REEDY LAKE FLORA ASSESSMENT

DERIVING A TIME-SERIES OF VEGETATION EXTENT CHANGE SINCE 1983

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

CORANGAMITE CMA

ACKNOWLEDGEMENT

We respectfully acknowledge the Traditional Custodians of Reedy Lake and Hospital Swamps, the Wadawurrung People of the Kulin Nation. We pay our respects to Elders past, to Elders present and to emerging leaders, recognising their continuing connection to land, water, culture and community.

BACKGROUND

Wetland is part of the Port Phillip Bay (Western Shoreline) & Bellarine Peninsula Ramsar site and has ecological character, environmental watering objectives and Limits of Acceptable Change (LAC) that must be met

Concern over Tall Reeds (Phragmites and Typha) dominating vegetation cover since listing in 1983

Natural water regime of wetland has been heavily modified (prior to and post 1983) and this has impacted wetland vegetation

Environmental watering regime introduced in 2016 to re-introduce drying cycles with the aim of creating conditions favouring diverse wetland vegetation

OBJECTIVES

Several studies have been completed including vegetation extent mapping at different times, however there is no consistent record of change in the extent of key vegetation types over time since 1983

- Yugovic mapping from 1983 provides the benchmark for the Ramsar LAC

Key questions asked in this study were:

- What does a more complete history of vegetation change at Reedy Lake, derived using a consistent method, tell us about
  - The dominance of Tall Reeds
  - The dynamics of key wetland vegetation types
  - The efficacy of the environmental watering regime in maintaining ecological character
- What appear to be the key vegetation lifecycle characteristics and environmental variables influencing wetland vegetation extents
- What does information on historic and recent changes in wetland vegetation tell us about how the wetland may respond in the future
  - based on current drivers and trends
  - in response to climate change projections

METHOD

To derive a consistent record of vegetation change since 1983 a combination of Landsat and Sentinel-2 satellite imagery was used

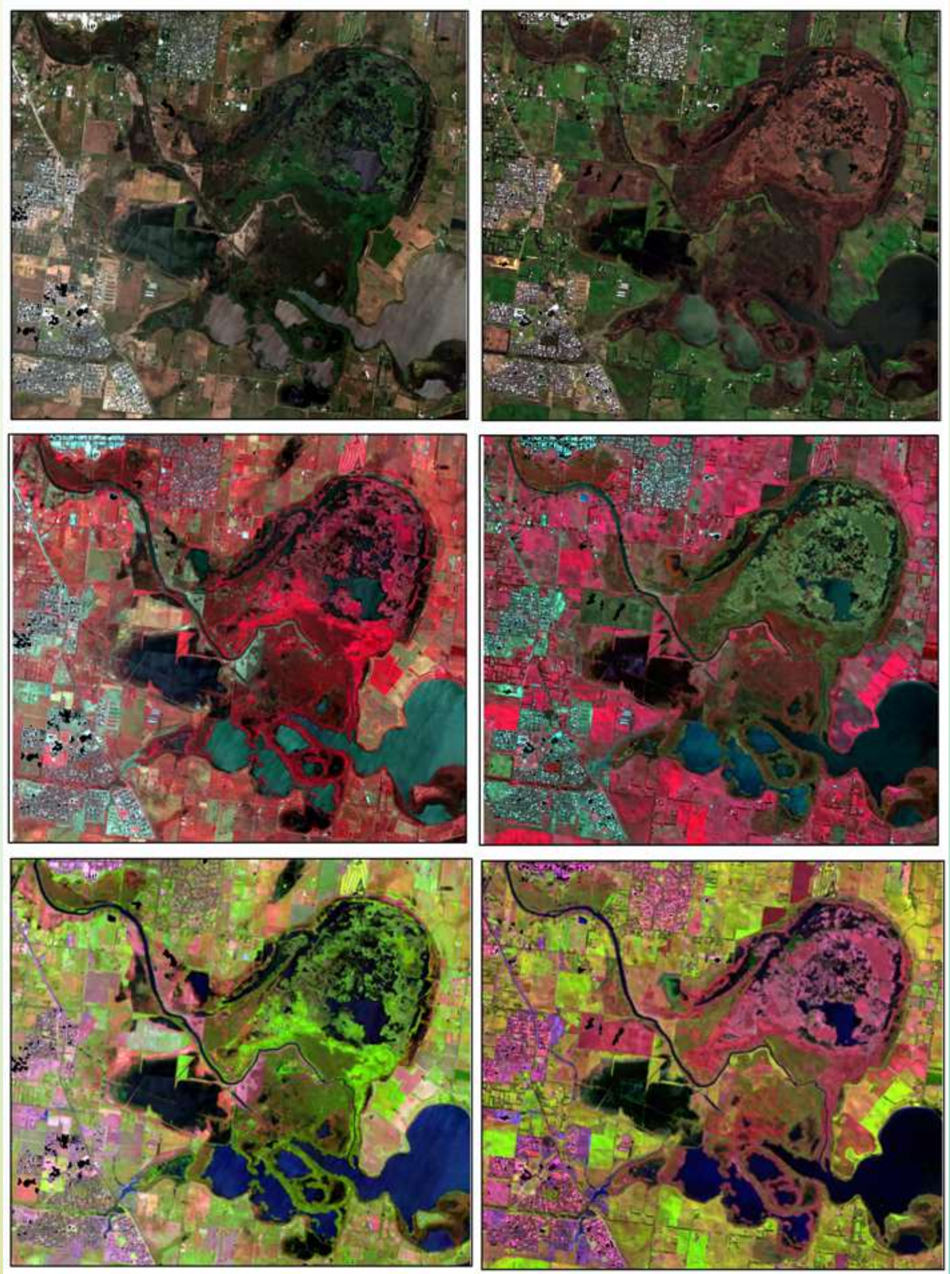
- 30m Landsat images were sourced at 5-yearly timesteps from 1983 to 2018
- 10m Sentinel-2 images were sourced at 6 monthly timesteps from 2016 to 2022

Each satellite image consists of pixels and several bands (layers) representing different parts of the electromagnetic spectrum

All images were analysed using a process called ‘supervised classification’ where a computer algorithm is trained by an operator to recognise vegetation types based on the spectral characteristics of the pixels in the imagery that represent that vegetation type

- Appropriate training samples were derived from previous vegetation maps and aerial photo interpretation

Efficacy of the satellite mapping was validated against previous mapping



FALSE COLOUR SUMMER (LEFT) AND FALSE COLOUR WINTER (RIGHT)

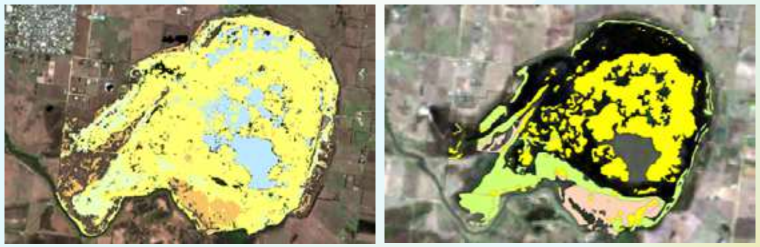
ANALYSIS

The results of the supervised classification of all images created a time series of vegetation extent maps. These maps were analysed to determine:

- Whether there have been any significant changes in extent over time
- Where those changes in extent have occurred within the wetland
- Whether any significant trends can be observed

These extent changes were interpreted in the context of

- The lifecycle and habitat preferences of the key vegetation types
- Wetland characteristics such as
  - surface elevation (using a 1m Digital Elevation Model with 10cm vertical accuracy)
  - soil and shallow groundwater salinities
- The influence of the environmental watering regime on
  - water extents and depths
  - inundation frequency
- Environmental variables such as rainfall and temperature



SENTINEL-2 2018 (LEFT) YUGOVIC 1983 (RIGHT)

INTERPRETATION

A series of questions were asked of the data:

Based on the habitat preferences of the vegetation types

- **Does their location within the wetland show any relationship to:**
  - wetland surface elevations
  - wetland water levels, extent, depths or inundation frequency
  - soil and shallow groundwater salinity

Do vegetation extent changes show any relationship to changes in:

- **wetland water levels, extent, depths or inundation frequency**
  - As influenced by the environmental watering regime

Does rainfall or temperature have any influence on vegetation

Do the lifecycle characteristics of the vegetation types affect their response

RESULTS

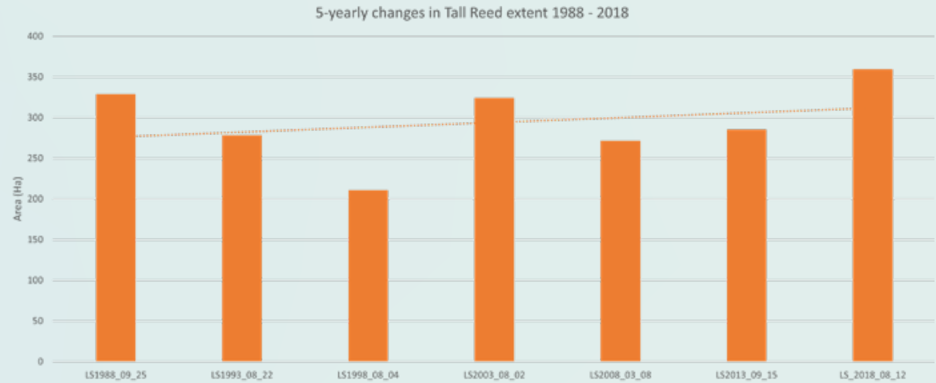
CHANGES IN VEGETATION EXTENT OVER TIME

Changes in extent over time

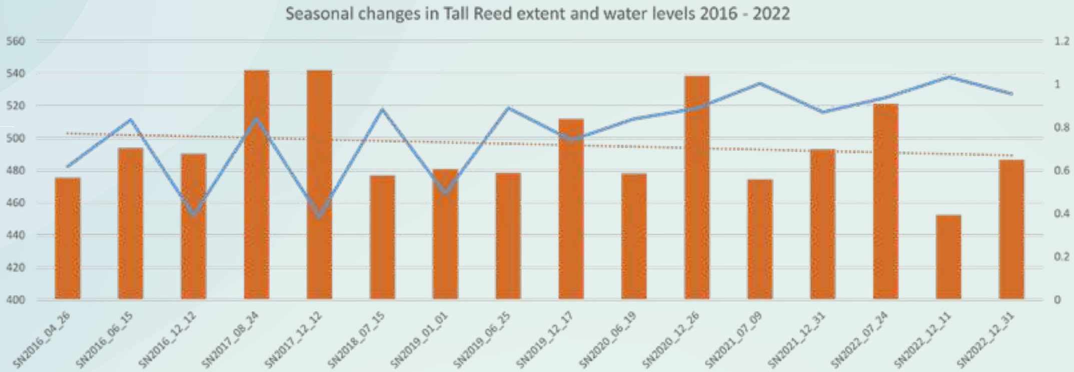
- **Charts of changes over entire wetland shown in Ha and % total area**
- **Relationship to wetting/drying phases or water levels (where available)**

Limit of Acceptable Change: a habitat mosaic will be maintained at Reedy Lake that comprises open water, emergent native vegetation (sedges, rushes, and reeds), submerged vegetation and lignum shrubland with no habitat comprising more than 70 percent of the total wetland area for more than five successive years.

Results for Tall Reeds for the period 1988 to 2018 show they are within the Limit of Acceptable Change.



% cover	LS1988_09_25	LS1993_08_22	LS1998_08_04	LS2003_08_02	LS2008_03_08	LS2013_09_15	LS_2018_08_12
Tall Reed 1988-2018	37	31	24	37	31	32	41

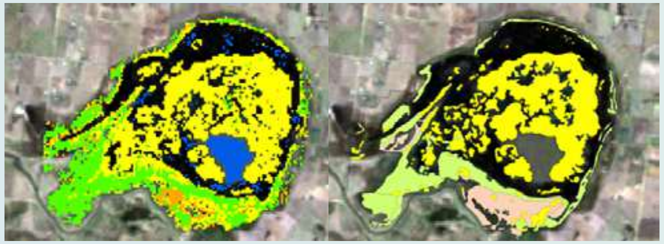


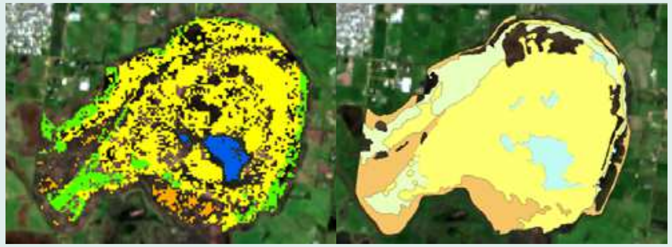
Results for Tall Reeds for the period 2016 to 2022 show they are within the Limit of Acceptable Change.
The blue line is the changing water level. The orange line is the trend over time.

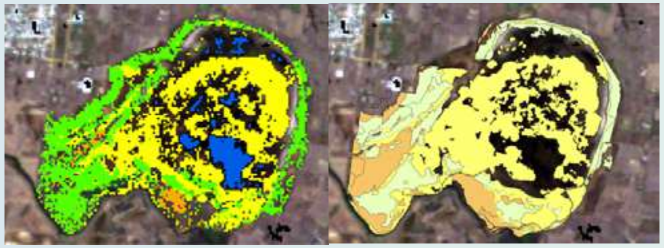
% cover	SN2016_06_15	SN2016_12_12	SN2017_08_24	SN2017_12_12	SN2018_07_15	SN2019_01_01	SN2019_06_25	SN2019_12_17	SN2020_06_19	SN2020_12_26	SN2021_07_09	SN2021_12_31	SN2022_07_24	SN2022_12_11
Tall Reed 2016-2022	56	56	62	62	54	55	55	58	55	61	54	56	60	52

VALIDATION OF SATELLITE IMAGE CLASSIFICATION AGAINST EXISTING MAPPING

- Yugovic equivalent maps of vegetation extent at 1988, 2008, 2013 and 2018
- Most of the comparisons with previous mapping rely on Landsat
- Sentinel-2 imagery provides a finer level of detail compared to Landsat
- There is generally very good agreement in the locations and extents of vegetation mapped using satellite image classification when compared to traditional methods
- Satellite image classification provides consistently comparable results over time providing greater confidence when interpreting changes in vegetation extent


LANDSAT 1988


LANDSAT 2018


LANDSAT 2008


SENTINEL-2 2018


LANDSAT 2013


LANDSAT 2018 VS SENTINEL-2 2018

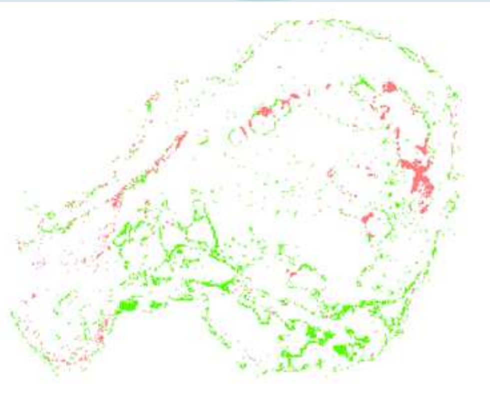
Legend of vegetation classification:

- Tall Reed (Phragmites australis and Typha orientalis)
- Sedges and Rushes (mostly Bolboschoenus caldwellii)
- Lignum (Duma florulenta)
- Open water (if present at time of image)

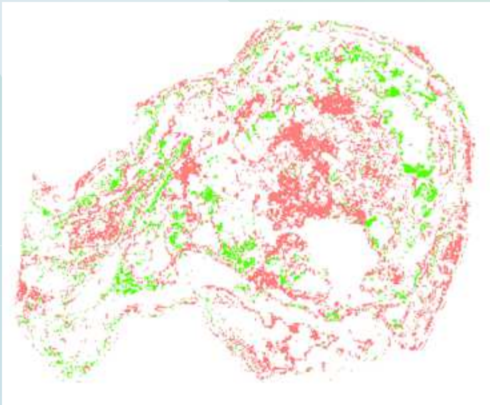
LOCATIONS OF CHANGE IN VEGETATION EXTENT

Location of changes in summer (maximum) extent 2016 to 2022

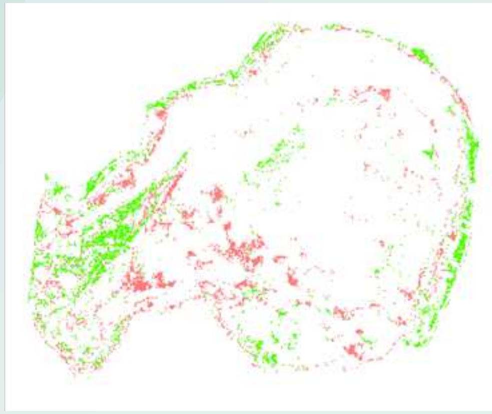
- *Phragmites australis*
- Typha association (*Typha orientalis*, other emergent plants, open water)
- Sedges/Rushes (predominantly *Bolboschoenus caldwelii*)
- Lignum (*Duma florulenta*)



PHRAGMITES CHANGE 2016-2022



TYPHA ASSOC CHANGE 2016-2022



SEDGES/RUSHED CHANGE 2016-2022

LIGNUM CHANGE 2016-2022

Legend:

Contractions

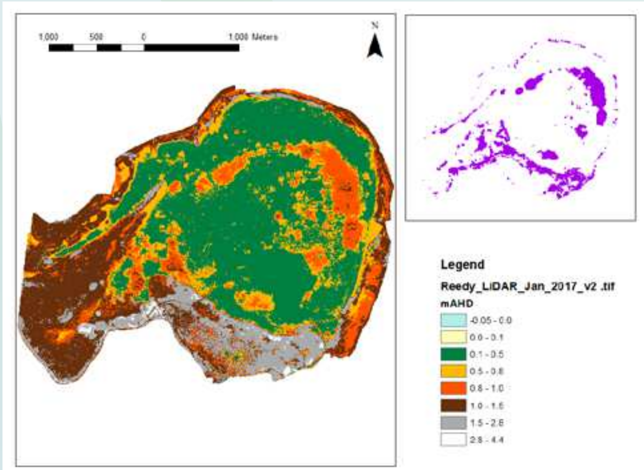
No change

Expansion

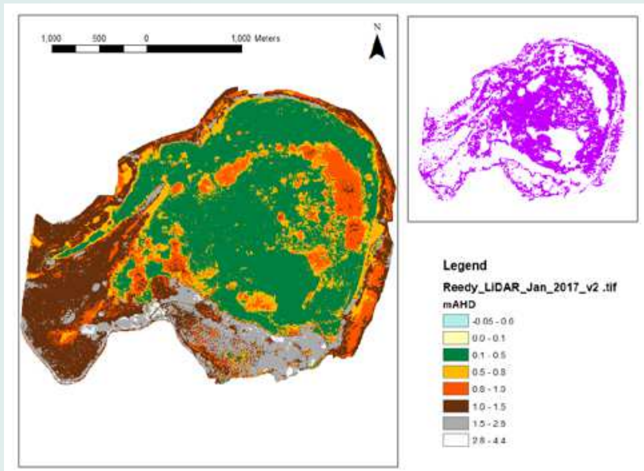
VEGETATION ELEVATION ASSOCIATIONS

Vegetation elevation associations

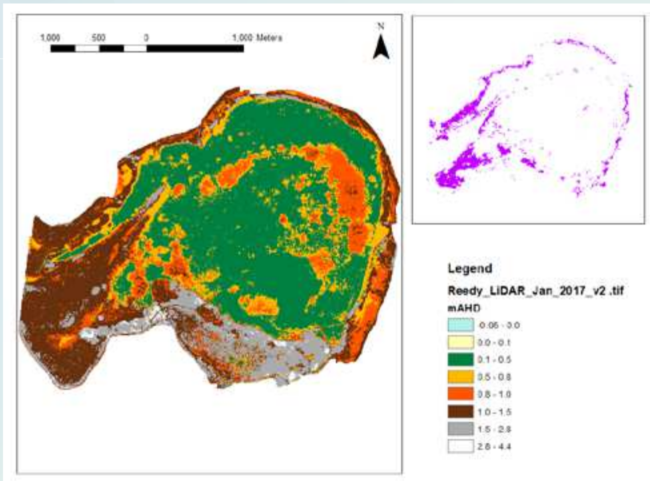
- **2017 satellite derived vegetation extents (summer) shown in purple**
- **2017 Digital Elevation Model (DEM) classified into elevation ranges in mAHD**
  - Phragmites: in wetland typically 0.8-1mAHD ; southern perimeter = above ~1.5mAHD
  - Typha association: in wetland typically ≤0.5mAHD; higher elevations around perimeter
  - Sedges/Rushes: above 1.0mAHD
  - Lignum: above 1.0mAHD



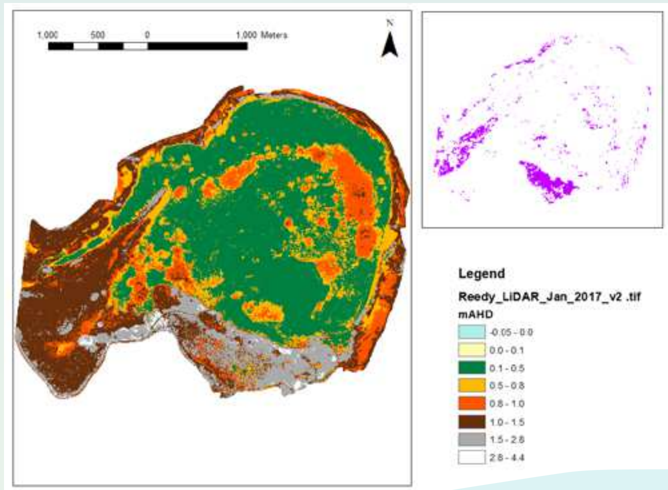
PHRAGMITES



TYPHA ASSOCIATION



SEDGES/RUSHES

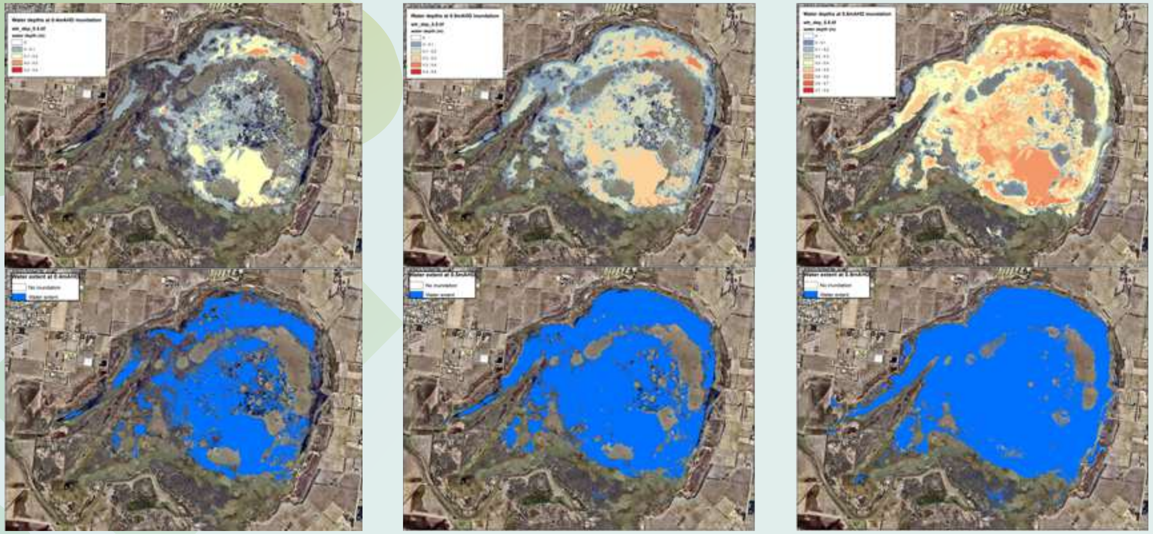


LIGNUM

WATER EXTENTS AND DEPTHS

Water extents and depths

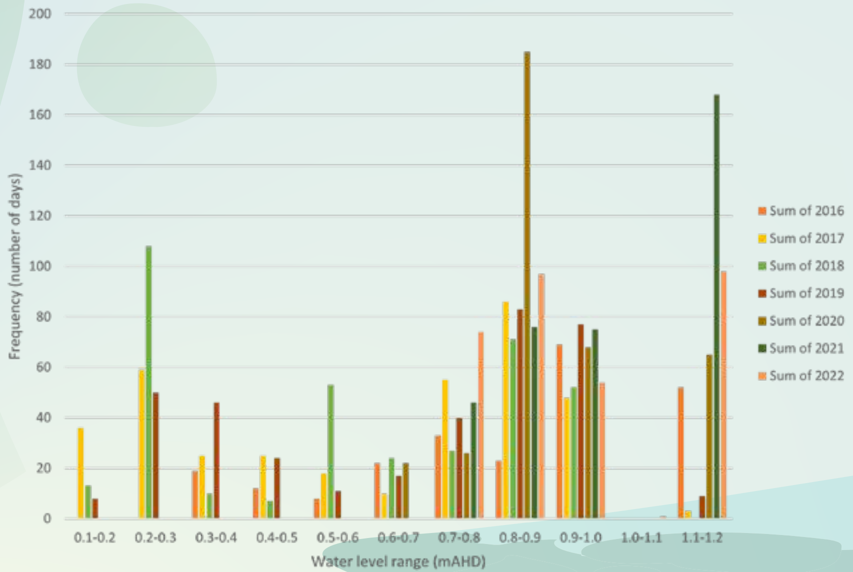
- **Wetland surface topography creates most difference in water extents and depths between**
  - 0.0-0.4mAHD
  - 0.4-0.5mAHD
  - 0.5-0.8mAHD



INUNDATION FREQUENCY

Inundation frequency

- **Watering regime: 2016 – 2019**
  - Greatest number of days <0.8-1.0mAHD
  - Winter high, summer low water levels
- **La Nina events: 2020 – 2022**
  - Greatest number of days >0.8-1.2mAHD
  - Highest water levels dominate

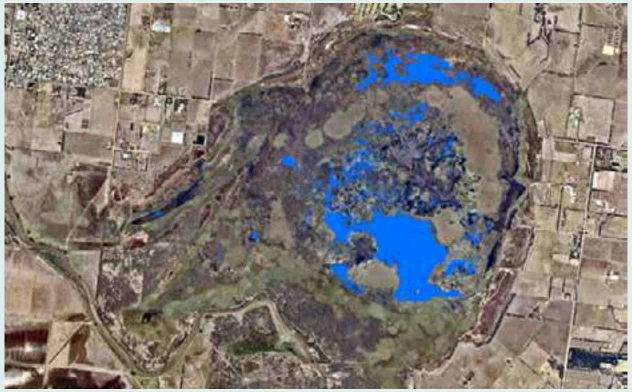


THE CRITICAL WATER LEVEL OF 0.3MAHD

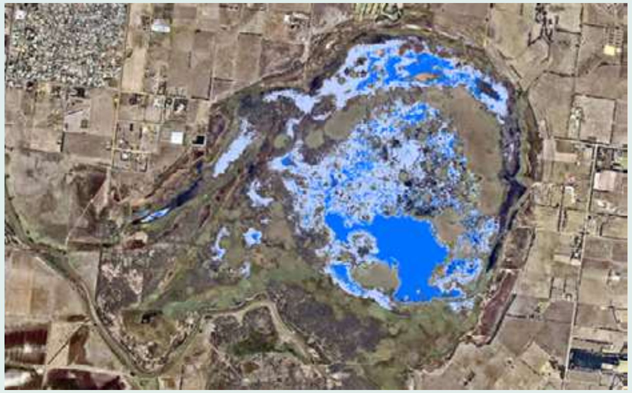
The watering regime for Reedy Lake requires summer draw down to 0.3mAHD to support achievement of the environmental objectives (VEWH, 2022).

- This level has been shown in this study to be a critical water level given the drastically reduced extent of water across the bed of the wetland compared to 0.4mAHD.
- At a water level of 0.4mAHD, large areas of the wetland bed are covered with 0.1-0.2m of water.
- If this water level occurs during the spring-summer growth season, where temperatures are warmer, this provides ideal conditions for germination of Typha from seed.
- To maintain a balance in vegetation types between Tall Reed and other vegetation communities which provide important habitat for birds and fish, periodic drawing down to 0.3m AHD is required.
- Drawing down to 0.3mAHD will assist to dry the wetland bed sufficiently to promote increase in soil salinity preferencing other vegetation types, and constraining Typha germination.

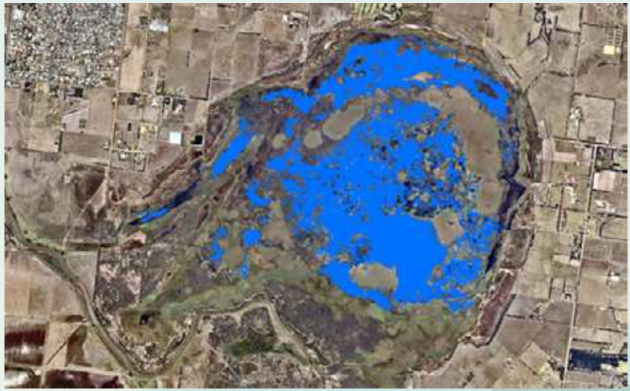
The difference in water extents between these two water levels is illustrated in these images.



WATER EXTENT AT 0.3M AHD



WATER EXTENT AT 0.3M AHD (DARK BLUE) 0.4M AHD (LIGHT BLUE)



WATER EXTENT AT 0.4M AHD

GROUNDWATER AND SOIL SALINITY

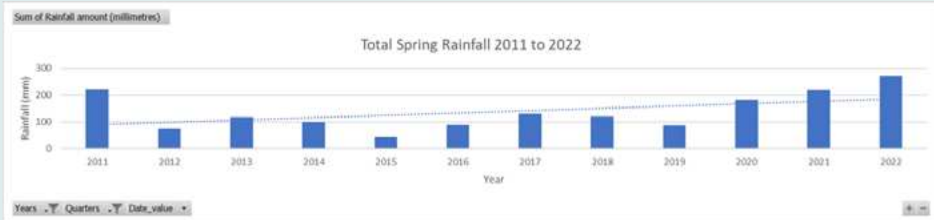
Previous studies and the recent Water-Salt Balance modelling indicate

- Regional saline groundwater influences northern perimeter (west-east)
- Shallow saline groundwater intrusion from Lake Connewarre under wetland
- Strong surface-ground water level relationship exists (from bore monitoring data)
- Local fresh groundwater from Barwon River influences southern perimeter
- Wetland soils are highly permeable permitting two-way flux of water which influences soil salinity levels

RAINFALL AND TEMPERATURE

Rainfall and Temperature

- Historic patterns and trends
- Projected future patterns and trends (VCP19)



TREND TOWARD INCREASING TOTAL SPRING RAINFALL

NO OBVIOUS TREND IN MAXIMUM SPRING TEMPERATURES

OUTCOMES

INTERPRETATION

Phragmites in wetland occurs at elevations less frequently wetted

- Surface elevation of classic 'semi-circle' feature is consistently 0.8-1.0mAHD
- Corroborated by historic imagery of permanence of this feature
- Indicates beds are connected to shallow saline groundwater

Typha in wetland occurs at elevations where frequently wetted

- Prefers inundation depths fluctuating between 0.1 and 0.5m
- Has reduced in extent as a result of drawdowns induced by watering regime
  - Drying has likely increased soil salinity around root zones (from shallow saline groundwater)

Typha is less tolerant of salinity compared to Phragmites

Sedges/Rushes prefer wetland perimeter and tolerate salinity

Lignum prefers higher elevations, tolerates salinity, connected to groundwater

Water regime does have an effect through its interaction with salinity

- Wet phase provides freshwater influx and reduced soil salinity
- Dry phase allows groundwater intrusion and increased soil salinity
- Timing of wetting and drying in relation to vegetation lifecycle is important

Rainfall influences flows in the Barwon River and thus the wetland

Spring temperatures dictate start of growing season

Spring-Autumn temperatures dictate length of growing season

SUMMARY

- Tall Reeds showed a trend toward increased overall extent since 1983
  - Since 2016 Tall Reed has showed a trend toward decreased extent
    - Indicates positive influence of watering regime
- Vegetation types exhibit some elevation preferences
  - Indicates an influence of inundation depth and frequency on habitat preferences
  - Shallow groundwater plays a more significant role (needs further investigation)
- Vegetation extent change is seasonally dynamic (several tens of Ha)
  - Explained by a combination of the
    - lifecycle and rhizomatous nature of the key vegetation types
    - changing wetland conditions creating suitable and unsuitable areas in different parts of the wetland
- Vegetation extents are well within the Limits of Acceptable Change
- Ecological character of Reedy Lake is being maintained and environmental watering objective is being met

CONCLUSION

- Continuation of wetland draw downs will assist in sustaining reduced extents of Phragmites and Typha in the wetland (<0.8mAHD)
- A greater duration of the watering regime being in place is required to see the ultimate degree of influence on Tall Reed extents
  - Response seen over first three years (last three impacted by La Nina)
- Principal constraint on efficacy of watering regime are water levels in the Barwon River, particularly the inability to draw down wetland when water levels in the River are high and spilling into the wetland
- Projected future warming and reduced rainfall totals should assist in creating a drier regime that favours a more saline wetland