GOVERNMENT OF WESTERN AUSTRALIA

Department of **Biodiversity, Conservation and Attractions**
Department of **Primary Industries and Regional Development**
Department of **Water and Environmental Regulation**







# *A Year on the Vasse-Wonnerup Wetlands*

*An Ecological Snapshot*
*March 2017—January 2018*

Murdoch UNIVERSITY

*Revitalising Geographe Waterways*

VASSE taskFORCE

Musk duck (*Biziura lobata*) (Photo: Mark Oliver)

# The Vasse-Wonnerup Wetlands

The conservation values of the Vasse-Wonnerup wetlands are recognised on a local, state, national and international level. The wetlands provide habitat to thousands of Australian and migratory water birds as well as supporting the largest breeding population of black swans in the state. In 1990 the wetlands were recognised as a 'Wetland of International Importance' under the Ramsar Convention. The wetlands are also one of the most nutrient enriched wetlands in Western Australia, characterised by extensive macroalgae and phytoplankton blooms and occasional major fish kills. Poor water quality in the wetlands is a major concern for the local community.

Over the past four years scientists have been working together to investigate options to improve water quality in the wetlands by monitoring seawater inflows through the Vasse surge barrier and modelling options to increase water levels and flows into the Vasse estuary. These trials have successfully shown that seawater inflows can reduce the incidence of harmful phytoplankton blooms and improve conditions for fish in the Vasse Estuary Channel over summer months. What isn't as well understood is how these management approaches and subsequent increased water levels may impact on the broader wetland system, especially how the ecology of the wetlands responds to changes in the timing and volume of seawater inflow through the surge barriers.

The Ecological Monitoring Study was initiated in March 2017 to help scientists and managers understand the potential longer-term impacts on the ecology of the wetlands that may occur through changes to the water regime over summer (salinity and water levels). This snapshot is a presentation of the results of the first year of the program. The study, funded through the Revitalising Geographe Waterways program, will continue until January 2020 and will be used to inform ongoing management of the wetlands. An integrated analysis and interpretation of the data collected over the first two years will be undertaken in 2019 to improve our understanding of the relationships between water regimes and the ecology of the wetlands.

## Photo Credits:

Cover Photos: Pink eared duck (Mark Oliver), *Lamprothamnium macropogon* (Jane Chambers), Hardyhead (Fish of Australia), *Simplisetia aequisetis* (Leon Altoff)

Rear Cover Photo: Yellow-billed Spoonbill *Platalea flavipes* (Mark Oliver)

Acknowledgements:
Thank you to Jane Wilshaw and the Vasse-Wonnerup Science Advisory Group for preparation of this Ecological Snapshot.

# About the Ecological Monitoring Program


***Water quality and levels, aquatic plants, benthic invertebrates, fish and water birds have been monitored seasonally since March 2017. Monitoring was undertaken seasonally to capture seasonal variations in water levels and water quality and to assess how these conditions influence the ecology of the wetlands. Monitoring is conducted by scientists from Murdoch University and the Departments of Water and Environmental Regulation and Biodiversity, Conservation and Attractions.***

Monitoring is undertaken within four sites across five regions in the wetlands. Regions were selected to represent the different habitat types within the wetland system (see map below). The Vasse and Wonnerup Estuary main water bodies were split into upper and lower regions. The upper regions are subject to greater extremes in water levels than the lower regions, completely drying out in late summer/autumn, therefore providing different habitat to the lower estuaries. The Wonnerup Inlet, which occurs below the surge barriers and is mostly open to Geographe Bay, was included in the study to assess the difference in water quality and ecology above and below the surge barriers.

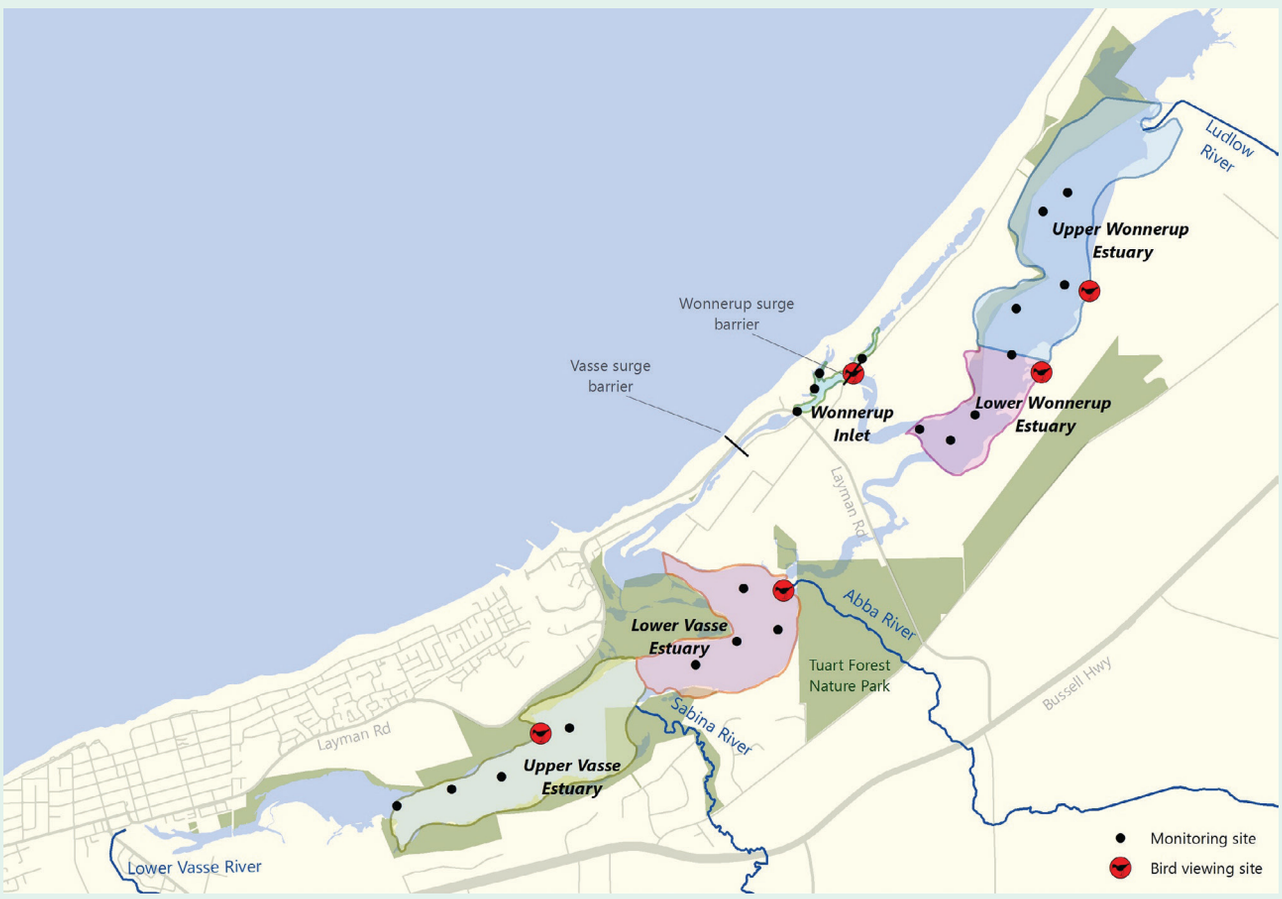



**Figure 1: Vasse-Wonnerup wetlands ecological monitoring regions and monitoring sites**

# WATER QUALITY

***Salinity, water levels and nutrient concentrations in the wetlands change dramatically throughout the year and are affected by many factors including rainfall, evaporation, sandbar openings and surge barrier management.***

## Water levels and Salinity

In summer 2017 water levels in the estuaries were higher than usual due to late winter rains. As a consequence seawater was not let into the upper estuaries through the surge barriers until early March. In autumn 2017 water levels were at their lowest with both the upper Vasse and Wonnerup regions partially dry. Despite the later seawater inflows, salinity was still relatively high across the system in autumn 2017, ranging from 26-28 ppt salinity upstream of the surge barriers. In winter high rainfall and river flow raised the water level in the estuaries and started to flush out the salty water.

By spring both the Vasse and Wonnerup regions above the surge barriers were relatively fresh (0-5 ppt) due to continued winter rainfall.

In summer, salinities in both the Vasse and Wonnerup Estuaries increased due to evaporation and cessation of river flows. Salinity in the Wonnerup Estuary rose to around 23 ppt. As part of the Seawater Inflow Trial, seawater was let into the Vasse Estuary in early December 2017, which maintained summer water levels around 20cm higher than previous years and salinities close to seawater (~35 ppt). The Wonnerup Inlet remained around seawater salinity (~35 ppt) all year due to continued exchange with Geographe Bay. The figures below shows the changes in water levels and salinity throughout the snapshot year.

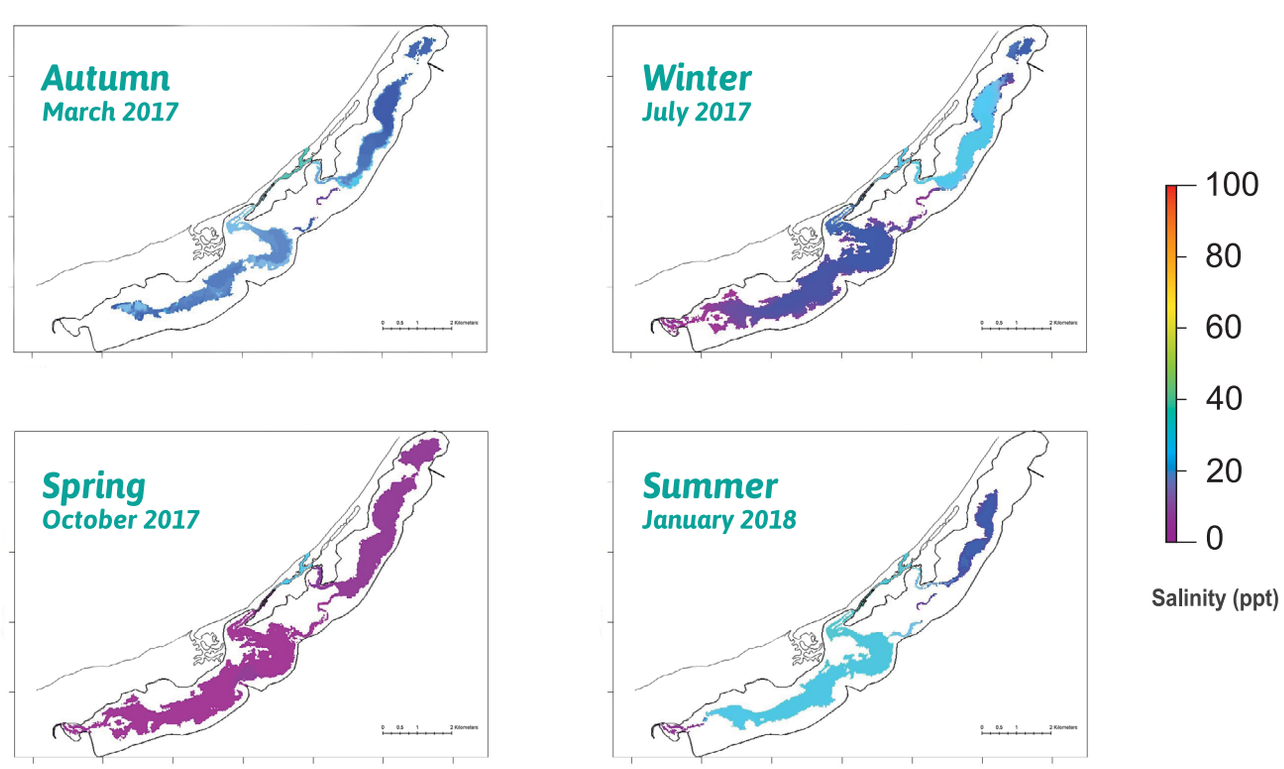



Figure 2: Seasonal salinity and water levels over the snapshot year.

# WATER QUALITY

## Nutrients

***Nutrients enter the Vasse-Wonnerup wetlands from river flow off the catchment and through internal recycling of nutrients through growth and decomposition of aquatic plants and release of nutrients from the sediment. Excess nutrients drive macroalgal and phytoplankton blooms impacting on water quality. The most important nutrients for plant growth are nitrogen and phosphorus. The figure below shows the mean Total Nitrogen (TN) and Total Phosphorus (TP) concentrations over the snapshot year.***

| | Upper Vasse Estuary | Lower Vasse Estuary | Wonnerup Inlet | Lower Wonnerup Estuary | Upper Wonnerup Estuary |
|---|---|---|---|---|---|
| AUTUMN 2017 | P N | P N | P N | P N | P N |
| WINTER 2017 | P N | P N | P N | P N | P N |
| SPRING 2017 | P N | P N | P N | P N | P N |
| SUMMER 2018 | P N | P N | P N | P N | P N |

Total Phosphorus (mg/L)

| | | |
|---|---|---|
| P | < 0.06 | LOW |
| P | 0.06 – 0.15 | MOD/HIGH |
| P | > 0.15 | V. HIGH |

Total Nitrogen (mg/L)

| | | |
|---|---|---|
| N | < 1.5 | LOW |
| N | 1.5 – 3.75 | MOD/HIGH |
| N | > 3.75 | V. HIGH |

**Figure 3: Seasonal mean Total Nitrogen (TN) and Total Phosphorus (TP) over the snapshot year expressed as 'low' (below ANZECC guidelines for wetlands), 'moderate/high' and 'very high'.**

Nutrient concentrations varied seasonally in both the Vasse and Wonnerup estuaries over the snapshot period with lower nutrients in winter and spring. The decline in nutrients in winter was likely due to increased river flows, diluting the high nutrient concentrations at the end of autumn, while also delivering fresh nutrients off the catchment. A drop in nutrient concentrations was observed in all regions in spring coinciding with the peak period of growth for aquatic plants and uptake of nutrients.

Nutrient concentrations increased in summer with highest nutrient concentrations recorded in autumn. Evaporation over summer and autumn would have concentrated nutrients and plant uptake would have been dramatically reduced due to a reduction in aquatic plant biomass through senescence and/or grazing. Low oxygen conditions over this period, due to low flows and higher temperatures, may also have triggered nutrient release from the sediments contributing to higher nutrient concentrations.

Nutrient concentrations were low in the Wonnerup Inlet across all seasons. The Inlet is regularly flushed with seawater from Geographe Bay maintaining low nutrient conditions.

# Phytoplankton

***Phytoplankton are tiny photosynthetic organisms that float freely in water. A microscope is needed to see individual phytoplankton cells, but at high numbers (blooms) they can discolour the water. Phytoplankton form the beginning of the food chain for a number of aquatic animals in the wetlands however excessive nutrients can lead to cyclic phytoplankton blooms in the wetlands. Some species of phytoplankton are harmful. For example blue-green algae can be toxic and cause bad odours, fish kills and be harmful to humans and wildlife. Other phytoplankton are not toxic however in large numbers may become a problem for fish and other animals.***

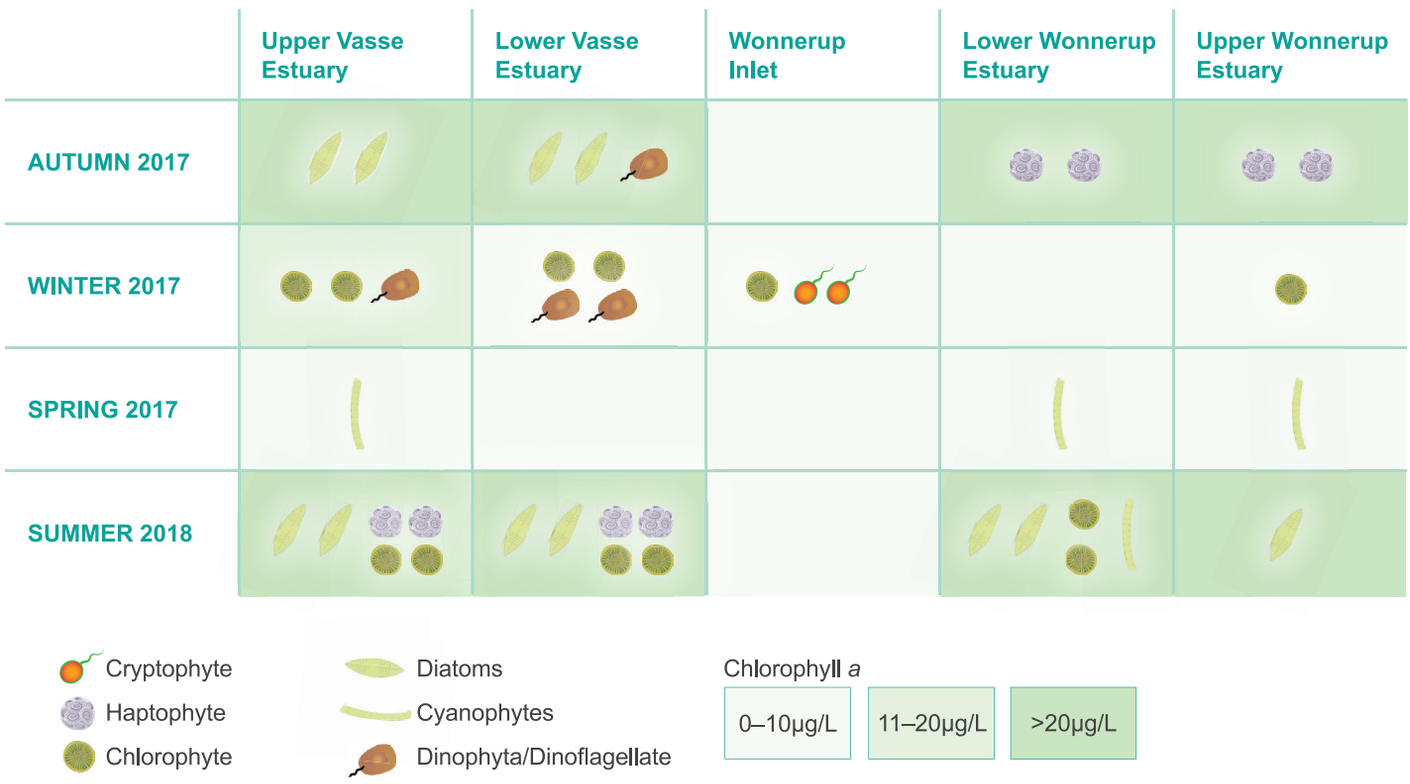



**Figure 4: Seasonal density and composition of the dominant phytoplankton and chlorophyll *a* concentration over the snapshot year.**

There were seasonal differences in phytoplankton densities and composition across the five regions over the snapshot period. Phytoplankton density was at its lowest in spring. This is a time when aquatic plant biomass was highest taking up nutrients and making them less available to phytoplankton. Phytoplankton density increased substantially across the two estuaries in summer and were dominated by diatoms and chlorophytes. Warm temperatures, low flows and high nutrient availability in summer and autumn created ideal conditions for phytoplankton, which corresponded to higher Chlorophyll *a* concentrations recorded in these seasons. Chlorophyll *a* concentrations are a useful indicator of nutrients incorporated into phytoplankton biomass.

In winter the types of phytoplankton changed in both estuaries in response to winter river flows carrying freshwater and nutrients into the system. Winter was also the only season where higher phytoplankton levels were recorded in the Wonnerup Inlet, potentially coming in from Geographe Bay.

Over the snapshot year small harmless diatoms were the most consistently occurring phytoplankton group observed, appearing over most seasons and in all regions. Harmless Chlorophyta were also dominant and occurred in high densities, particularly in the Vasse Estuary. Overall the Haptophyta had the highest count of all phytoplankton over the year. This dominance was due to four very large blooms that occurred in autumn and summer in the upper and lower Wonnerup and Vasse estuaries.

# AQUATIC PLANTS

***Aquatic plants are critical to the Vasse-Wonnerup wetlands as they are the dominant primary producers and provide a variety of ecosystem services such as creating habitat, oxygenating the water, using nutrients and stabilising sediments. They are also the major food source for many water birds that use the wetlands.***

## What Species Did We Find?

A total of eight species of aquatic plants were found in the wetlands during the 2017–2018 ecological survey. Aquatic plants included macrophytes (seagrasses and submerged plants) and macroalgae (seaweeds and filamentous algae). The most dominant macrophytes were *Ruppia polycarpa* (a seagrass) and *Lamprothamnium macropogon* (an algae). The most dominant macroalgae was *Cladophora vagabunda*, a filamentous green algae.

### Macrophytes

Two species of seagrasses were found throughout the wetlands, *Ruppia megacarpa* and *Ruppia polycarpa*. *Ruppia* is an important food source for the population of black swans that inhabit the wetlands. *Ruppia* has a broad salinity tolerance growing in both estuaries from winter to summer.

*Stuckenia pectinata*, commonly known as 'pondweed' was also common in the lower estuaries. *Stuckenia* produces tubers rich in starch that provide food for water birds.

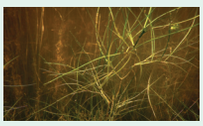
*Althenia cylindrocarpa* is a submerged plant found in fresh to brackish waters. *Althenia* was predominately found in the Upper Vasse estuary.

*Lamprothamnium macropogon* is a freshwater algae that can form dense mounds. As it provides ecological benefits similar to seagrasses this species is included with macrophytes. This species dominated the Wonnerup estuary in winter.

### Macroalgae

Macroalgae found in the wetlands were *Ulva flexuosa*, *Ulva intestinalis*, *Cladophora vagabunda* and *Rhizoclonium tomentosum*. Macroalgae can grow in low light and rapidly take up nutrients from the water. They may be attached to the seagrass (epiphytic) or free-floating.

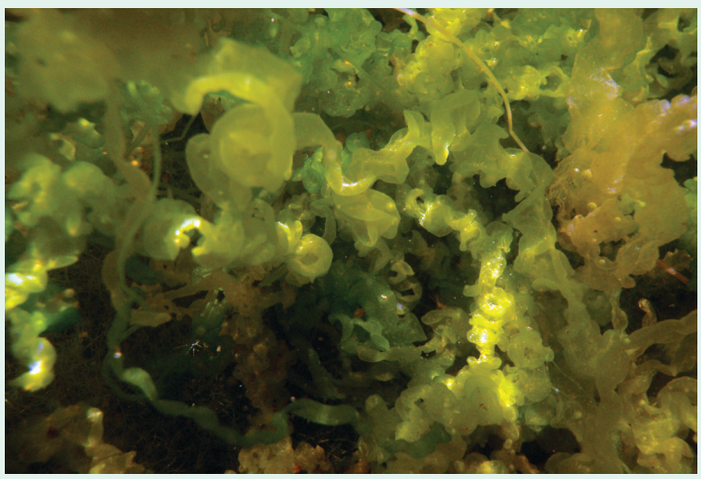
*Ruppia*



*Stuckenia*

*Althenia*

*Lamprothamnium*



*Ulva flexuosa*

*Rhizoclonium tomentosum*

All Photos: Jane Chambers

# Seasonal Density Of Macrophytes And Macroalgae

There was considerable seasonal and regional variation in the density and composition of aquatic plants over the snapshot year. Overall the Lower Vasse Estuary and Wonnerup Inlet favoured macroalgal species while the Wonnerup estuary and Upper Vasse Estuary were populated by a diversity of macrophytes. The results show that spring is an important time for aquatic plants in the wetlands, particularly for beneficial macrophytes *Ruppia, Stuckenia* and *Lamprothamnium.*

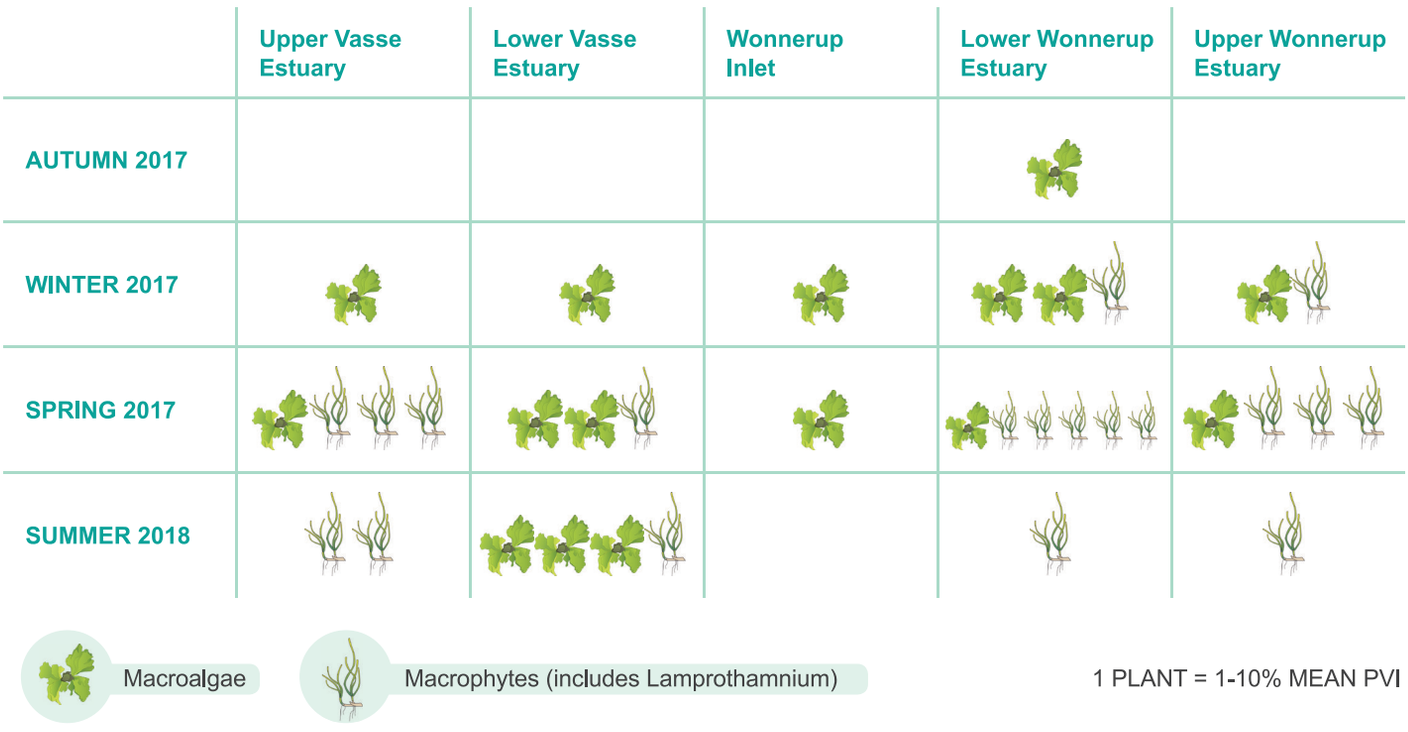



**Figure 5: Seasonal Percentage Volume Infested (PVI) and composition of aquatic plants over the snapshot year.**

The density, distribution and composition of aquatic plants is dependent on environmental and biological conditions such as salinity, water depth, herbivory and germination success, all of which dramatically change with the season and region in the Vasse-Wonnerup wetlands.

In autumn 2017 there were almost no aquatic plants recorded across the wetlands with only a small amount of macroalgae (*Rhizoclonium*) present in the Lower Wonnerup Estuary. The conditions at this time did not favour the growth of aquatic plants as the upper estuaries had mostly dried out and the lower regions were highly saline with poor water quality. It is also likely that water bird grazing in earlier seasons contributed to the low abundance of aquatic plants.

In winter the conditions for plants improved as river flows brought fresh water and nutrients to the wetlands increasing the abundance and distribution of plants through germination and growth. By spring macrophytes dominated the wetlands with the highest abundance recorded in the Lower Wonnerup Estuary, which supported over three times the aquatic plants recorded in other regions. Macroalgal species were present across all regions during spring, but in lower abundance than macrophytes.

There was a reduction in aquatic plants between spring and summer across most regions, which was likely due to a combination of grazing by water birds, declining water levels and increases in temperature and salinity. A major *Cladophora vagabunda* bloom (a macroalgae) dominated the Lower Vasse Estuary during summer, which was most likely the result of summer rainfall events and higher salinity.

# AQUATIC PLANTS

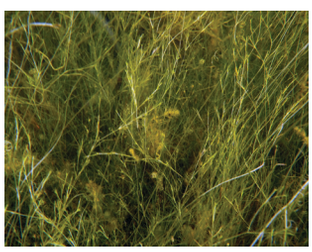
## Do The Surge Barriers Influence The Species Of Aquatic Plants?

The Wonnerup Inlet is intermittently open to Geographe Bay (when the sandbar is open) resulting in different water quality conditions upstream and downstream of the surge barriers.

The results of the 2017/2018 Ecological monitoring survey showed us that there is also a distinct difference between the aquatic plant communities upstream and downstream of the surge barriers.

Over the year there was a general absence of aquatic plants in the Wonnerup Inlet (downstream of the surge barriers). In contrast, upstream of the surge barriers the Vasse and the Wonnerup estuaries provide a variability of habitat supporting a higher diversity of plants.

### Upstream of surge barriers

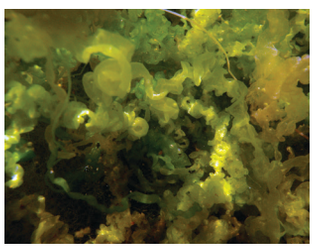


*Althenia*

*Ruppia*

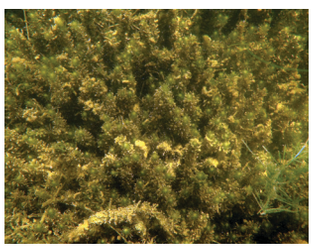
*Cladophora*

*Stuckenia*



*Ulva*

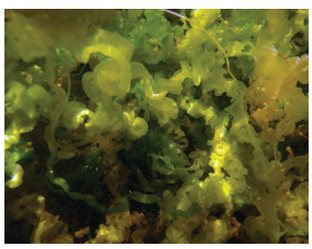
*Rhizoclonium*



*Lamprothamnium*

### Downstream of surge barriers (Wonnerup Inlet)

*Cladophora*



*Ulva*

*Rhizoclonium*

All photos: Jane Chambers

# BENTHIC MACROINVERTEBRATES

Photo: James Tweedley

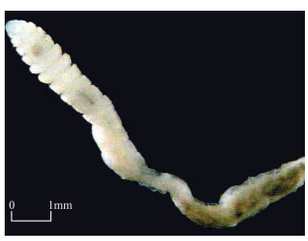
***Benthic macroinvertebrates are bottom dwelling invertebrates (no backbone) that are greater than 0.5mm in size such as worms, shrimps, snails and the aquatic larval stages of insects. These invertebrates are an important part of the food web in the wetlands and perform a range of functions including the decomposition and movement of organic matter and recycling of nutrients. Due to their limited mobility invertebrates are strongly affected by their surroundings and can be used as a biological indicator that reflects the overall condition of the wetlands.***

▲ Sampling benthic invertebrates

## What species did we find?

A total of 84 species of benthic invertebrates were recorded, of which 20 species were dominant (making up 97% of all animals). Seven phyla (major taxonomic groups) were represented including Platyhelminthes (flatworms), Nematoda (Roundworms), Mollusca (molluscs), Annelida (segmented worms), Crustacea (crutaceans), Hexapoda (Class Insecta) and Chordata (a teleost). Below are images of species from the four most dominant phyla. The highly tolerant polychaete *Capitella captitata* from the phyla Annelida, was the most dominant, individuals comprising 42% of all macroinvertebrates. The Pea clam (*Arthritica semen*), a bivalve mollusc, and the freshwater mud snail (*Potamopyrgus sp.*) a gastropod mollusc were also dominant species comprising 12% and 14% of all benthic macroinvertebrates respectively.

### ANNELIDA
### Class polychaeta

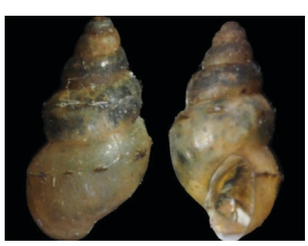



*Capitella capitata (species complex)*[1.]

*Simplisetia aequisetis (Bristle worm)*[5]

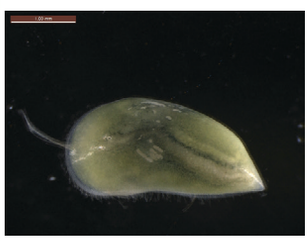
### MOLLUSCA
### Class Bivalvia

*Arthritica semen (Pea clam)*[2]



*Potamopyrgus sp. (Mud snail)*[1.]

### CRUSTACEA
### Class Ostracoda



*Mytilocypris sp. (Seed Shrimp)*[4.]

*Corophium minor (Amphipod)*[6]

### HEXAPODA
### Class Insecta

*Procladius sp. (non-biting midge larvae)*[7.]

Images:

1. City U
2. Museum of New Zealand Te Papa Tongarewa
3. John Fisher – Fisherscollection.com
4. SNSB, Zoologische Staatssammlung Muenchen
5. Leon Altoff
6. Hans Hillewaert, Wikimedia Commons
7. Mike Pearson

# Seasonal Density Of Dominant Macroinvertebrate Phyla

There was considerable variation in the density and composition of benthic marcoinvertabrates across seasons and regions. Density and composition of invertebrates in the wetlands are likely to be influenced by the water quality and sediment characteristics such as grain size and organic matter content.

A consistently high density of invertebrates occurred in the Wonnerup Inlet throughout the year, and primarily consisted of invertebrates typical of estuaries that live within the sediment (infauna) such as the pea clam (a bivalve mollusc) and estuarine polychaete worms.

In contrast, the Vasse and Wonnerup estuaries showed greater seasonal variation, with high densities of invertebrates in winter and spring and low densities in summer and autumn (with the exception of the Lower Wonnerup Estuary). The dominant invertebrates in these regions were wetland species that live on or above the sediment (epifauna) such as the mud snail. These results indicate that winter and spring provides better conditions for these wetland species when the water is fresher, water levels are higher and filled with aquatic plants.

Densities of benthic macroinvertebrates are likely to be lower in summer and autumn in these regions due to predation by wading shorebirds. In summer many thousands of wading shorebirds arrive at the wetlands to feed on invertebrates as water levels drop exposing sediments and providing favourable feeding conditions. In winter water levels rise and there are less feeding areas available.

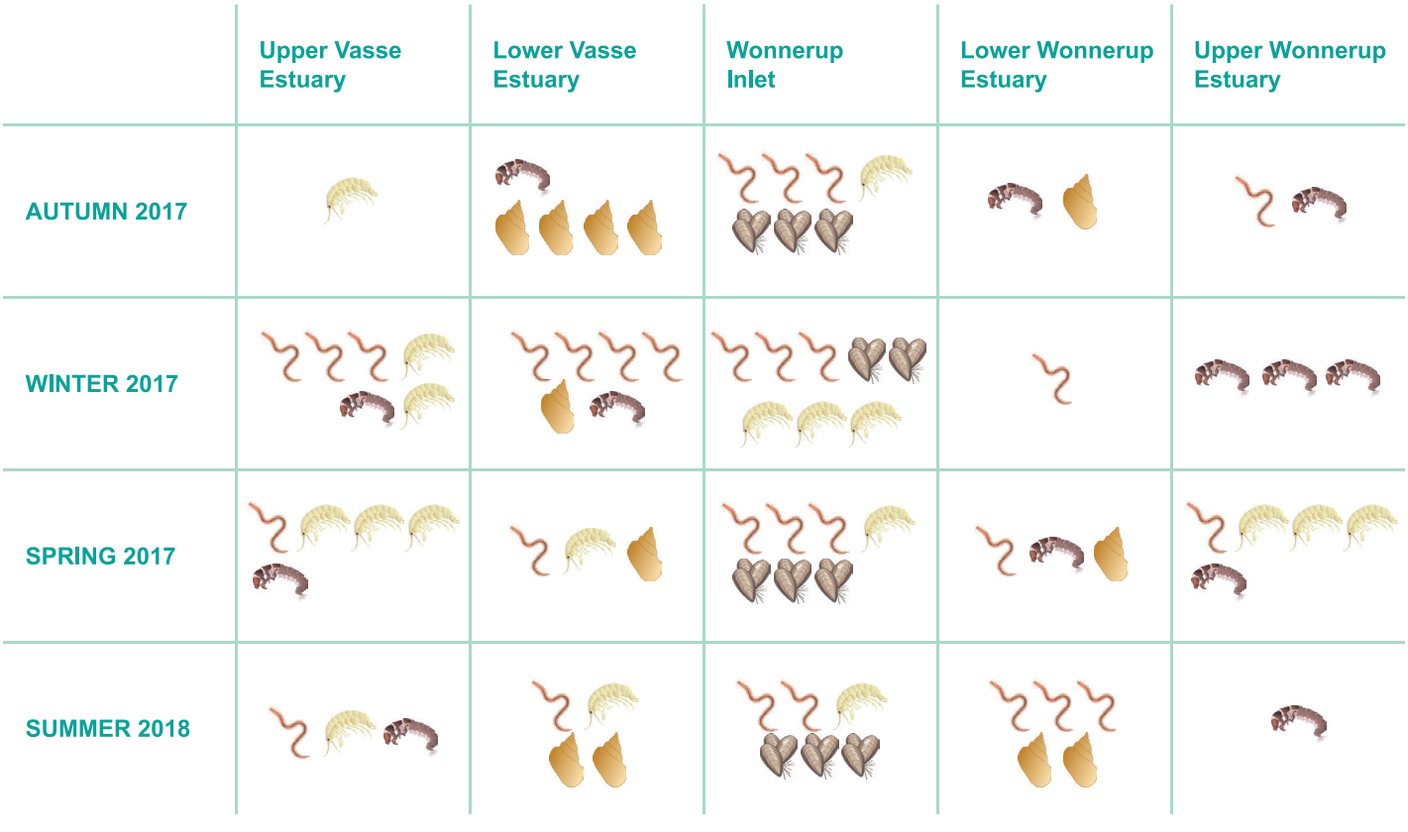



**Figure 6: Seasonal density and composition of dominant phyla of benthic macroinvertabrates over the snapshot year.**

# BENTHIC MACROINVERTEBRATES

Molluscs were most dominant in the lower reaches of the estuary. The Lower Vasse Estuary had a very high density of molluscs in autumn 2017, comprised of the Mud Snail *Potamopyrgus sp.* and Pea Clam *Arthritica semen* that make their way through the surge barriers.

*Capitella capitella* (species complex), a polychaete worm, occurred in all regions over all seasons showing their tolerance to a variety of environmental conditions.

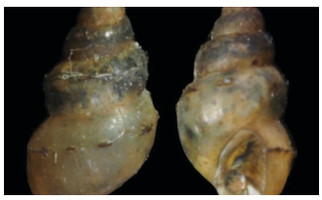
Black-winged stilts feeding on invertebrates ▸

## Do the surge barriers influence invertebrate composition?

The Wonnerup Inlet (downstream of the surge barriers) was found to have a greater density of species and number of species than those regions upstream of the surge barrier. Species found in the Wonnerup Inlet were found to be those typical of an estuarine system (e.g. Polychaetes *Pseudopolydora kempi, Scoloplos normalis, Simplisetia aequisetis* and *Capitella capitate* (species complex), the amphipod C*orophium minor* and bivalve *Arthritica semen*) in contrast to the regions upstream of the surge barriers that were found to be mostly species typical of a wetland environment (such as the larval chironomid *Procladius* sp. and the gastropod *Potamopygrus*). The surge barriers are therefore likely to have a major influence on invertebrate composition.

### Upstream of surge barriers

- **Wetland species**
- **Dominated by Insects**
- **Mostly Epifauna**



### Downstream of surge barriers (Wonnerup Inlet)

- **Estuarine species**
- **Dominated by Annelids, Molluscs, Crustaceans**
- **Mostly Infauna**
- **Greater density of individuals**
- **Greater number of species**


# FISH

Photo: James Tweedley

***The wetlands provide important habitat and nursery grounds for a variety of fish species. These include important recreational and commercial species such as Black Bream. Fish are also an important food source for many waterbirds in the wetlands.***

## What Species Did We Find?

Over 59,000 fish from 19 species and 12 families were caught and released over three seasons of monitoring. No fish monitoring was undertaken in autumn 2017.

Most of the species recorded were fish that spawn in marine waters (e.g. whiting). The highest number of fish species were recorded in spring and summer when the sandbar was open and dominant fish species had recently spawned. Only six different species were recorded in winter when the sandbar was closed.

The most numerous fish were the Hardyheads and Gobies making up 99% of the fish caught. These fish complete their lifecycles within the estuary and are commonly found in the shallow, nearshore waters of estuaries in Western Australia.

Very few freshwater fish were recorded. Two invasive goldfish were recorded in the Upper Vasse region in spring, likely having entered the system from the Lower Vasse River during winter river flow.

Bluespot Goby

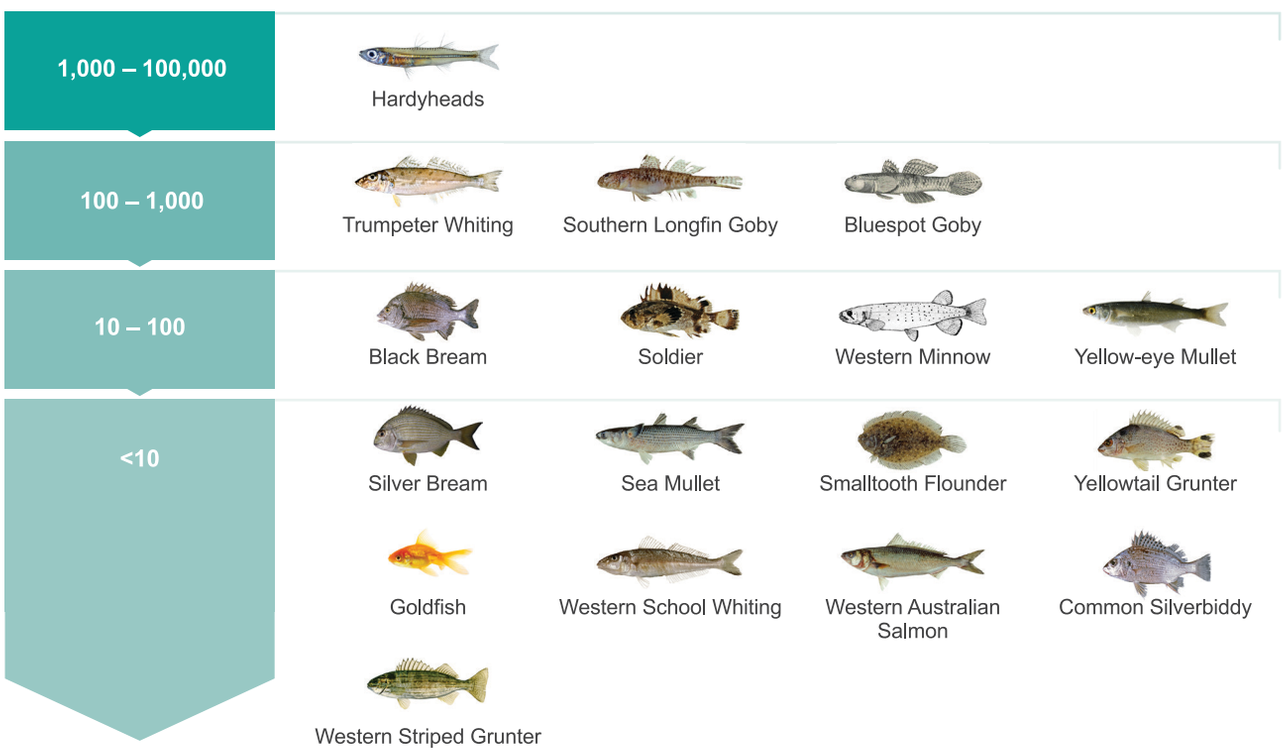



**Figure 7:Total abundance of fish species recorded from July 2017— January 2018**

# Seasonal abundance of dominant fish species

There was a major difference in the fish caught in the Wonnerup inlet compared to the two estuaries, with both the number of fish caught and number of species much higher in the Wonnerup Inlet.

| | Upper Vasse Estuary | Lower Vasse Estuary | Wonnerup Inlet | Lower Wonnerup Estuary | Upper Wonnerup Estuary |
|---|---|---|---|---|---|
| AUTUMN 2017 | No Sampling | No Sampling | No Sampling | No Sampling | No Sampling |
| WINTER 2017 | | | | | |
| SPRING 2017 | | | | | |
| SUMMER 2018 | Too shallow to use siene net, no fish observed | | | Too shallow to use siene net, no fish observed | Too shallow to use siene net, no fish observed |


**Figure 8: Seasonal density and composition of dominant fish species over the snapshot year.**

Fish were most abundant in the summer with over 10,000 individuals recorded in both the Lower Vasse Estuary and Wonnerup Inlet. No fish were recorded in the upper Vasse and Wonnerup estuaries or Lower Wonnerup Estuary due to low water levels, warmer water and exposure to predators. Higher fish numbers in summer in the Lower Vasse Estuary was likely due to the deeper cooler water habitat created by the *Cladophora* bloom in January 2018, which provided ideal habitat for fish.

The lowest fish numbers were recorded in winter across all regions with less than a 1000 individuals being caught. At this time fish are distributed across a greater area of the wetlands (including deeper waters and saltmarsh) resulting in lower catch rates. Numbers increased across most regions in spring, which was likely due to recent spawning.

Fish numbers were consistently higher in the Wonnerup Inlet in comparison to the Estuary regions, this region featuring as an important habitat for fish in the Vasse-Wonnerup wetlands.

The lower Vasse Estuary (Left) provided deeper, cooler water and protection from predators compared to the upper Vasse Estuary (Right)

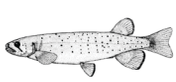
# Do The Surge Barriers Influence Fish Species?

There was a clear difference in the type of fish caught in the Wonnerup Inlet (downstream of the surge barriers) compared to the upper estuaries (upstream of the surge barriers). The Wonnerup Inlet had both more fish species and greater numbers of fish than the estuaries. Wonnerup Inlet is open to Geographe Bay for much of the year which creates a favourable environment for species such as mullet and whiting that spawn in the ocean and whose juveniles use estuaries as a nursery area, as well as estuarine species such as the Black Bream. In contrast fish upstream of the barriers was dominated by *Atherinidae* (Hardyheads and Gobies), estuarine species which can tolerate the salinity fluctuations upstream of the barriers.

Comparing fish species downstream and upstream of the surge barriers over several seasons allow us to determine what influence both the sandbar and the surge barriers have on the type of fish that occur in the different habitats.

## Upstream of surge barriers

Hardyheads



Western Minnow

Bluespot Goby

Yellow-eye Mullet

Goldfish

## Downstream of surge barriers (Wonnerup Inlet)

Bluespot Goby

Smalltooth Flounder

Western Australian Salmon

Soldier

Sea Mullet

Yellow-eye Mullet

Black Bream

Southern Longfin Goby

Western School Whiting

Yellowtail Grunter

Silverbream

Trumpeter Whiting

Western Striped Grunter

Common Silverbiddy

All photos in Fish section: Fishes of Australia.net.au; James Tweedley

# WATERBIRDS

The Australian Pelican in a feeding circle feeding on fish in the Vasse Estuary. (Photo: Mark Oliver)

***The wetlands provide habitat to thousands of Australian and migratory water bird species as well as supporting the largest breeding population of black swans in the state. The Ramsar status of the wetland is based on several criteria, one is the wetland regularly supporting ≥ 20,000 waterfowl and another for supporting at least 1% of the individuals of a population of several highly conservation significant species.***

## What Species Did We Find?

During the snapshot study a total of 86 species of water birds were recorded. The four species on which the Ramsar listing of the wetland is partially based were observed: the Black Winged Stilt *Himantopus himantopus* (2118), the Australian Shelduck *Tadorna tadornoides* (779), the Red-Necked Avocet *Recurvirostra novaehollandiae* (756) and the Australasian Shoveler *Spatula rhynchotis* (74).

To assist in the interpretation of monitoring results the birds observed in the snapshot have been grouped into feeding and behavioural "guilds". These guilds group birds into a community that exploit the same resources, but do not indicate that the birds are related taxonomically. The dominant guilds observed in the snapshot, and the dominant species in those guilds, are shown below.

### Surface dabblers – mixed diet

**Total count 13,211**

This guild had the highest number of individuals, comprised of ducks that feed on a mixed diet including aquatic plants and invertebrates. The dominant species were the Grey Teal *Anas gracilis* and the Australian Shelduck *Tadorna tadornoides*. The Australasian Shoveler *Anas rhynchotis* belongs in this guild.

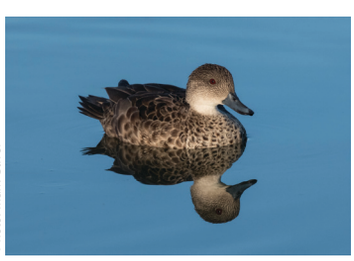


Photo: Mark Oliver

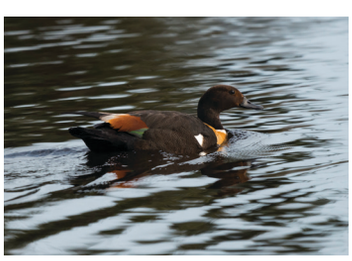


Photo: Mark Oliver

Grey Teal (left), Australian Shelduck (right)

### Small waders – predatory (fish, invertebrates)

**Total count 3,859**

The migratory shorebirds belong in this guild as well as local waders. Dominant species were the Black Winged Stilt, *Himantopus himantopus* the Red Necked Stint *Calidris ruficollis*, Red Necked Avocet *Recurvirostra novaehollandiae* and Red Capped Plover *Charadrius ruficapillus.*

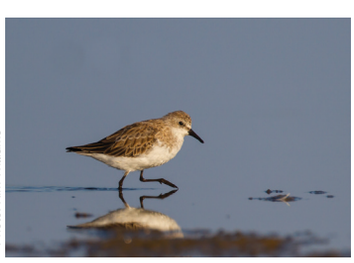


Photo: Kim Williams

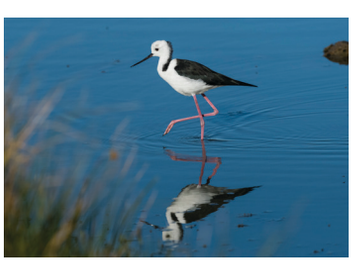


Photo: Mark Oliver

Red necked stint (left) and Black Winged Stilt (right)

# WATERBIRDS

### Divers – herbivorous
**Total Count 2,065**

The dominant species in this guild was the Black Swan *Cygnus atratus* and the Eurasian Coot *Fulica atra*. These species feed on aquatic macrophytes such as Ruppia and pasture grasses.

Black Swan *Cygnus atratus*

Photo: Kim Williams

Silver Gull *Chroicocephalus novaehollandiae*

### Shoreline – predatory
**Total count 1,633**

Birds in this guild are generalist feeders capable of both hunting small live prey (e.g. insects, baby birds, eggs, small fish) and scavenging from carcasses. The dominant species in the Vasse Wonnerup is the Silvergull *Larus novaehollandiae.*

### Large waders – predatory (fish, invertebrates)
**Total count 635**

This guild includes species of Heron, Egret and Ibis. Dominant species were the White necked Heron *Ardea pacifica* and Australian White Ibis *Threskiornis molucca.*

Photo: Mark Oliver

Photo: Mark Oliver

White Necked Heron (left), Great Egret (right)

### Divers – predatory
**Total count 591**

Birds in this guild dive for fish and invertebrates. The dominant species were the Hoary-headed Grebe *Poliocephalus poliocephalus,* Pied Comorant *Phalacrocorax varius* and Australian Pelican *Pelecanus conspicillatus.*

Photo: Mark Oliver

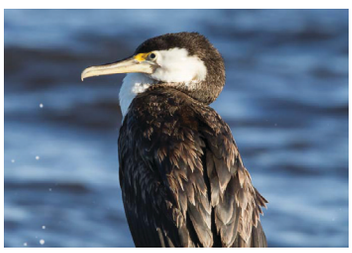


Photo: Kim Williams

Hoary Headed Grebe (left) Pied Cormorant (right)

Several other guilds were represented over the four seasonal surveys, however in lower numbers (total bird count per guild below 50). This includes Divers with a mixed diet such as the Musk Duck *Biziura lobata*, Raptors such as the Whistling Kite *Haliastur sphenurus* and Swamp Harrier *Circus approximans*, Aerial divers that are predatory such as terns, the Osprey *Pandion haliaetus* and the White-bellied sea eagle *Haliaeetus leucogaster,* Shoreline birds that feed on vegetation such as the Swamphen *Porphyrio porphyrio* and Predatory Reed Skulkers such as the Buff Banded Rail *Gallirallus Philippensis*.

Photo: Mark Oliver

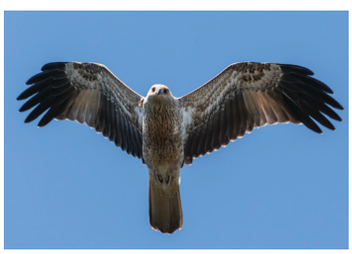
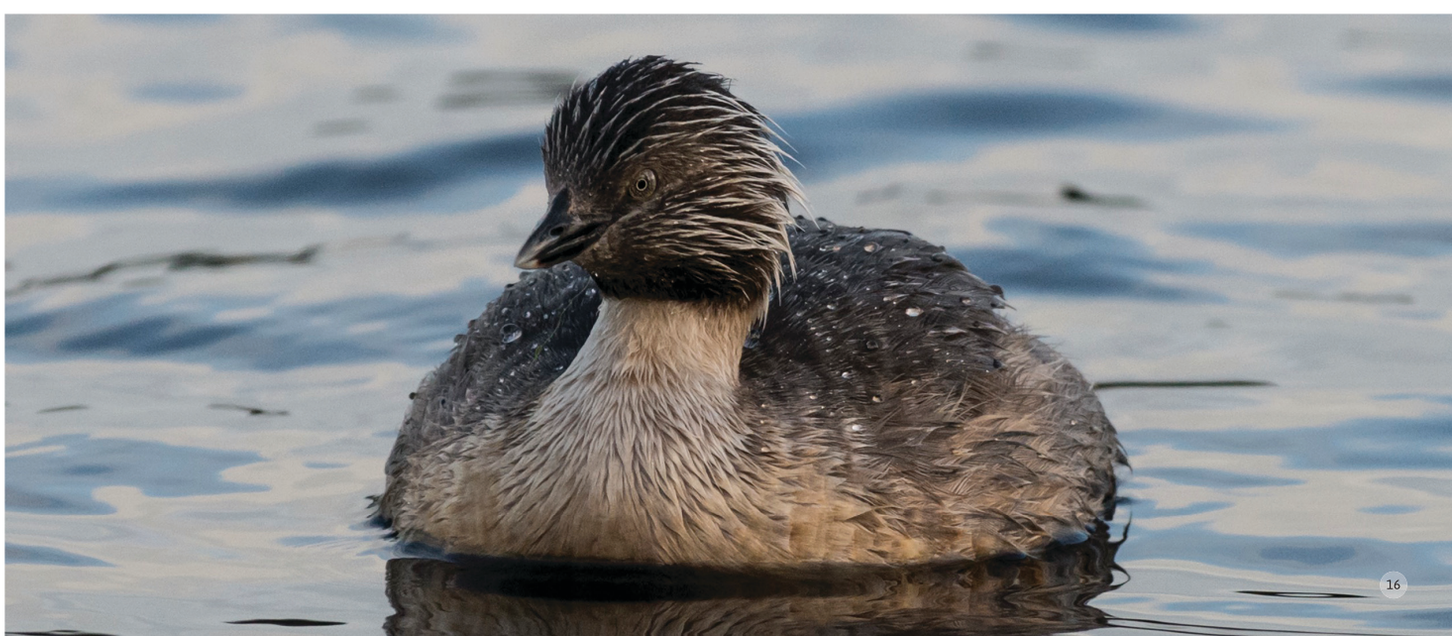


Photo: Mark Oliver

The Swamphen (left) and the Whistling Kite (right) can be observed feeding in the wetlands.



Hoary-headed Grebe (Photo: Mark Oliver)

# Seasonal abundance of dominant bird guilds

There was considerable regional differences in the density of water birds over the snapshot year with substantially higher numbers of birds recorded in the upper and lower regions of Vasse and Wonnerup estuaries.

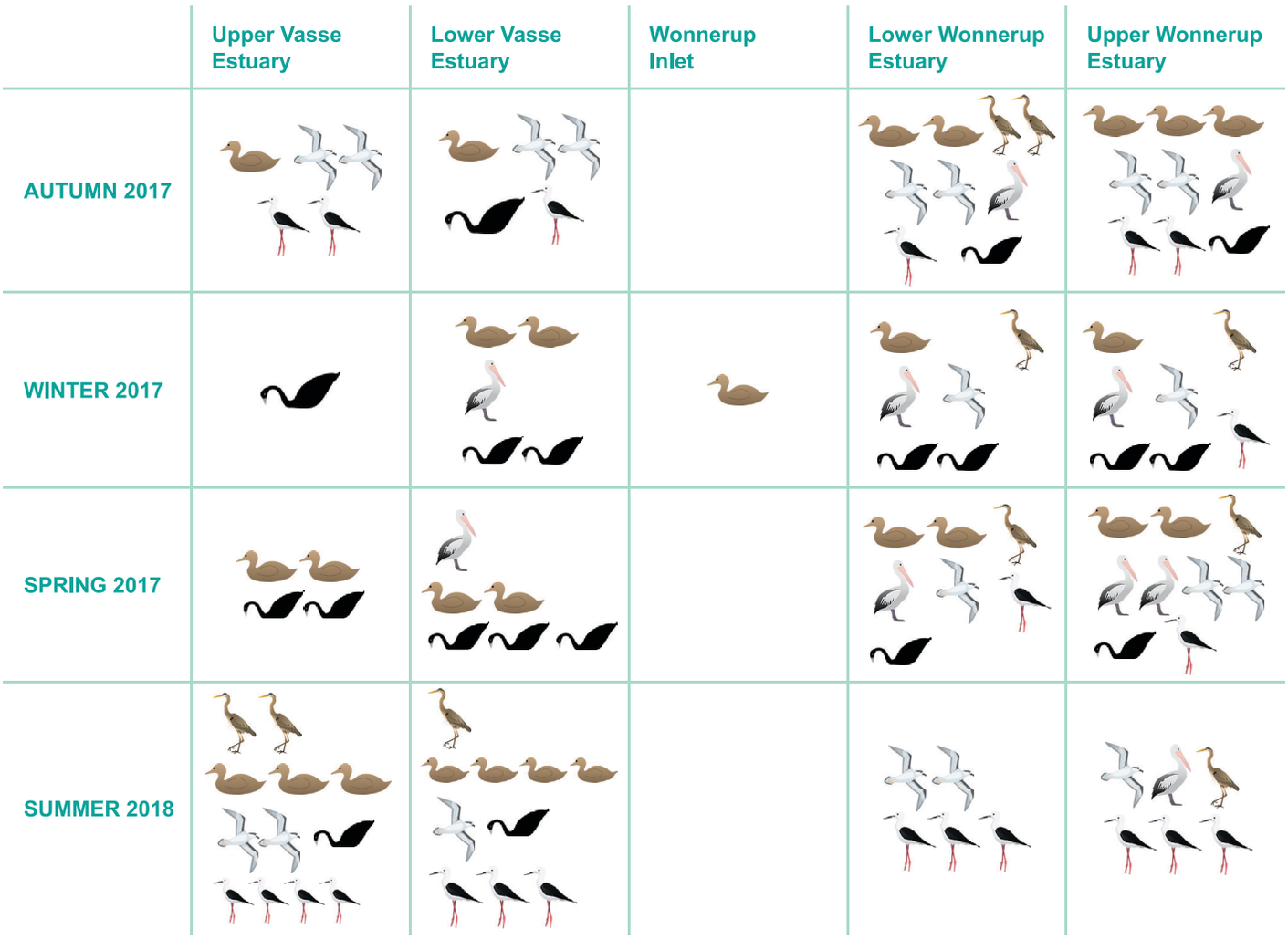



**Figure 9: Seasonal density and compostion of dominant water birds guilds over the snapshot year.**

Small predatory waders were at their highest in summer 2018, a time where shallow water and exposed mudflats provide good habitat for the thousands of migratory and Australian wading shorebirds feeding on invertebrates.

In winter these shorebirds are mostly absent however ducks (surface dabblers) were abundant and Black Swans (herbivorous divers) were building nests in open water and feeding on the macroalgae and macrophytes that emerge in the wetlands at this time. In the springtime the number of herbivorous divers increased in the Vasse Estuary as aquatic macrophytes, a key food source, were abundant in the wetlands and cygnets (young Swans) become part of the community. At this time of year cygnets are flightless and swimming in open water vulnerable to predatory birds such as the White bellied sea eagle and Whistling Kite.

# WATERBIRDS

The abundance of herbivorous divers was at its lowest in summer and autumn when aquatic plants were dying off and these waterbirds move to other areas.

Predatory divers such as the Australian pelican were present in their highest number in the Wonnerup Estuary where they are often observed resting on sandflats near the Wonnerup Estuary surge barrier.

The surface dabblers (duck species with a mixed diet) dominated the wetlands in the snapshot year, present across all seasons and found in all regions. The guild had its highest bird counts in summer 2018 in the Vasse Estuary and was absent in the Wonnerup Estuary.

The Wonnerup Inlet supported waterbirds throughout the year, however in very low numbers. All guilds were however observed in very low numbers with the exception 55 Pacific Black Ducks recorded in winter 2017. The total count for the snapshot year in the inlet was 75 birds, compared to 13136 for the rest of the estuary.

## Do the surge barriers influence waterbird composition?

Upstream of the surge barriers a variety of bird guilds were present, many in high numbers, in contrast the Wonnerup Inlet supported a very low diversity and number of waterbirds.

Upstream of the surge barriers the Vasse and the Wonnerup estuaries provide a greater variety of habitats and food sources in comparison with the Wonnerup Inlet. The wetlands upstream of the surge barriers are dense with aquatic macrophytes in winter and spring, encouraging the presence of herbivorous divers such as ducks and swans. These herbivorous divers are present in small number in the inlet where macrophytes are absent and macroalgae is found in low densities. The upper estuaries dry out in the summer months providing the perfect depth for wading shorebirds to pick invertebrates from the sediment. This habitat is mostly absent in the Inlet and this is reflected in the absence of small wading birds.

The results of the snapshot show that the Inlet provides a variety and abundance of benthic macroinvertebrates and fish. Bird guilds that feed on fish and invertebrates were, however not abundant in the Inlet. This result may suggest that although food may be available it may not be accessible to many species due to other factors such as water depth or water quality.

### Upstream of surge barriers

- **Higher waterbird count**
- **Diversity of guilds**
- **Wading shorebirds present**
- **Vegetarian divers present**

### Downstream of surge barriers (Wonnerup Inlet)

- **Lower waterbird count**
- **Fewer guilds**
- **Fewer smaller wading shorebirds**
- **Fewer herbivorous divers**

Photos: Mark Oliver, Kim Williams

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