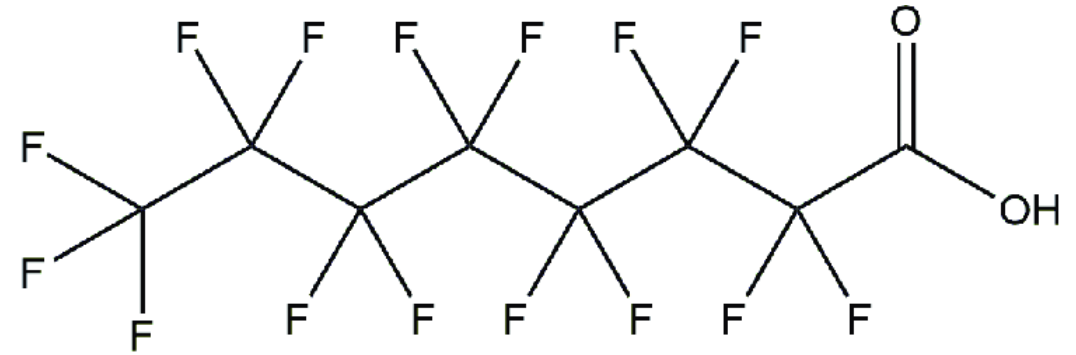
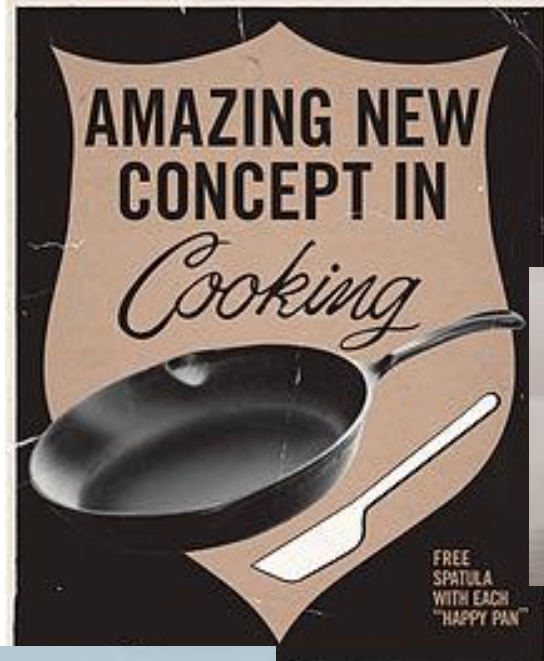


# Spatial and temporal variation in PFAS within an urban estuary and accumulation in biota

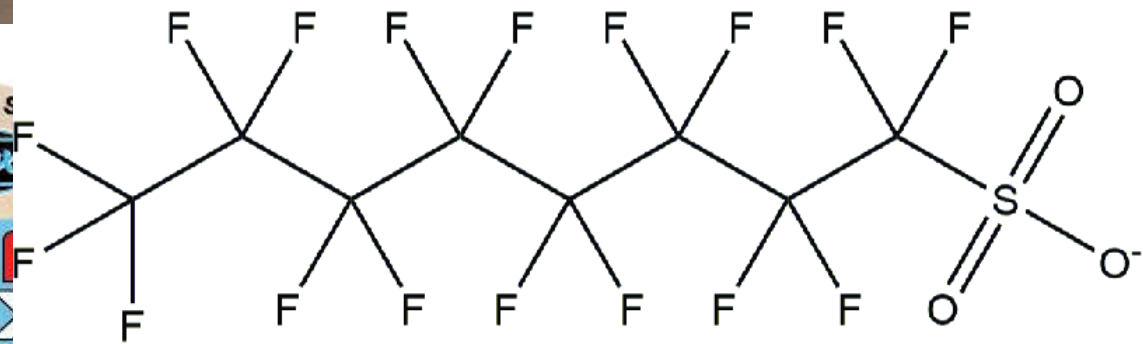
**Peter Novak and Steeg Hoeksema**  
Dept Biodiversity, Conservation and Attractions



# What is PFAS?



Perfluorooctanoic acid (PFOA)



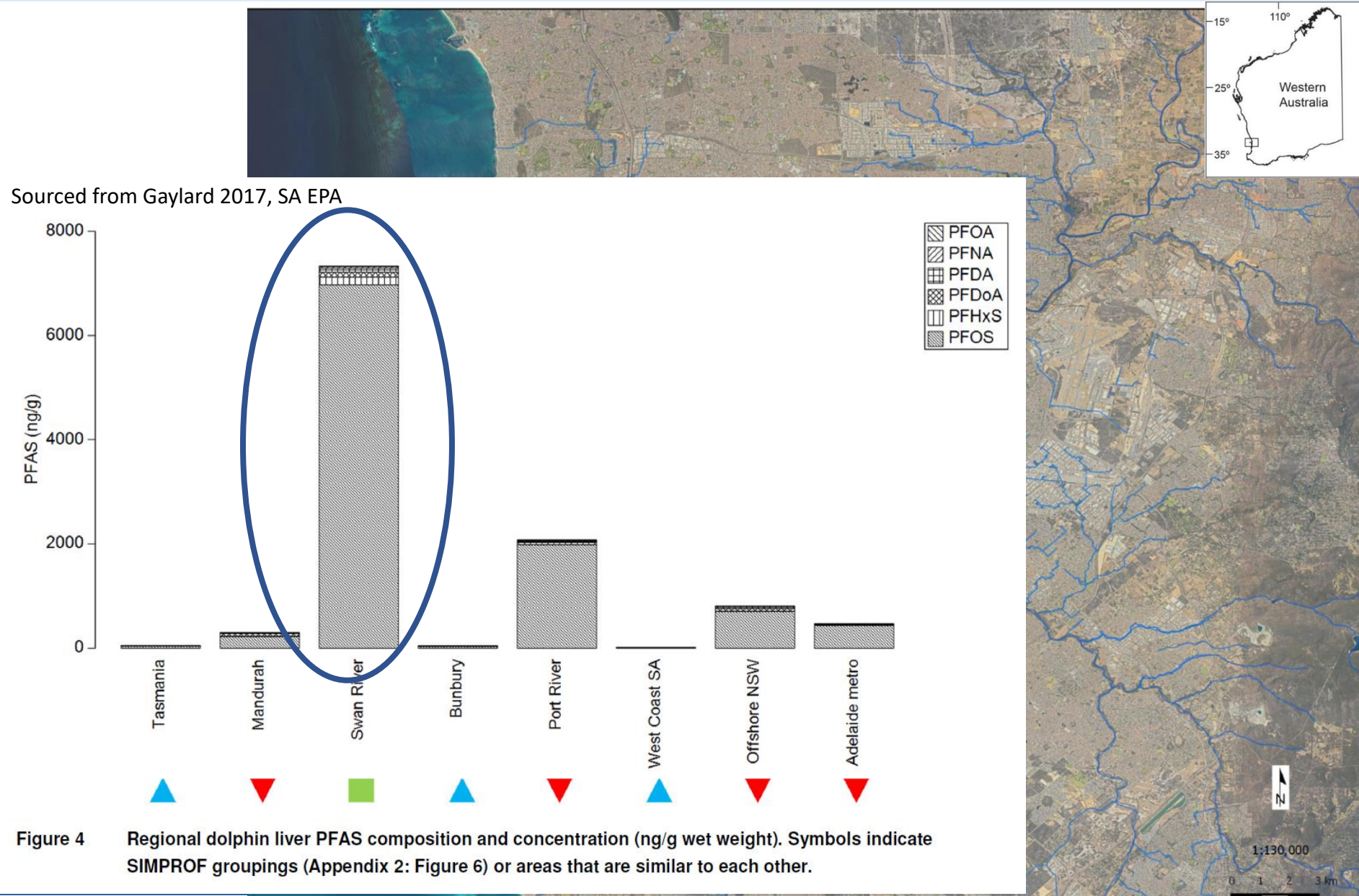
Perfluorooctane sulfonate (PFOS)

Source: Australian Broadcasting Commission





# In the Swan and Canning Estuary, Western Australia ?



# Aims of the study

- **Determine the extent and distribution of PFAS in the Swan Canning Estuary and its catchment**
  - Can potential sources be identified?
- **How is PFAS accumulating in key aquatic species** black bream (*Acanthopagrus butcheri*) and blue swimmer crabs (*Portunas armatus*)
  - Partitioning between body tissues
  - Differing accumulation in different regions of the estuary



# Methods – surface water

- 20 estuary sites and 32 catchment sites were targeted for PFAS analysis.
- Samples were collected every 6 months from December 2016 to June 2018



# Results – Surface water

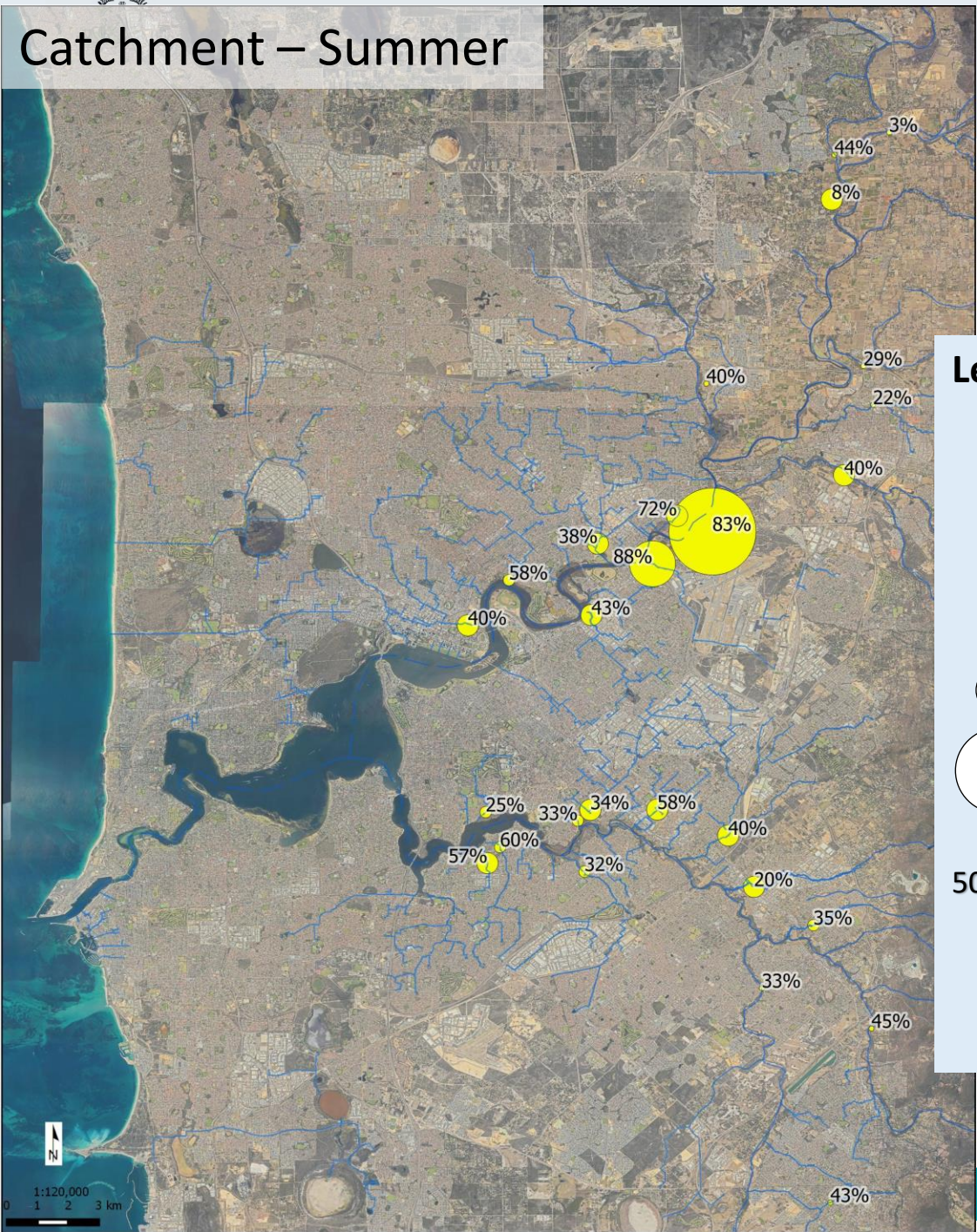
- PFAS every site
- PFOS and PFHxS were the dominant compounds
- PFOS below detect (0.0003 µg/L) at 1 site

<i>Catchment</i>						
Compound	Min	Max	Median	Detects	Count	
PFOS	0	4.1	0.0242	105	108	
PFHxS	0	1.8	0.0131	104	108	
PFOA	0	0.168	0.0067	87	108	
PFHpA	0	0.096	0.0048	97	108	
PFHxA	0	0.46	0.0096	102	108	
PFPA	0	0.27	0.00865	101	108	
PFBA	0	0.15	0	50	108	
PFBS	0	0.24	0.0042	100	108	
8:2 FTS	0	0.017	0	12	108	
6:2 FTS	0	0.66	0	43	108	
PFOS+PFHxS	0	5.9	0.03845	105	108	
∑PFAS	0.0051	7.072	0.08725	108	108	

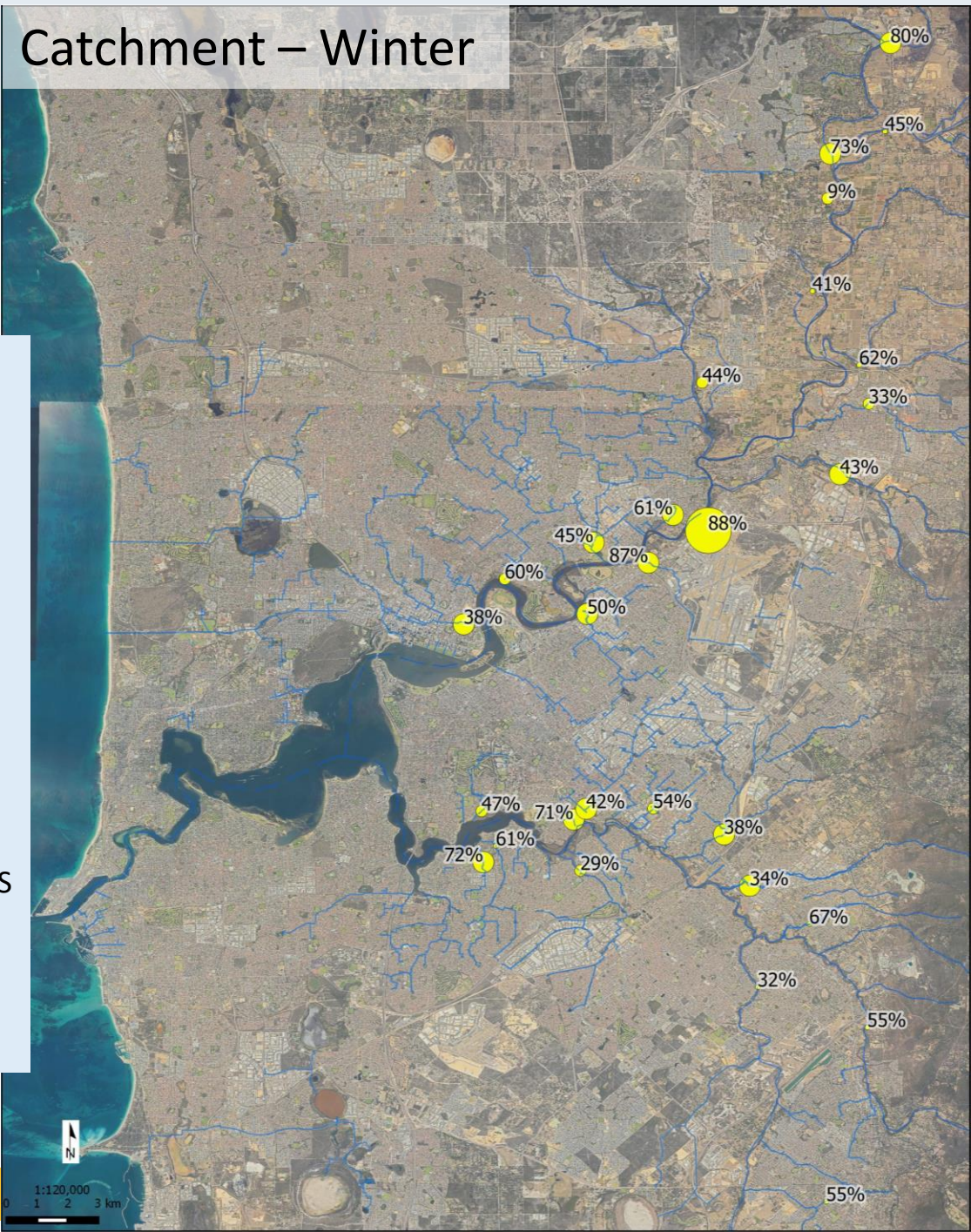
<i>Estuary</i>						
Compound	Min	Max	Median	detects	count	
PFOS	0.0041	0.12	0.0215	80	80	
PFHxS	0.0022	0.051	0.00895	80	80	
PFOA	0	0.015	0.0024	71	80	
PFHpA	0	0.016	0.00135	71	80	
PFHxA	0.0005	0.036	0.00335	80	80	
PFPA	0	0.047	0.0051	78	80	
PFBA	0	0.025	0	23	80	
PFBS	0	0.029	0.0019	68	80	
8:2 FTS	0	0	0	0	80	
6:2 FTS	0	0.037	0	30	80	
PFOS+PFHxS	0.0063	0.149	0.03	80	80	
∑PFAS	0.0101	0.353	0.0519	80	80	



# Catchment – Summer



# Catchment – Winter



## Legend

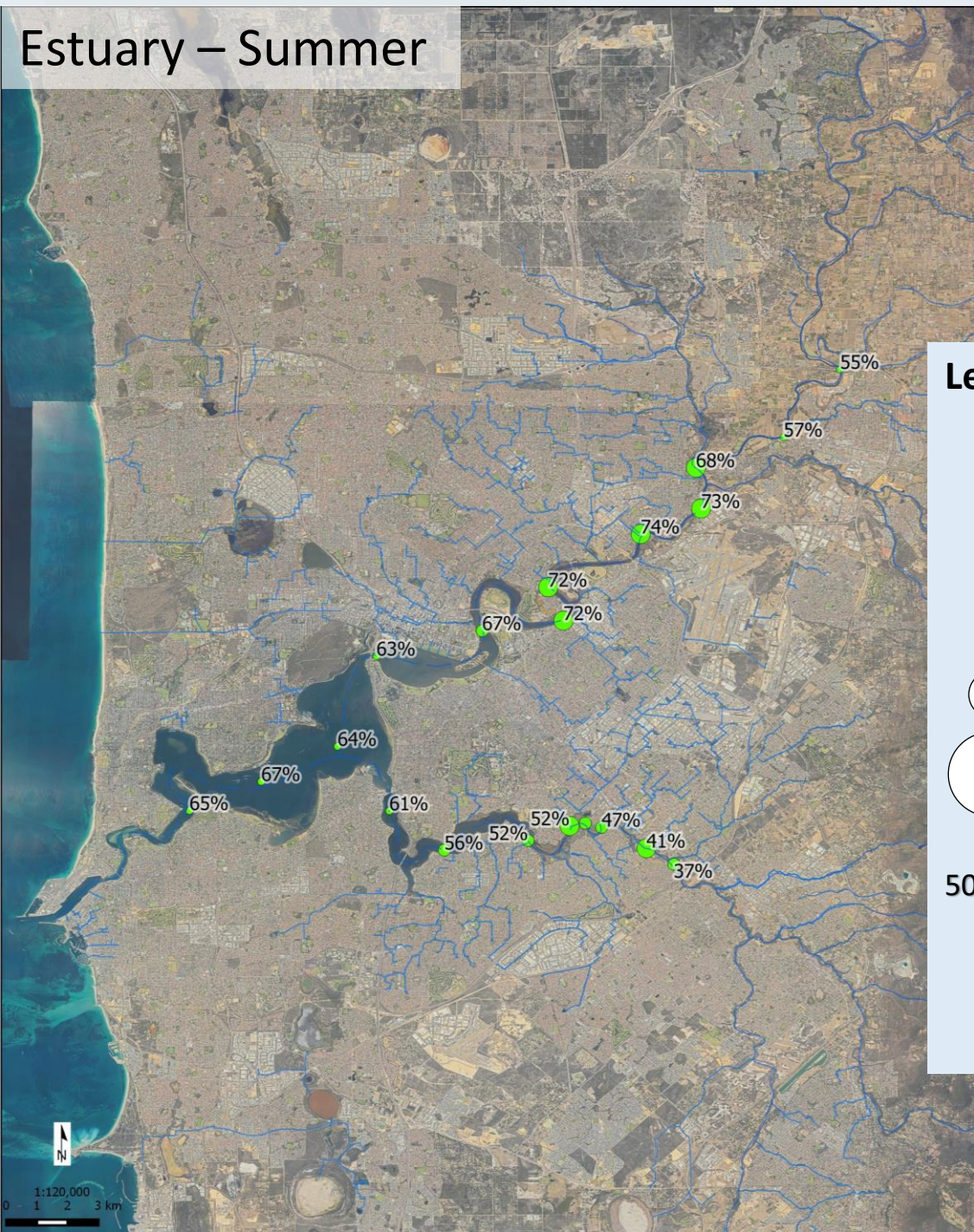
- 0-0.05 µg/L
- 0.05-0.1 µg/L
- 0.1-1.0 µg/L
- 1.0-5.0 µg/L
- >5 µg/L

50% - % of PFOS+PFHxS to total PFAS

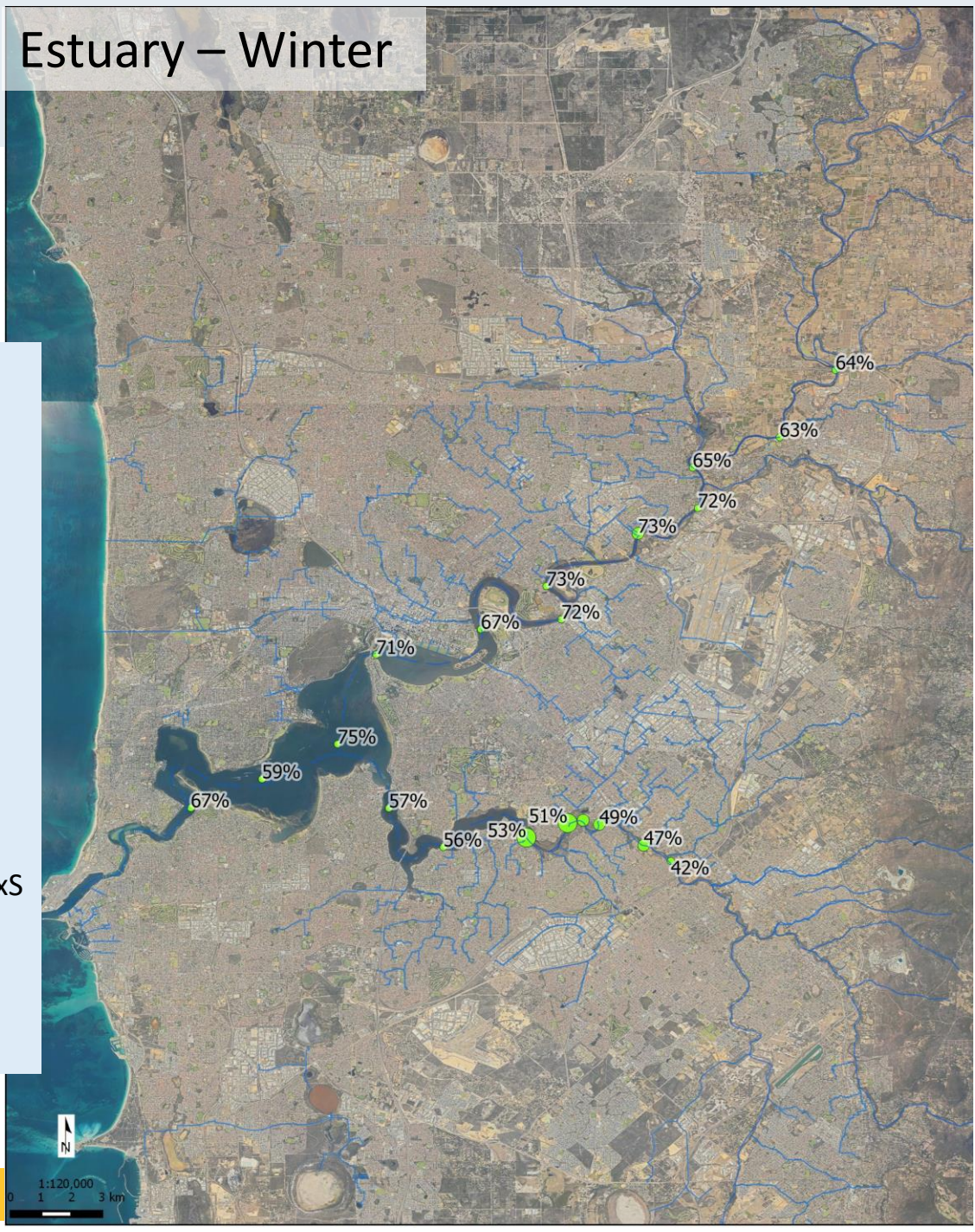




# Estuary – Summer



# Estuary – Winter



### Legend

- 0-0.05  $\mu\text{g/L}$
- 0.05-0.1  $\mu\text{g/L}$
- 0.1-1.0  $\mu\text{g/L}$
- 1.0-5.0  $\mu\text{g/L}$
- >5  $\mu\text{g/L}$

50% - % of PFOS+PFHxS to total PFAS





# PFAS in biota

## Aims

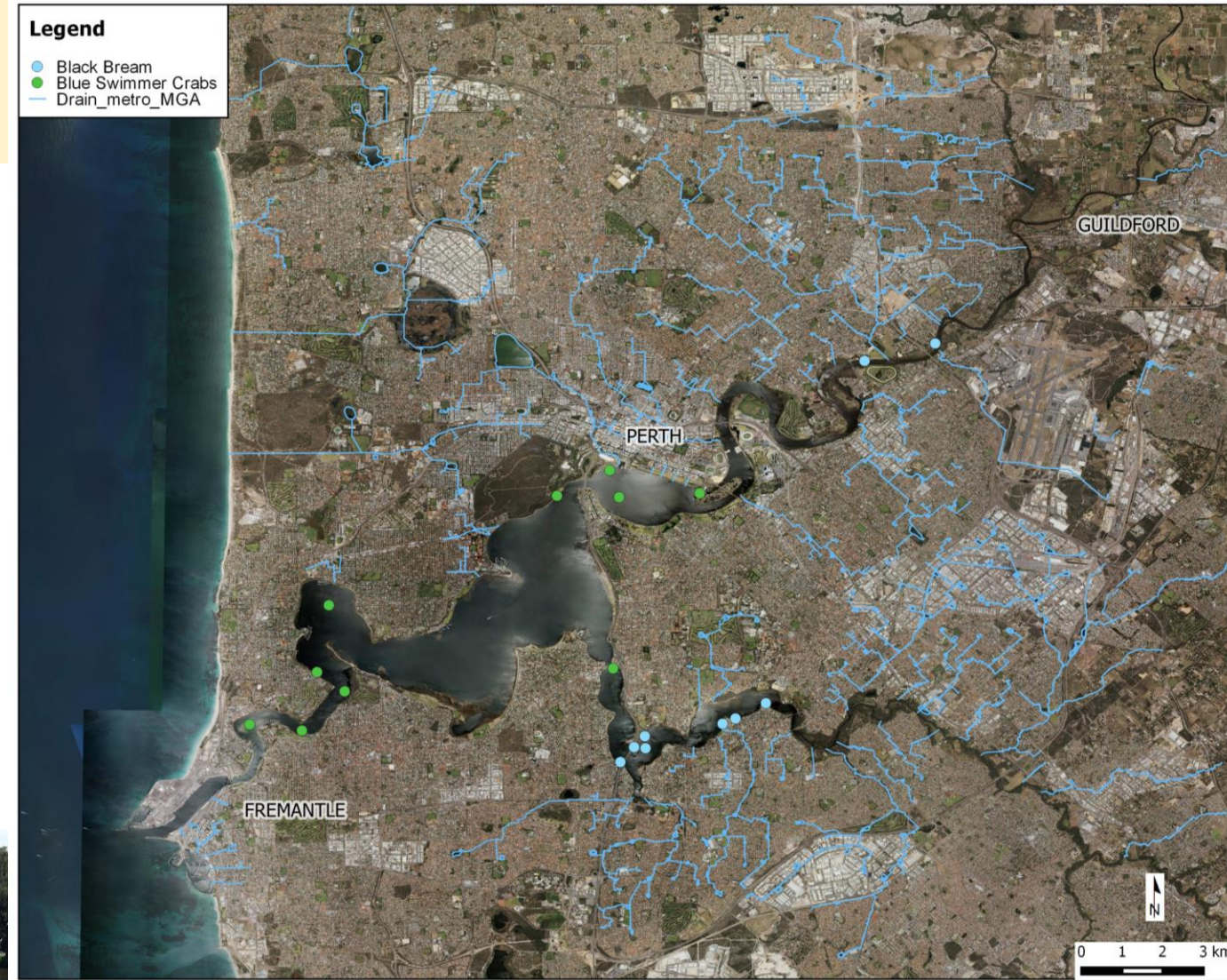
- **How is PFAS accumulating in key aquatic species** black bream (*Acanthopagrus butcheri*) and blue swimmer crabs (*Portunas armatus*)
  - Partitioning between body tissues
  - Differing accumulation in different regions of the estuary





# Methods – biota

- Blue swimmer crabs (*Portunas armatus*) and black bream (*Acanthopagrus butcherii*) were sampled
  - Crabs - muscle and viscera (hepatopancreas, gills and gonads)
  - Bream - muscle, liver, gonads and carcass

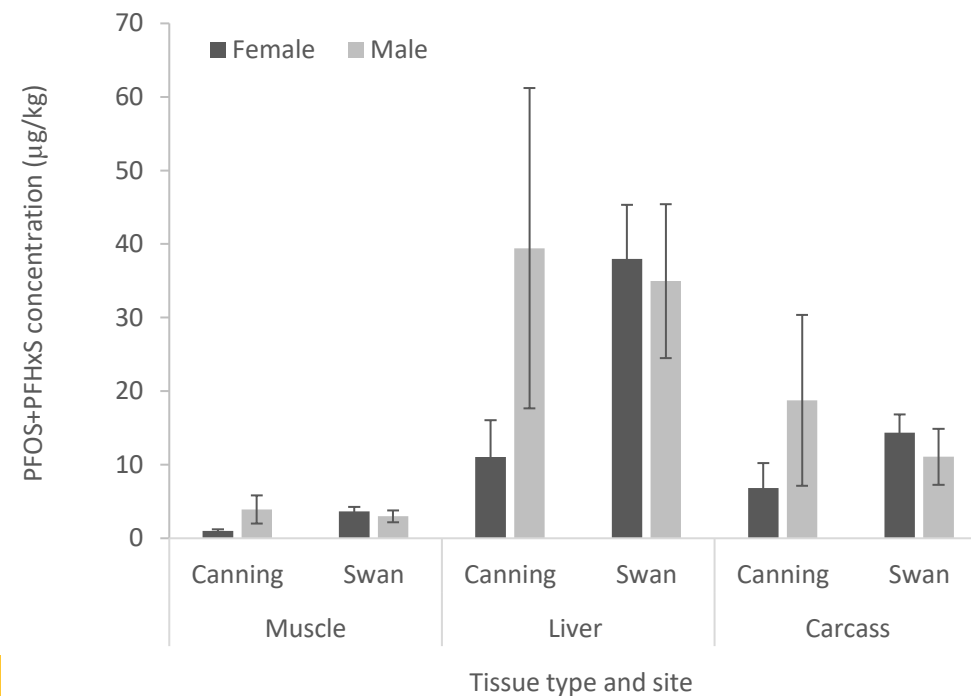
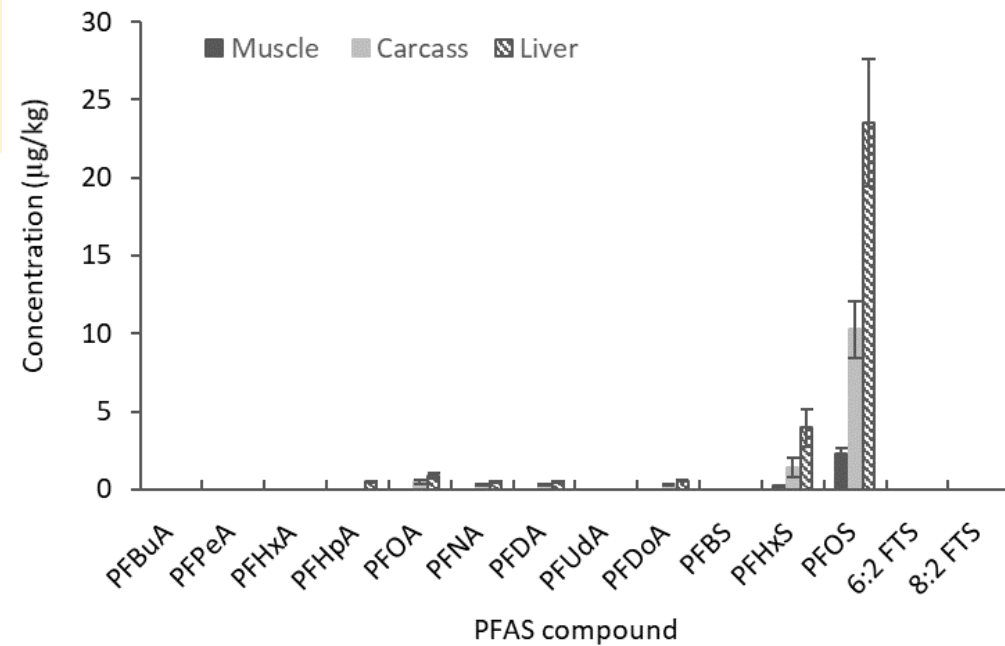
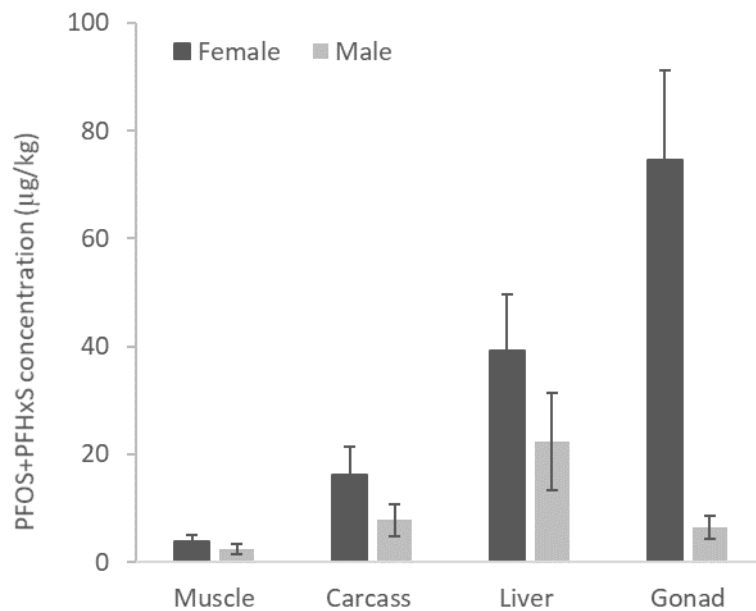




# PFAS in *Acanthopagrus butcheri*

Mean PFOS+PFHxS concentrations in bream tissue were:

- Muscle – 2.3 ( $\pm 0.4$  SE)  $\mu\text{g}/\text{kg}$
  - Carcass – 10.3 ( $\pm 1.8$  SE)  $\mu\text{g}/\text{kg}$
  - Liver – 23.5 ( $\pm 4.1$  SE)  $\mu\text{g}/\text{kg}$
- Significant ( $P < 0.05$ ) regional difference in female PFAS concentration

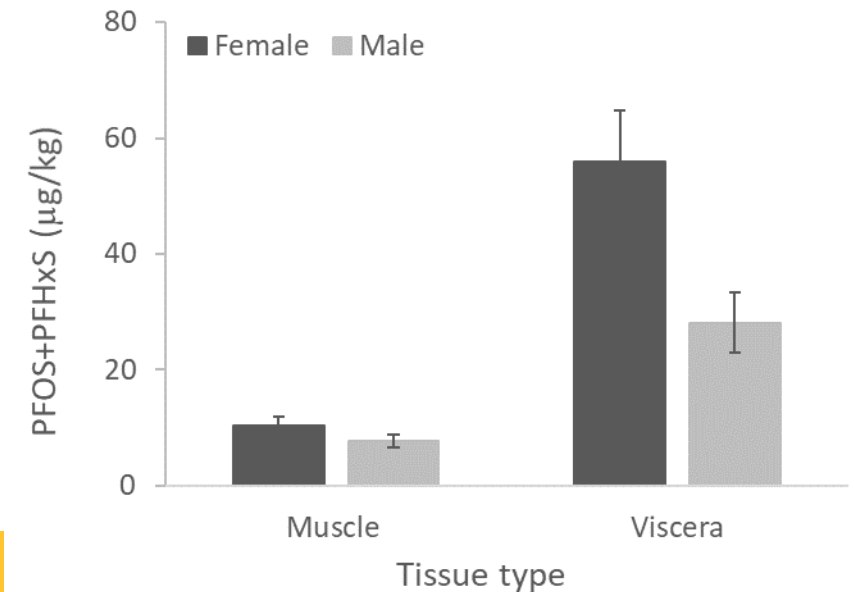
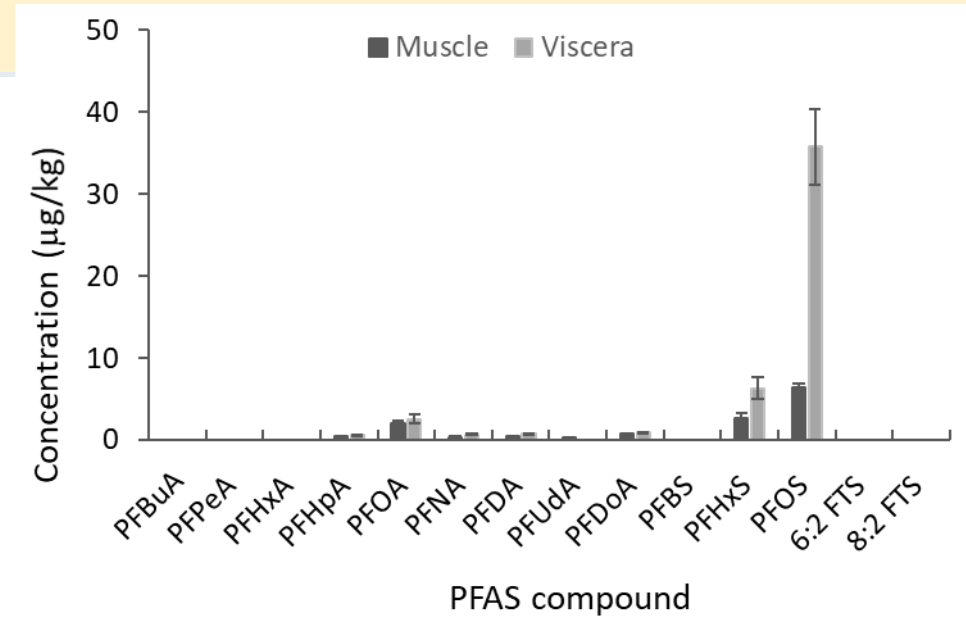




# PFAS in *Portunus armatus*

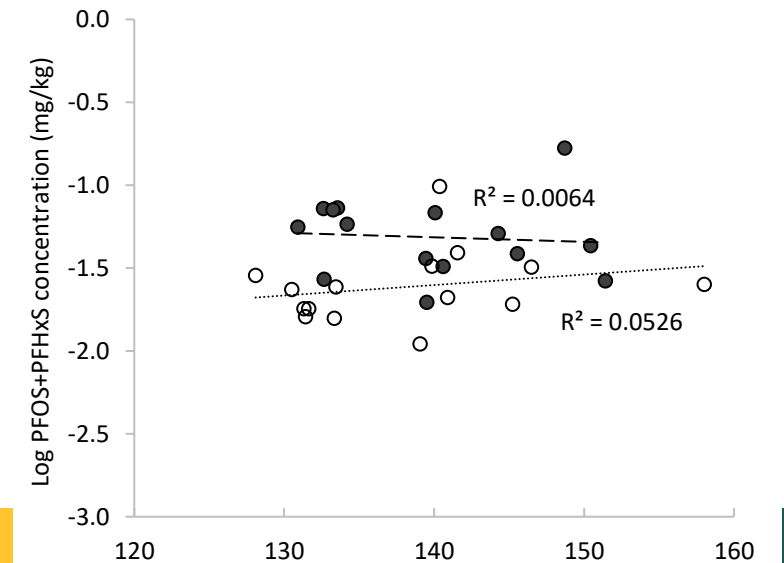
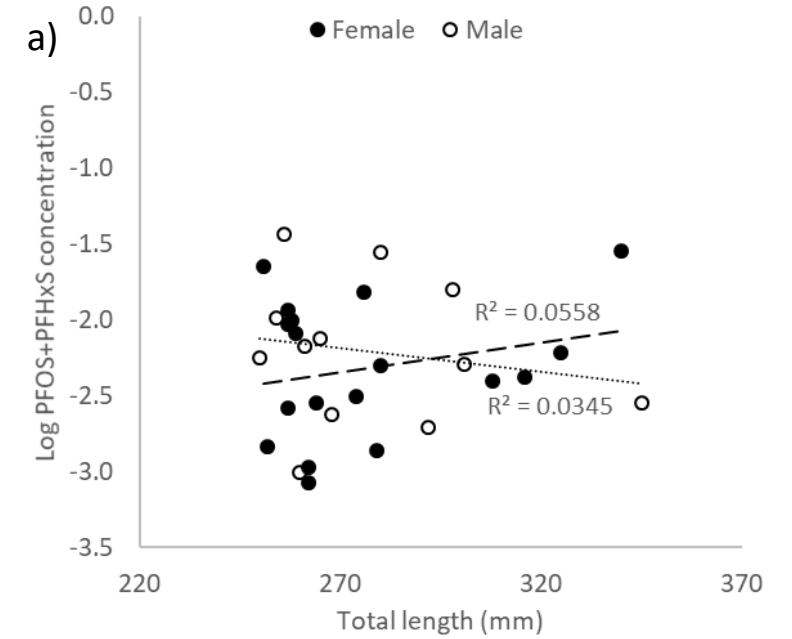
## Key results

- A greater number of PFAS compounds were detected in *P. armatus*
- PFOS+PFHxS concentrations were higher in viscera
- PFOS+PFHxS concentrations were higher in female *P. armatus*





# To what extent is PFAS accumulating?





# Conclusion

- PFAS was detected throughout the estuary, its catchment and key biota species
- Catchment sources varied both seasonally and spatially, highest concentrations were consistently associated with water courses draining:
  - Perth Airport
  - Pearce Airbase
- In the estuary legacy PFAS dominated - PFOS and PFHxS, elevated throughout the middle reaches of the Swan Estuary
- PFAS was detected in every biota specimen
  - Regional differences in PFAS concentration in female bream – reflect different catchment sources?
  - Didn't accumulate with length – postulated due to solubility with water
- Human health risk assessment completed



# Conclusion

- Knowledge gaps
  - Groundwater in the Swan Canning Estuary
  - More broadly, toxicity effects on biota and ecosystem function at relevant concentrations
  - Multiple stressor approaches
- Remediation
  - Airport North Main Drain
  - Pilot trial commenced to test efficacy of PFAS removal by a constructed wetland.





# Thank you

Thank you to all involved in the Rivers and Estuaries Science Program at the Dept of Biodiversity, Conservation and Attractions.

For more information contact:

[peter.novak@dbca.wa.gov.au](mailto:peter.novak@dbca.wa.gov.au)

<https://www.dpaw.wa.gov.au/management/swan-canning-riverpark/ecosystem-health-and-management>

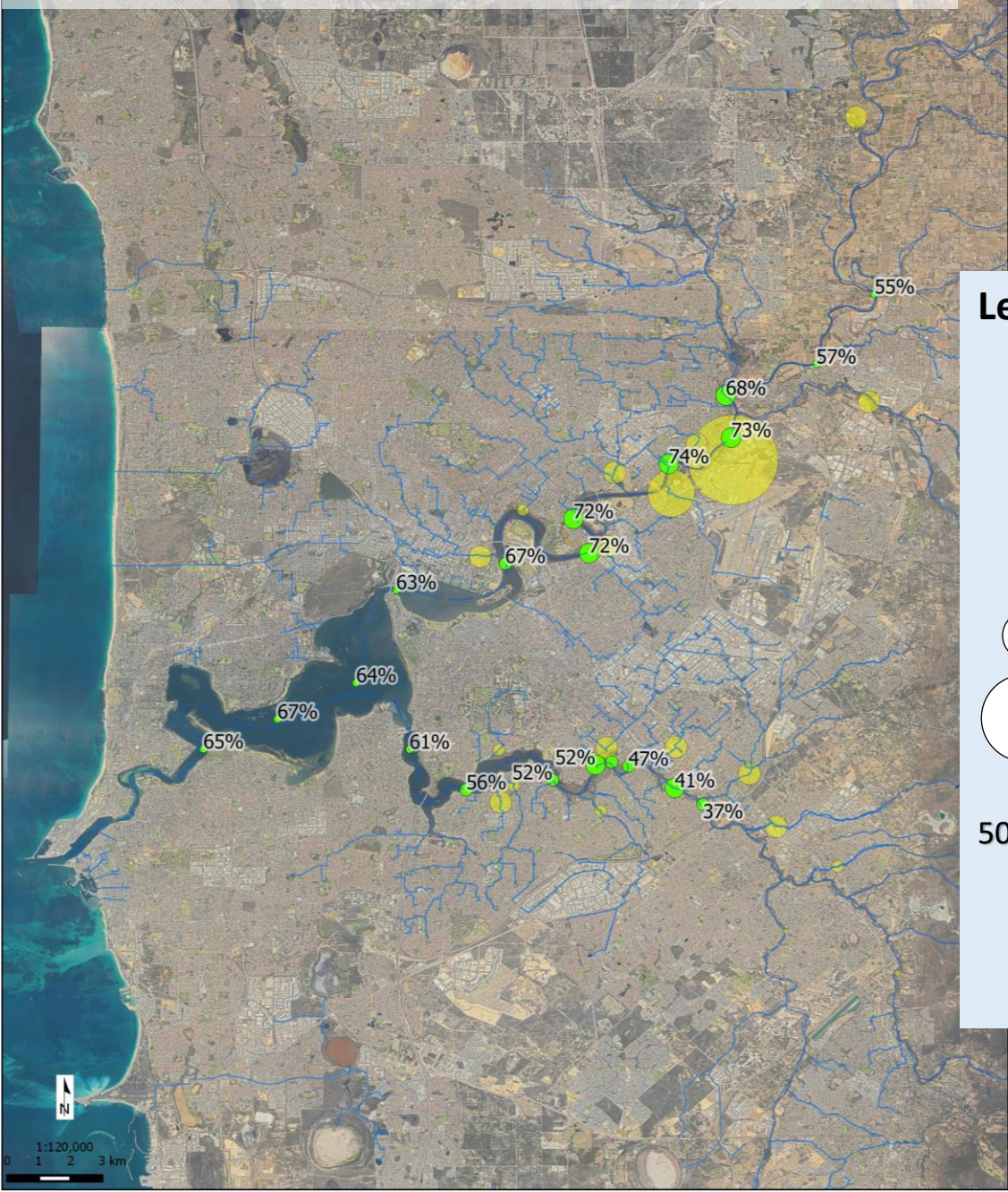


Department of **Biodiversity,  
Conservation and Attractions**





# Estuary and catchment links – Summer

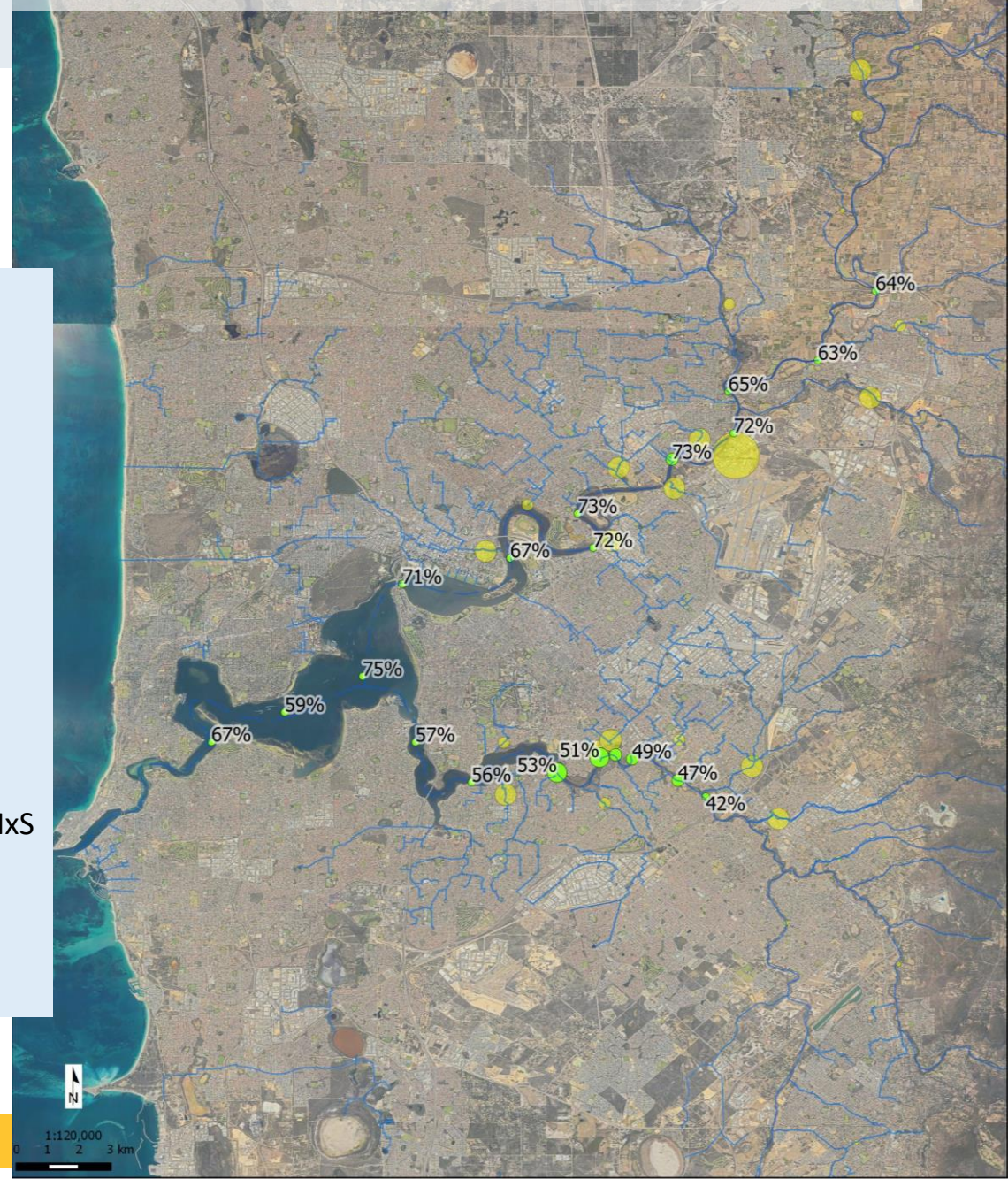


**Legend**

- 0-0.05 µg/L
- 0.05-0.1 µg/L
- 0.1-1.0 µg/L
- 1.0-5.0 µg/L
- >5 µg/L

50% - % of PFOS+PFHxS to total PFAS

# Estuary and catchment links – Winter



**Legend**

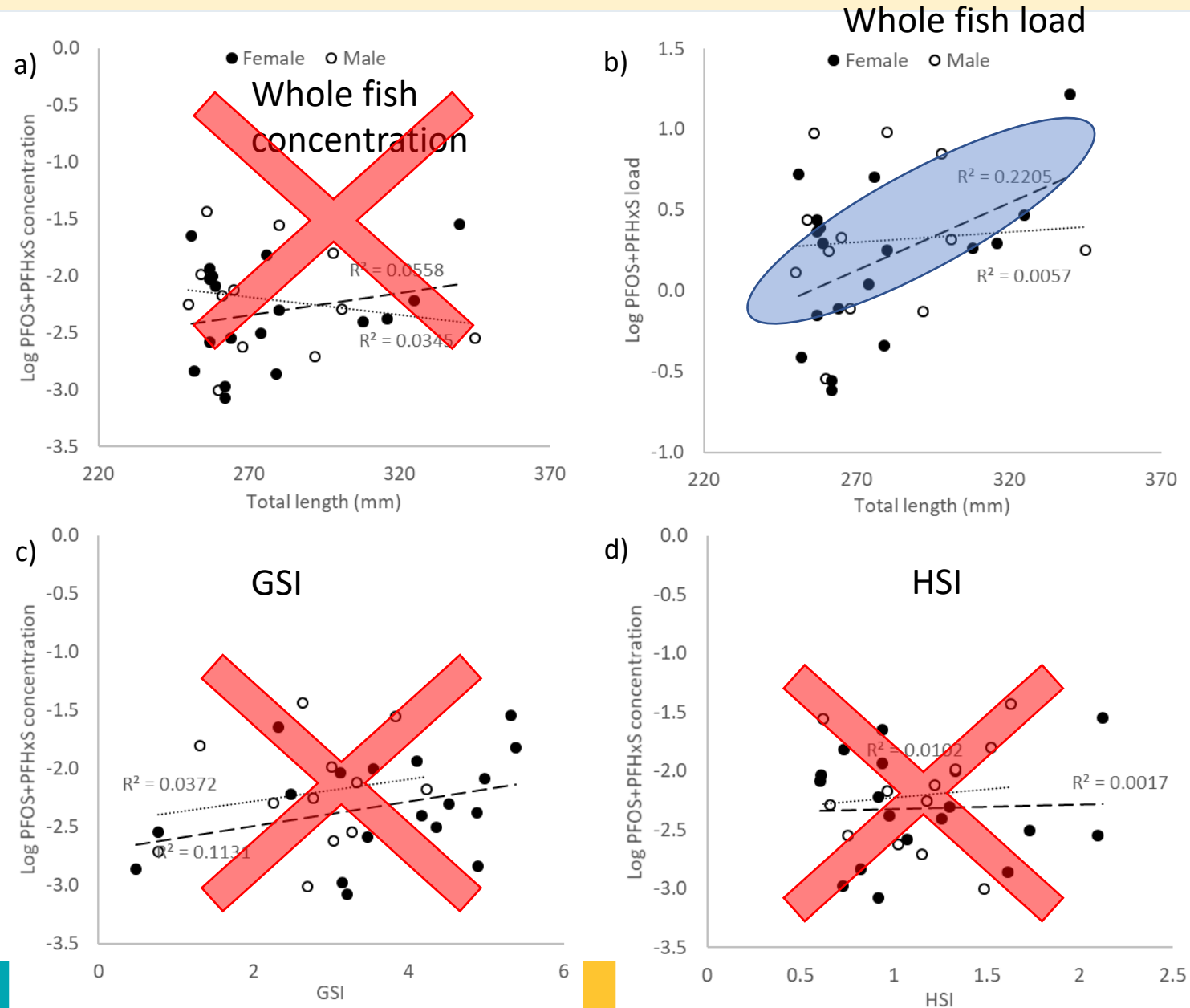
- 0-0.05 µg/L
- 0.05-0.1 µg/L
- 0.1-1.0 µg/L
- 1.0-5.0 µg/L
- >5 µg/L

50% - % of PFOS+PFHxS to total PFAS



# PFAS accumulation in *A. butcheri*?

- Expected PFAS concentration to increase with size
- No significant relationship between fish length and concentration, nor Hepatosomatic index or gonadosomatic index
- Significant positive trend for female body burden
- Bioaccumulation factor = 207 (mean whole fish PFOS = 7.5  $\mu\text{g}/\text{kg}$ , mean estuary water PFOS = 0.0361  $\mu\text{g}/\text{L}$ )





# PFAS accumulation in *P. armatus*

- No significant relationship between size and muscle or viscera concentration
- No significant relationship between size and muscle load or viscera load for females, but
- Significant positive relationship for male viscera load

