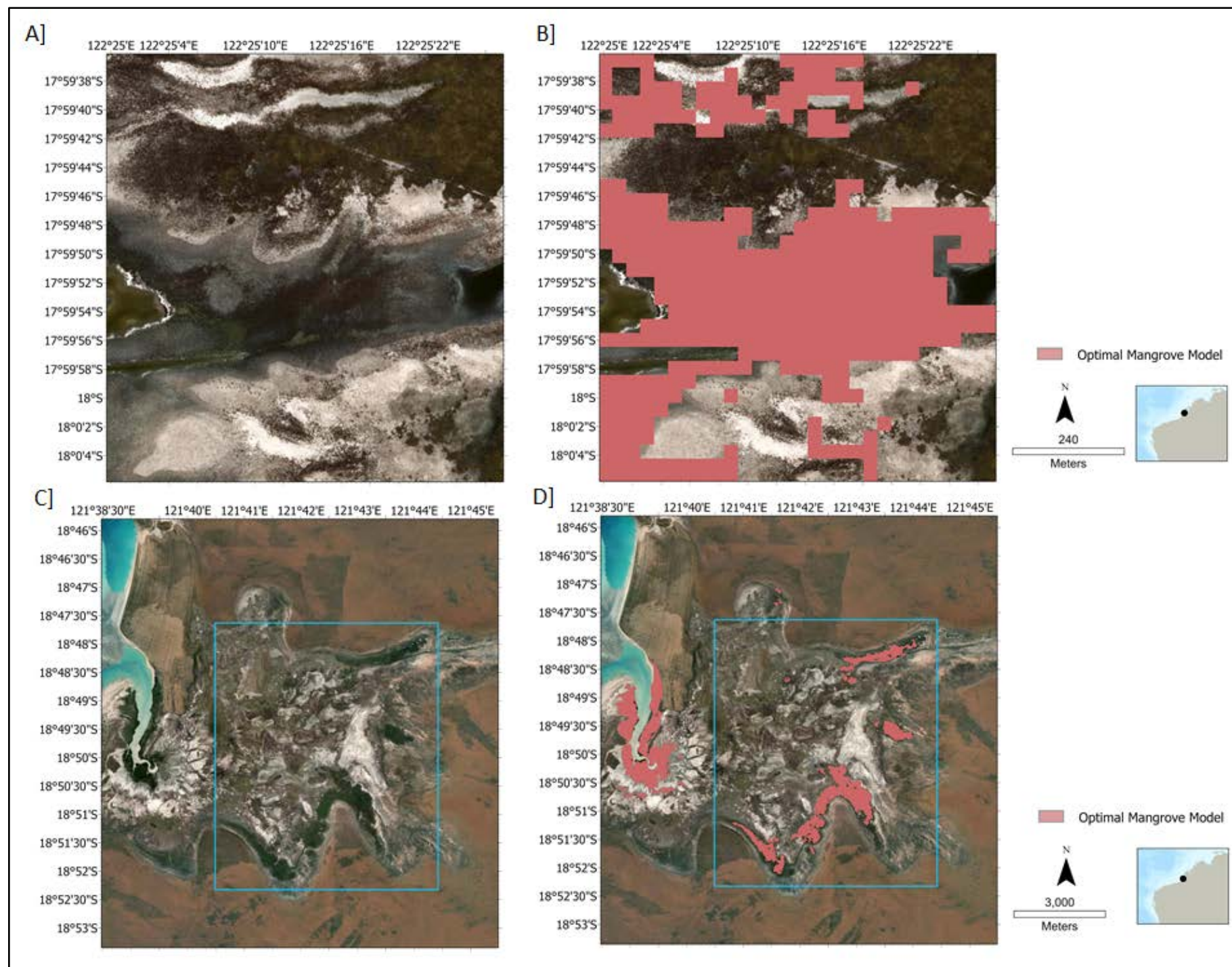


Figure S6: [A] - [D] Depict some of the common commission errors apparent in the optimal WA mangrove model (red). [A] and [B] show the optimal WA mangrove model (B- red) misclassifying cyanobacterial mats behind the mangroves as mangrove. [C] and [D] optimal WA mangrove model (D- red) mislabelling other shrubs (blue box) as mangrove behind the mangroves.

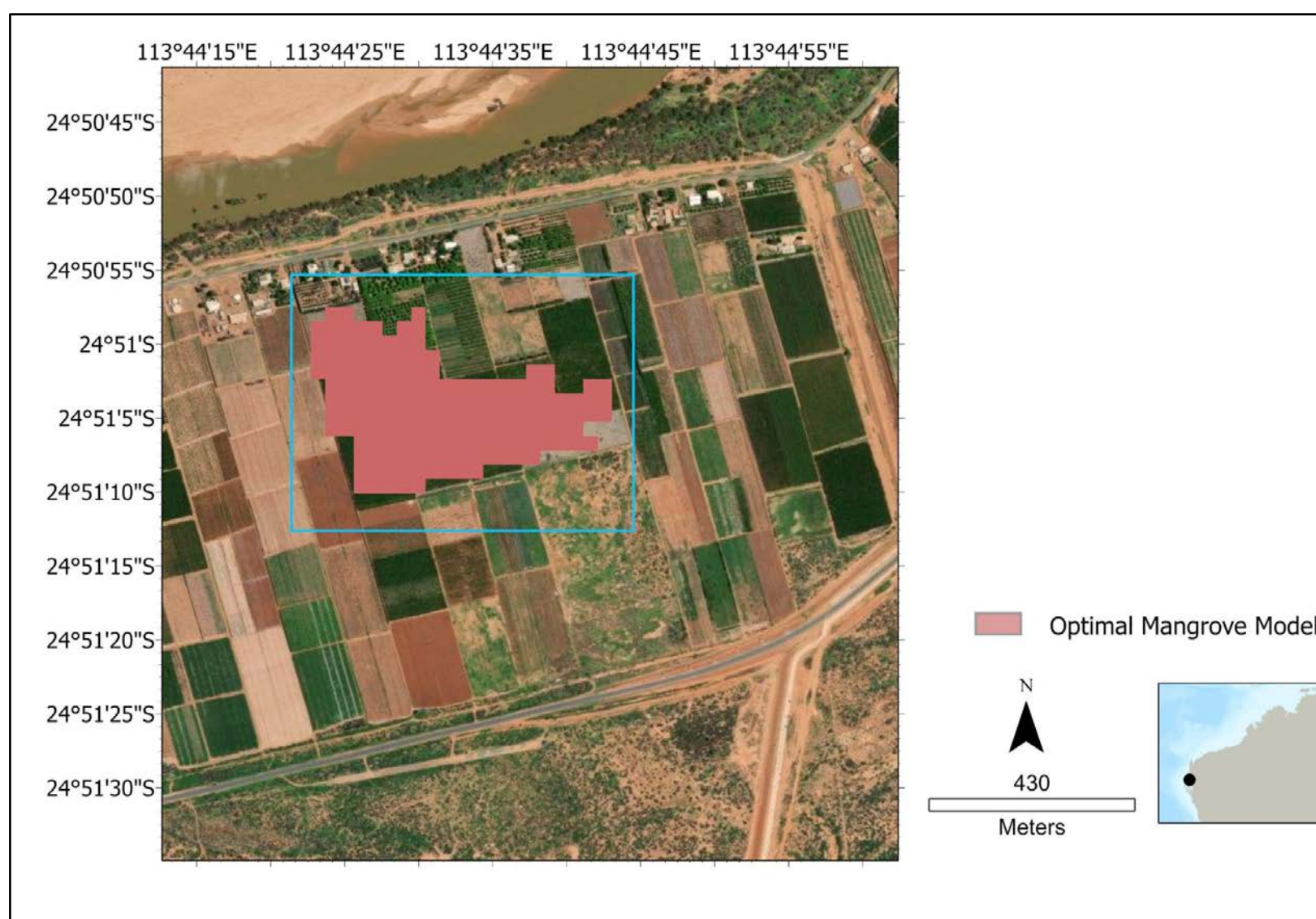


Figure S7: Example of misclassification of agriculture land predicted as mangrove in the model. Example is near Oyster Creek at Carnarvon.



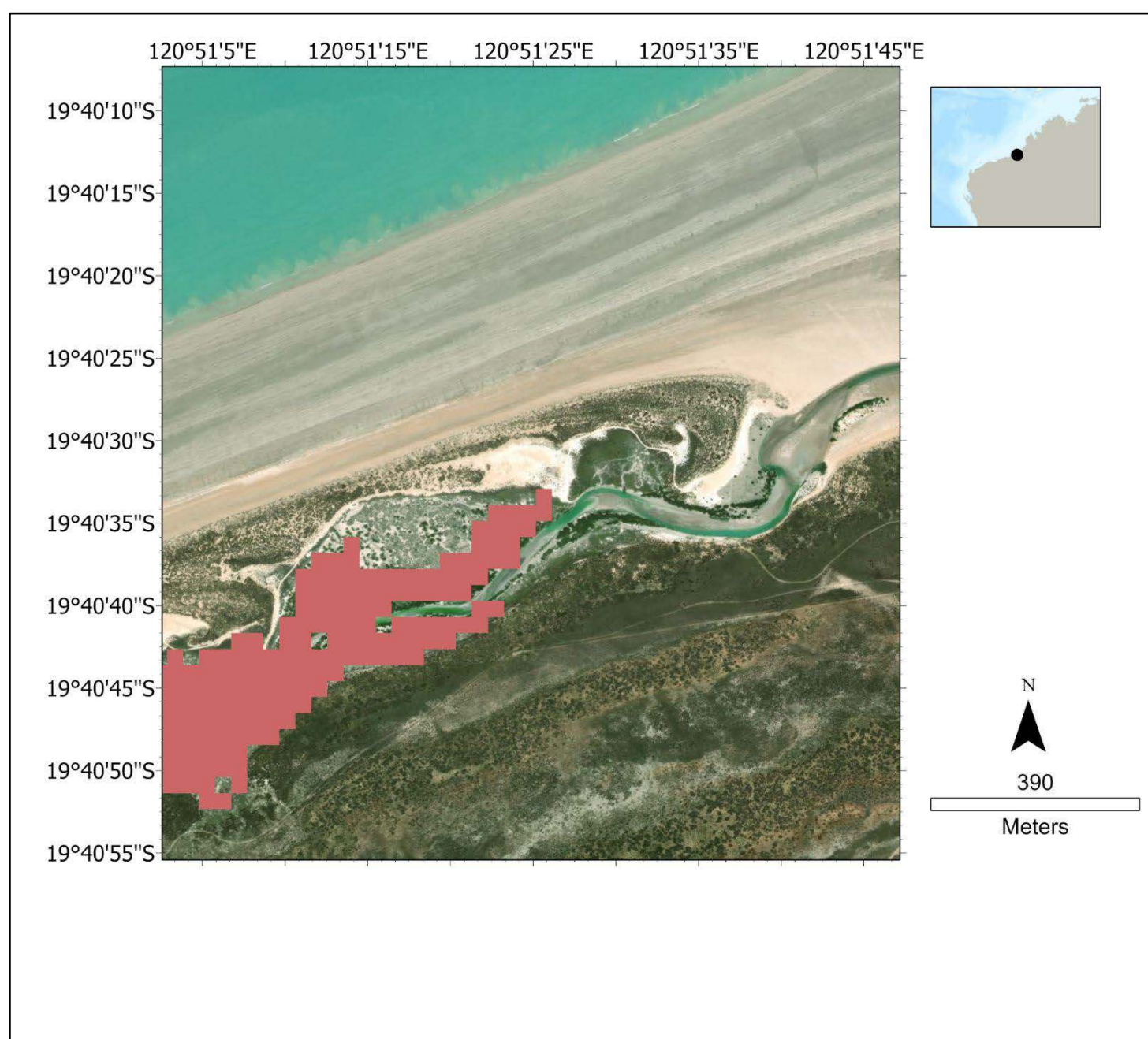


Figure S8A: Periodically inundated Mangroves in Wyall zone that were not previously mapped in national or global datasets. These areas have not been ground verified in this study but were recorded in previous studies (Johnstone 1990; Hale and Butcher 2009) and occur in the Ramsar site - Mandora Salt Marsh. This predicted habitat model area includes some omission and commission classification, though does correctly overlap and identify mangrove presence here.

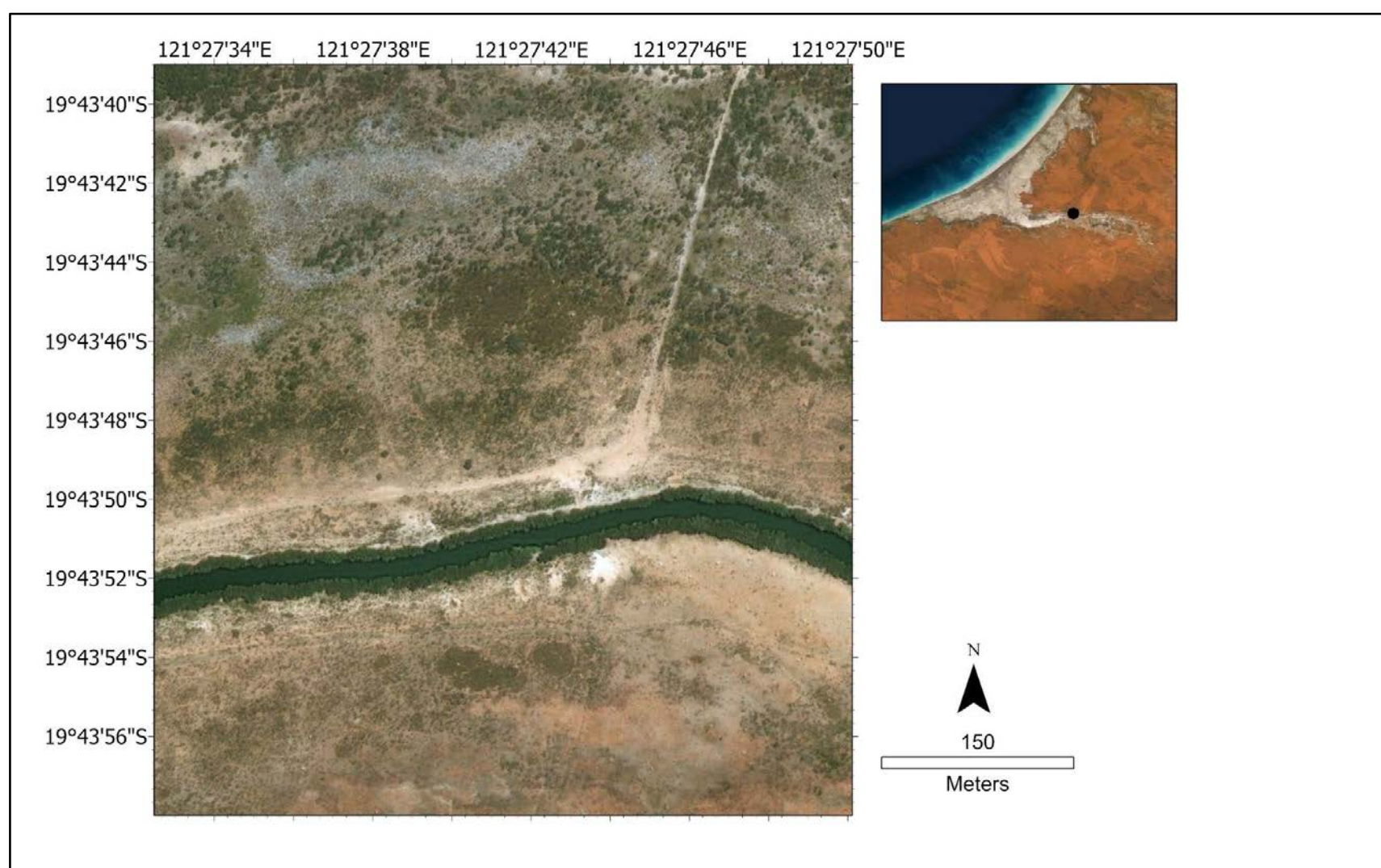


Figure S8B: Mangroves in the Wyall zone, that were not previously mapped in national or global datasets. These areas have not been ground verified in this study but were recorded in previous studies, and are listed as the most landward occurrence on the north-west coast (Johnstone 1990; Hale and Butcher 2009). This predicted habitat model did not detect this small fringing area of mangroves lining Salt Creek near 80 Mile Beach. Inset map show location of Salt Creek landward of coastline near 80 Mile Beach, though it occurs within Mandora Marsh Ramsar extent.



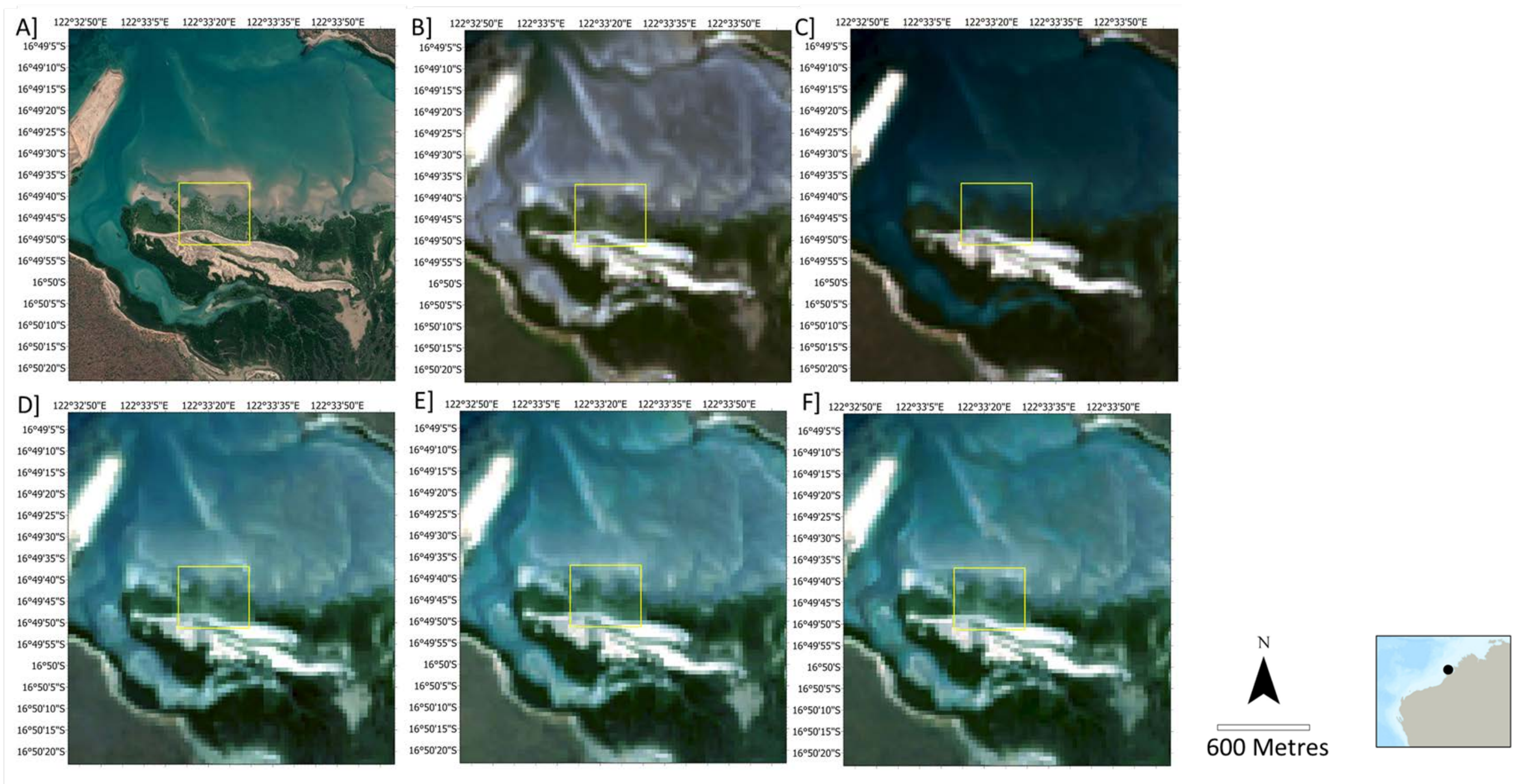


Figure S9: Example of differences in Landsat satellite single image scenes (B-C), and annual composite images (D-F). [A] High resolution image showing a section of coastline derived in the WA optimal mangrove layer not previously detected in broadscale layers (yellow box). This area is highly tidal which influences the pixel spectral signature (background noise), and depending on image is can represent mangrove and sediment (B - captured 17/3/2020) at a lower tide, or mangrove and water (C - 5/6/2020) at a high tide. The annual composite images minimise the differences between the tidal variations, showing a more 'standard' image across the representative years (D) 2018, (E) 2019, (F) 2020.