

NESP 1.15 Coastal wetland restoration for blue carbon

Spatial analysis workflow – Ord River case study, WA

Purpose: To identify the coastal wetland restoration opportunity in the Ord River study area. Economic and co-benefit analyses were not conducted for Ord River, because of limited opportunity for tidal restoration and no available data to estimate degraded wetland area and no current ERF method for avoiding disturbance to coastal wetlands. Therefore, there are no associated R codes. However, preliminary carbon abatement and co-benefit estimates were done following the report methods (Hagger et al. 2022). Spatial analysis conducted in ArcMap 10.8 (ESRI, 2019) for restoration opportunity and QGIS (Open-source software, 2002) for co-benefits.

1. Delineate study area

a. NRM clusters

- Downloaded “NRM regions shapefile” from <https://climatechangeinaustralia.gov.au/en/overview/methodology/nrm-regions/>
- Select by attributes NRM region = “Rangelands Region” = new layer “NRM_Rangelands”.

b. WA catchments

- Import “Hydrographic catchments basins” shape file
- Select by attributes:
 - Keep river
 - Ord river
 - Save as “Ord_river_catchment”
- Clip to “NRM_rangelands” extent so that only the parts of the Ord catchment that are within WA “Ord_river_catchment_WA”.

2. Pre-European vegetation

- Download data from <https://catalogue.data.wa.gov.au/dataset/pre-european-dpird-006>
- Need a SLIP data account
- Vegetation types have different classifications – decide which ones are coastal wetlands in the descriptions in Page 16 of Byrne et al. 2013 ([https://www.dpaw.wa.gov.au/images/documents/about/science/cswa/articles/CONSERVATION SCIENCE VOL 9.1print ready low.pdf](https://www.dpaw.wa.gov.au/images/documents/about/science/cswa/articles/CONSERVATION%20SCIENCE%20VOL%209.1print%20ready%20low.pdf)).
- Select attributes by veg_type
 - 3. Woodland: jarrah, marri, wandoo, tuart and flooded gum
 - 6. Low forest: acacia, peppermint, coastal moort, Rottnest pine or mixed tropical forest
 - 9. Low woodland, open low woodland: other species
 - 10. Mangroves: low forest (Kimberley) or thicket (Pilbara) mangroves (Avicennia marina, Rhizophora stylosa, Bruguiera exaristata)
 - 14. Thicket: wattle, casuarina and teatree (Acacia–Allocasuarina–Melaleuca alliance).
 - 29. Short bunch-grass savanna
 - 32. Riverine sedgeland/grassland with trees
 - 33. Sedgeland: (mainly in the South West) Cyperaceae, Restionaceae, Juncaceae
 - 38. Shrub-steppe
 - 51. Salt lake, lagoon, claypan
 - 53. Tidal mud flat
 - Mosaic 101. Medium forest or woodland/Low woodland/Low forest or woodland

- Mosaic 106. Low woodland/Scrub or thicket
- Mosaic 107. Scrub-heath/Thicket
- Mosaic 116. Short bunch-grass savanna/ Grass-steppe
- Save selected features and export data as “PreClearVeg_Wetland” then clip to Ord River study area “PreClearVeg_Wetland_Ord”.

3. Land use mapping

- Download data from <https://catalogue.data.wa.gov.au/dataset/catchment-scale-land-use-mapping-for-western-australia-2018/resource/3c28bef9-04e1-44f7-9866-a80272d9c8cb>
- Open data WA_CLUM_August 2018
- Clip to Ord River study area “CLUM_2018_Ord”
- Select Secondary V8 “WA_cropping_grazing”
 - 2.1 Grazing native
 - 3.2 Grazing modified
 - 3.3 Cropping
 - 4.2 Grazing irrigated
 - 4.3 Irrigated cropping
 - 5.2.8 Abandoned intensive animal production
- Clip to Ord River study area “WA_cropping_grazing_intensive_Ord”.

4. Tides

- Data from: Vertical Datum Transformations across the Littoral Zone
- Appendix C, Table 19
- HAT (m above AHD) predictions were obtained for WA and NT.
- Add WA_tides as spatial data layer (add as xy data and export as a shape file WA_Tides_point).
- Selected tide points along the coast of Ord River study area “WA_Tides_point_Ord”
 - Wyndham
- Only one point near the Ord so used this one to calculate HAT above msl = 4.25m
- Sea level rise (SLR) for RCP 8.5 2081-2100 of 0.71m (IPPC, 2019) = 4.25 + 0.71 = 4.96m
- SLR of 1m as in blue carbon method = 4.25 + 1 = 5.25m.

5. Digital Elevation Model (DEM)

- Download UTM zone 52 at <https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/89644>
- Import (without building pyramids) and clip to Ord River study area “dem1sv1_0_Ord_1”. Save as a shape file. Import clipped file and build pyramids.
- Reclassify values for each basin according to HAT_m_above_AHD value (Arc Toolbox > Spatial Analyst Tools > Reclass > Reclassify). Classify to change values into 4 classes and change break values:
 - 1 (AHD TO MHWN)
 - 2 (MHWN TOMHWS)
 - 3 (MHWS TO HAT)
 - 4 (>HAT)
 - No data
 - Note tick box ‘change missing values to no data’ for 25m DEM, not for 5m DEM

- Save as "Reclass_dem_Ord"
- Then create polygon from raster (Arc Toolbox > Conversion tools > from raster to polygon) don't select simplify polygons but do select 'create multipart features'. "PolygonDEM_Ord" Select gridcode 1-3 (<HAT). "tidedem_Ord"
- Export data to new shapefile "tidedem_Ord".

6. DEM plus SLR

- Reclassify dem1sv1_0_Ord_1
 - 1 = 0 to 4.96m
 - 2 > 4.96m
 - SLR_dem_Ord
- Then create polygon from raster (Arc Toolbox > Conversion tools > from raster to polygon) don't select simplify polygons but do select 'create multipart features' "Polygon_SLR_dem_Ord"
- Select gridcode 1(<HAT+SLR). "SLR_tidedem_Ord"
- Repeat for 1m SLR.

7. Identify restoration sites

- Intersect land use "WA_cropping_grazing_intensive_Ord" with new tidal layer "tidedem_Ord" to get grazing areas that could receive tidal water up to HAT ("tidal_cropping_grazing_intensive_Ord").
- Intersect grazing areas <HAT "tidal_cropping_grazing_intensive_Ord" with preclear regional ecosystem "PreClearVeg_Wetland_Ord" to get preclear veg types per polygon "tidal_cropping_grazing_intensive_Preclear_Ord".
- Dissolve boundaries of adjacent polygons "tidal_cropping_grazing_intensive_Preclear_Ord_Dis" (don't dissolve on a field and disable multipart features).
- Calculate geometry attributes (area_ha) and select >1ha. Export as a shape file "Ord_rsites_1ha".
- Aggregated sites within 5km of each other using "aggregate polygons" input "Ord_rsites_5ha"
 - To get "Ord_rsites_Aggregate". Some of these are now <1ha. Calculate geometry attributes (area_ha) and select >1ha. = "Ord_rsites_1ha_Aggregate"
 - Export data to new shapefile. Export table to excel.

8. Restoration sites plus SLR

- Import "SLR_tidedem_Ord".
- Intersect land use "WA_cropping_grazing_intensive_Ord" with new tidal layer "SLR_tidedem_Ord" to get grazing areas that could receive tidal water up to HAT ("SLR_tidal_cropping_grazing_intensive_Ord").
- Intersect grazing areas <HAT+SLR "SLR_tidal_cropping_grazing_intensive_Ord" with preclear regional ecosystem "PreClearVeg_Wetland_Ord" to get preclear veg types per polygon "SLR_tidal_cropping_grazing_intensive_Preclear_Ord".

- Dissolve boundaries of adjacent polygons
“SLR_tidal_cropping_grazing_intensive_PreClear_Ord_Dis” (don’t dissolve on a field and disable multipart features).
- Calculate geometry attributes (area_ha) and select >1ha.
- Export as a shape file “SLR_Ord_rsites_1ha”.
- Aggregated sites within 5km of each other using “aggregate polygons”
“Ord_rsites_Aggregate”. This has some sites smaller than 1ha now so Calculate geometry attributes (area_ha) and select >1ha = “SLR_Ord_rsites_Aggregate_1ha”.
- Export table to excel and add up total ha and number of sites.

9. Intersections for data analysis in R

- Intersect “Ord_rsites_1ha” layer with:
 - a. “WA_cropping_grazing_intensive_Ord” to get landuse (“Ordsites_cropping_grazing_intensive”). Dissolve layer by site (FID_Tidal), Area_ha, and Secondary V8. ‘create multipart features’ to create “Ordsites_cropping_grazing_intensive_dis”.
 - Add Field (Alum_ha) and calculate geometry (area in hectares) of each polygon.
Export table to excel. Save as csv file for R manipulation
“Ordsites_cropping_grazing_intensive_dis.csv”.
 - b. “PreClearVeg_Wetland_Ord” to get pre clear veg_type per restoration site = “Ordsites_PreClearVeg_Wetland”. Dissolve layer by site (FID), Area_ha, and veg_type. ‘create multipart features’ = “Ordsites_PreClearVeg_Wetland_dis”.
 - Add Field (PCveg_ha) and calculate geometry (area in hectares) of each polygon.
Export table to excel. Save as csv file for R manipulation =
“Ordsites_PreClearVeg_Wetland_dis.csv”.
 - c. “tidedem_Ord” to get intertidal zones per site = “Ordsites_tidalzone”. Dissolve layer by site (FID_Tidal), Area_ha, and gridcode 1-3 (<HAT). ‘create multipart features’ = “Ordsites_tidalzone_dis”.
 - Add Field (tidal_ha) and calculate geometry (area in hectares) of each polygon.
Export table to excel. Save as csv file for R manipulation =
“Ordsites_tidalzone_dis.csv”.

10. Purple crowned fairy wren

- Formerly occurred in the Ord River catchment (Skroblin & Legge, 2010) but disappeared from the Ord in 2003
- Habitat notes from the listing advice
(<http://www.environment.gov.au/biodiversity/threatened/species/pubs/64442-conservation-advice-31102015.pdf>)
 - Dense riparian vegetation with preferred composing a dense canopy of *Eucalyptus spp.* and *Melaleuca*
 - In the Kimberley, strong association with *Pandanus aquaticus*, *Barringtonia acutangula* and freshwater mangrove species
- Primary factors linked to decline in the Ord are hydrological change from the dam, cattle disturbance on remaining riparian habitat and vegetation change in riparian areas primarily due to incursion of weeds.
- Matched habitat description from listing advice to WA vegetation types descriptions to come up with a short list of the following:

Vege type	Description	Notes
Low forest woodland		
10	Mangroves	Previous record from 2018 in this system (SOURCE_ID 97228), King River
Bunch and Spinifex grasslands		
23	With grey-box and cabbage gum	Previous records from 1981 on the Dunham River (SOURCE_ID 3907)
24	With bloodwood and stringybark	Previous records from 1981 on the Dunham River (SOURCE_ID 3907)
26	With scattered <i>Eucalyptus terminalis</i>	Previous record from 2000 (SOURCE_ID 0 from BORDATLAS2) on the Ord before the dam
27	Grassland	Scattering of previous records between 1970-2000 on the ex-Ord River now the dam and from a 1980 record in the upper reaches of the Ord and previous records from 1981 on the Dunham River (SOURCE_ID 3907)
29	Including salt water grasses	Previous record from 2000 (SOURCE_ID 7107) from the upper Ord
35	With bloodwood and snappy gum	Previous record from upper and low Ord (1971) in upper, and from a 1980 record in the upper reaches of the Ord
36	With bloodwood and snappy gum	Previous records from 1999 (SOURCE_ID 3660) from upper Ord and Negri and from a 1980 record in the upper reaches of the Ord

- Measured average distance of all records from a hydro-line:
 - Riparian vegetation generally limited to within 100m buffer
 - Records range outside of that, rarely beyond 100 but in two cases 500m and 2km
 - Be generous and give it a 1km buffer
- Clip to the vegetation types listed above in remnant status
 - All vegetation in the region listed as remnant despite the fact the recovery plan says habitat modification was a major factor in the extirpation of the Ord river population. We assume it's all remnant but in poor conditions.
- Three sites with three vegetation types come up with between 50 and 500 ha, so it'll be all sites with none as 0/100 then the others proportional out of 100 with 500ha a score of 100.

References

Skroblin A and Legge S (2010). The distribution and status of the western subspecies of the Purple-crowned Fairy-wren (*Malurus coronatus coronatus*). *Emu* 110, 339–347.