

How important are freshwater flows for Gulf estuaries? A study of the effect on fisheries & endangered species

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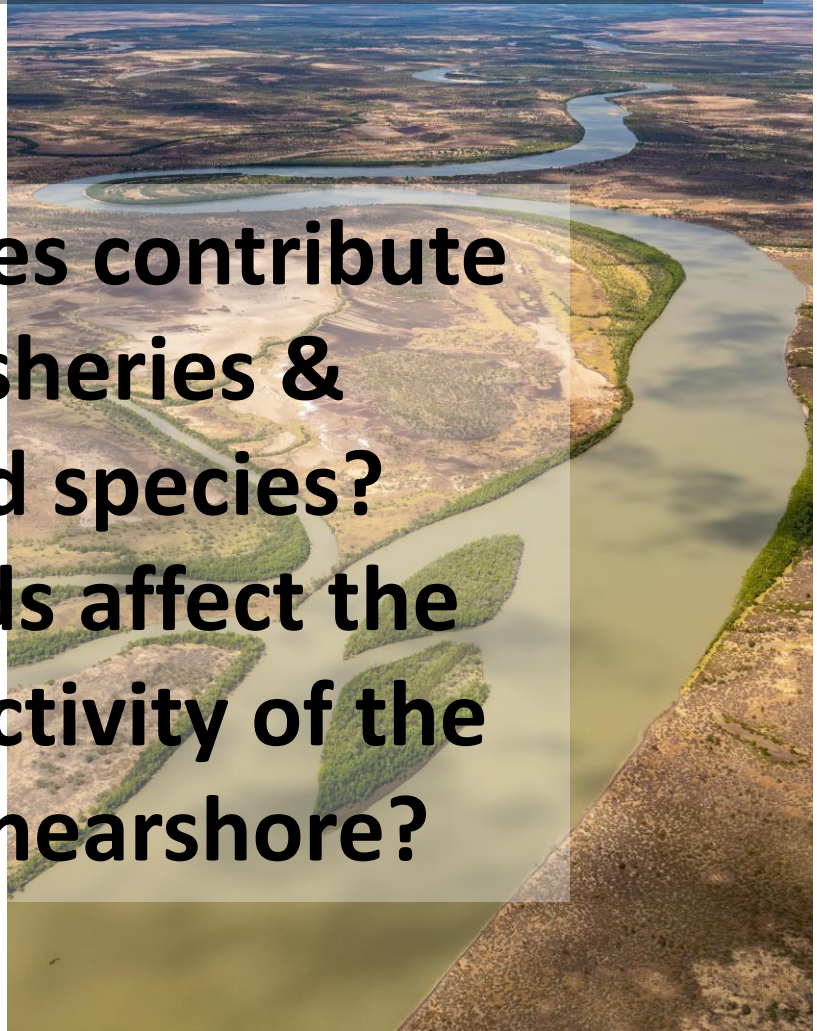

World-class research to support sustainable development in northern Australia

Acknowledgements



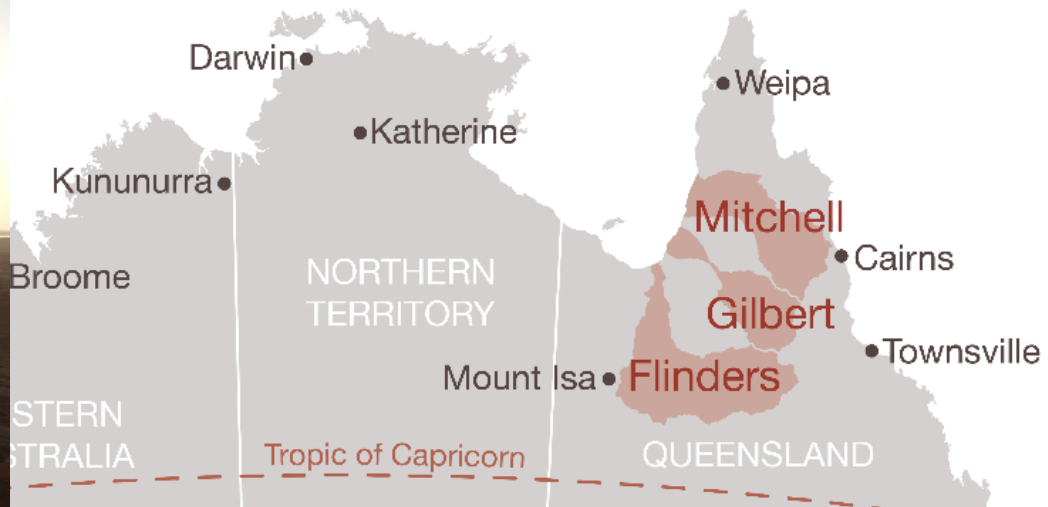
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Water development is occurring the Flinders, Gilbert and Mitchell Rivers



**Which estuaries contribute
most to fisheries &
endangered species?
How do floods affect the
overall productivity of the
estuaries & nearshore?**

Mitchell River



Gilbert River



Flinders River



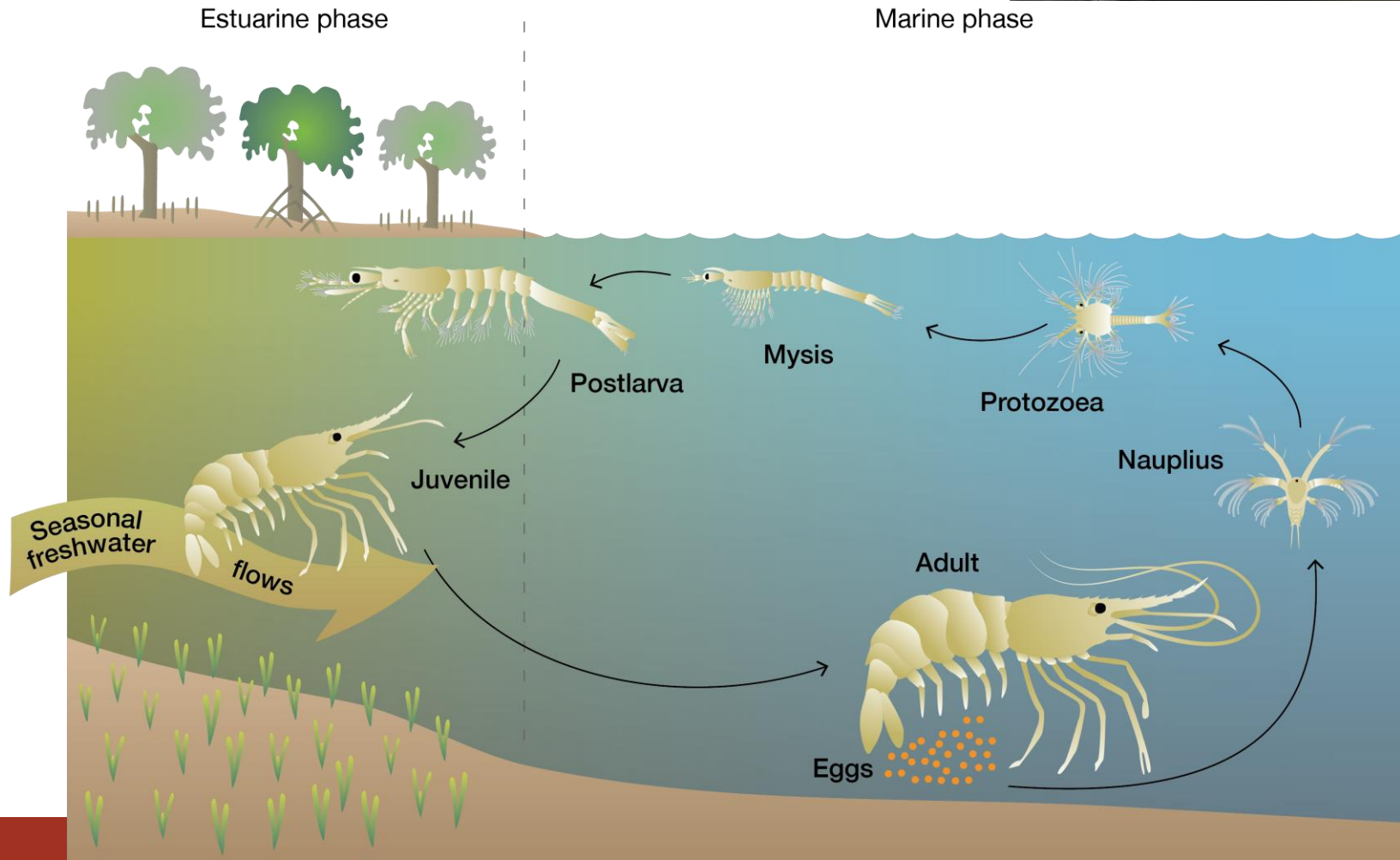




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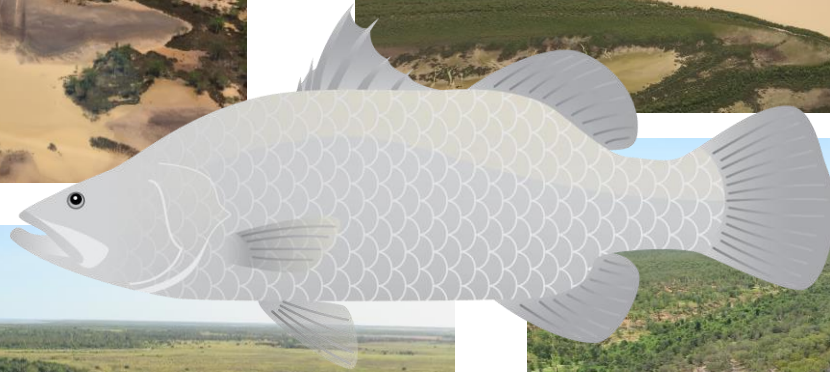
Banana prawn fishery is major industry in Gulf

\$217 million catch revenue in 2017 (AFMA)



Commercial barramundi fishery

\$15 million catch revenue in 2017 (Qld DAF)



Importance of southern Gulf for shorebirds

2nd most important shorebird site of International importance in Australia

50% (ca. 2,000,000) use Gulf from Oct-March

Endangered & critically endangered species



East-Asian Australasian Flyway

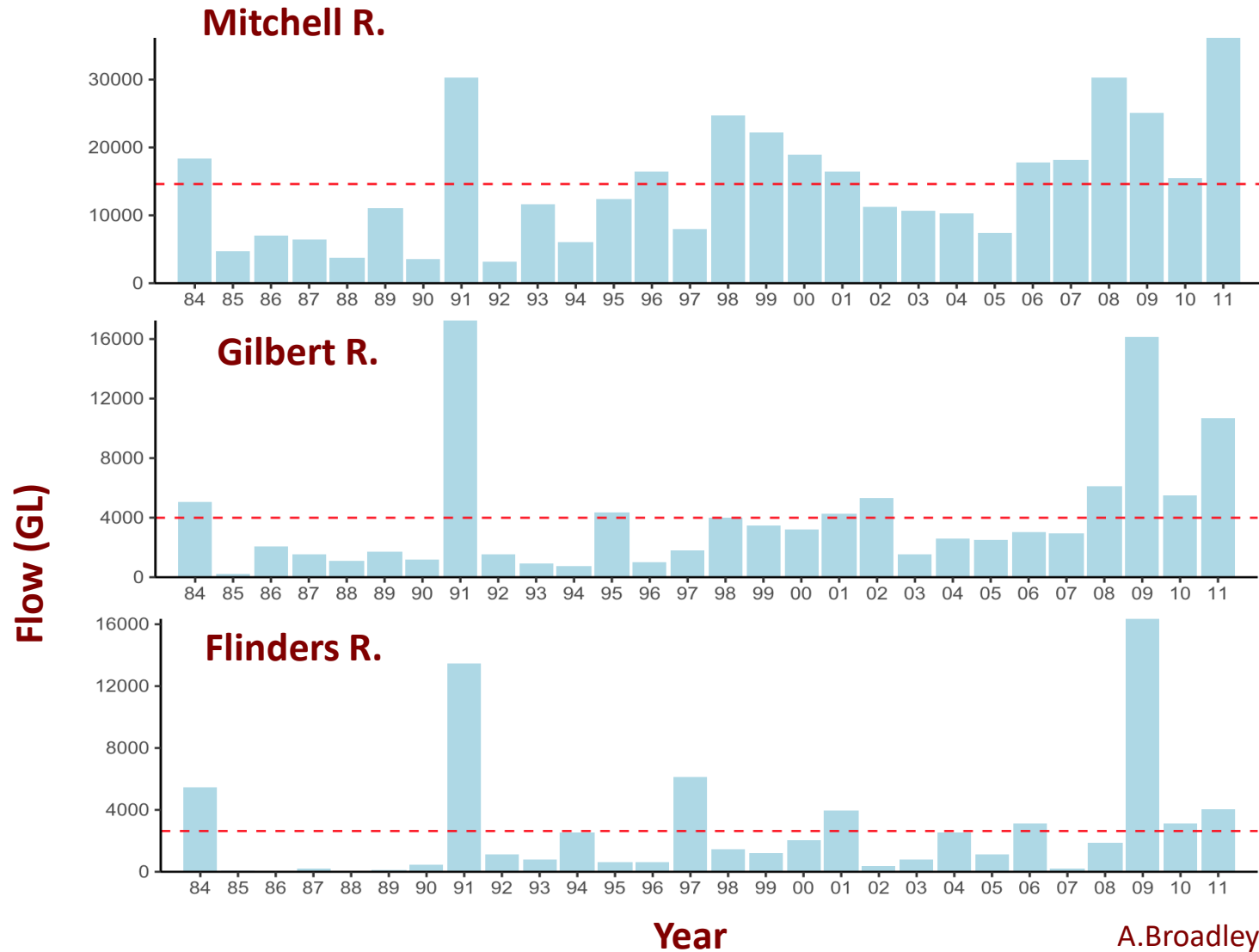


Bamford et al. 2008

How does flow affect food supply?



Annual flow



A. Broadley PhD student
CSIRO data

How productive are the estuaries?

All three estuaries had a similar concentration of algae in the water and on the mudflats, but Flinders was slightly higher

The wet season decreased the amount of algae



Food for prawns and birds



Bivalves



Crustaceans



Forams



Gastropods



Nematodes



Ostracods



Polychaetes



How does the abundance of benthic animals compare?

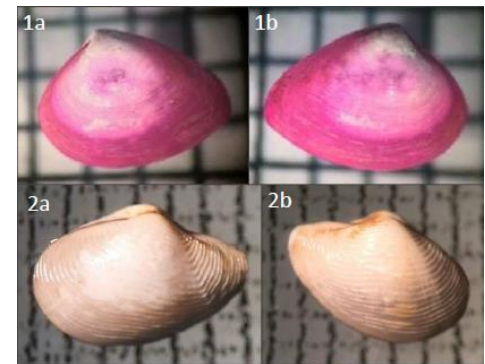


High abundances compared with other coastal areas in Australia

– polychaete worms dominate

No differences in numbers between estuaries

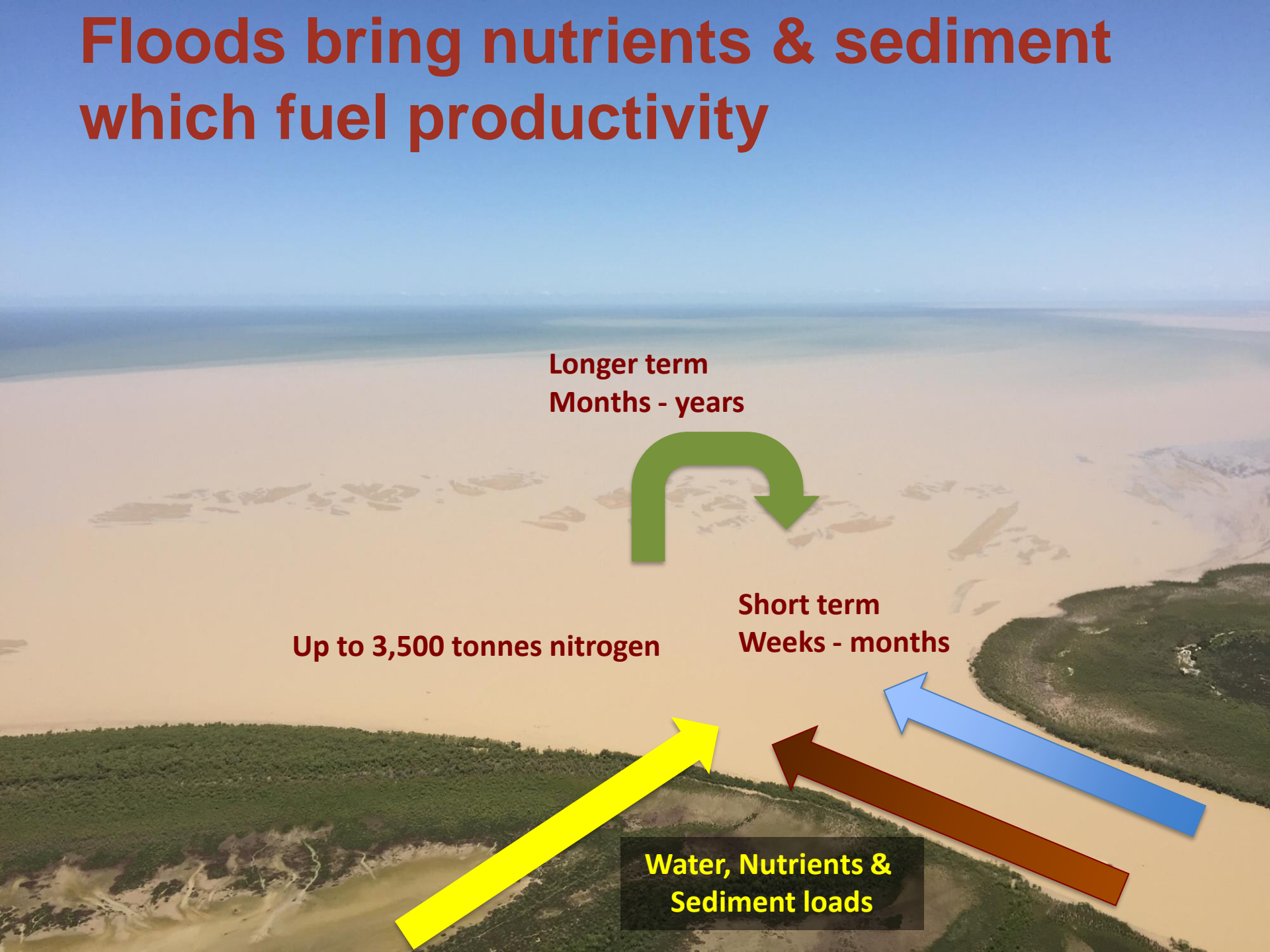
Numbers drop in floods



Nutrients critical for algae to grow



Floods bring nutrients & sediment which fuel productivity



Longer term
Months - years



Up to 3,500 tonnes nitrogen

Short term
Weeks - months

Water, Nutrients &
Sediment loads

Why are estuaries so productive?

Harsh environment, dry most of the year with little flow

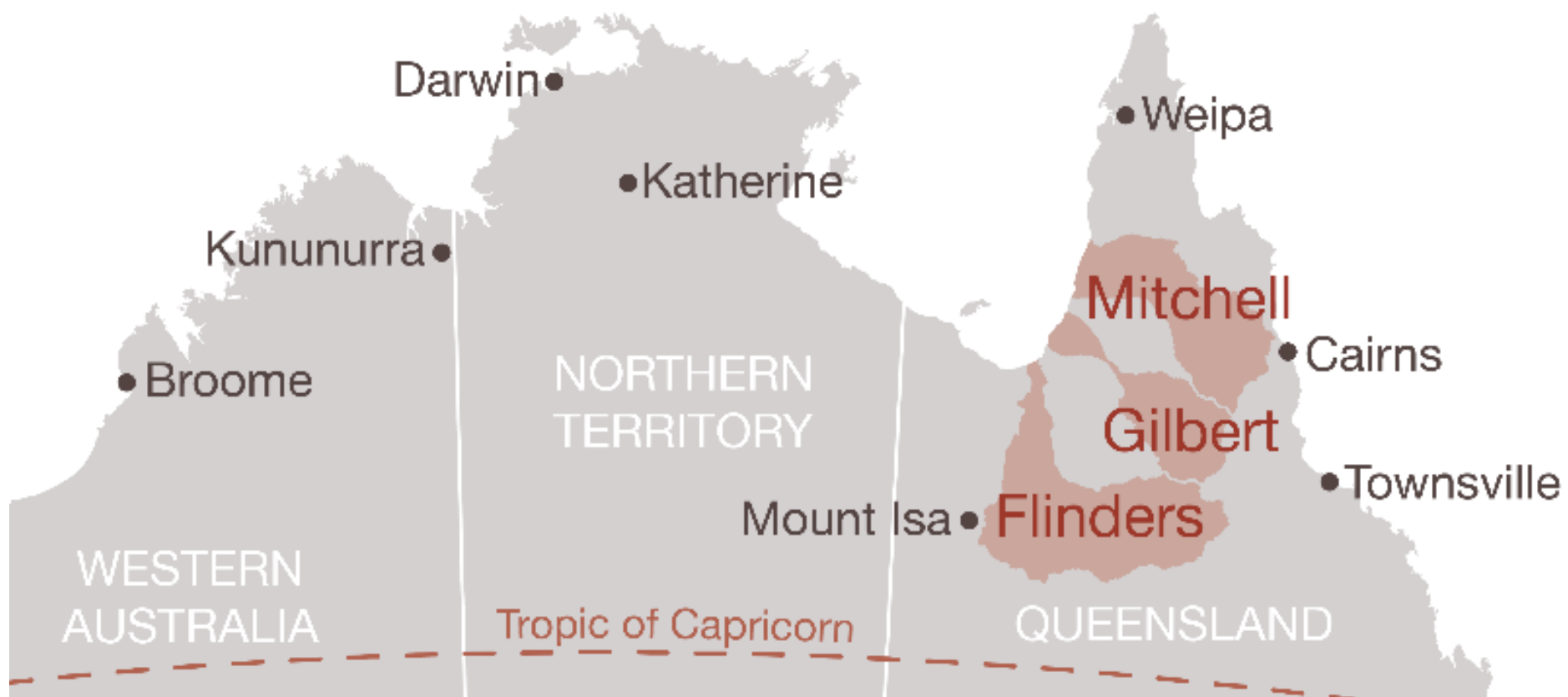
Lacks extensive mangrove areas

Coastal waters are low in nutrients

Rivers have massive catchments

Significant loads of sediment and nutrients enter estuaries and nearshore in floods

Saltflats are an important source of nutrients

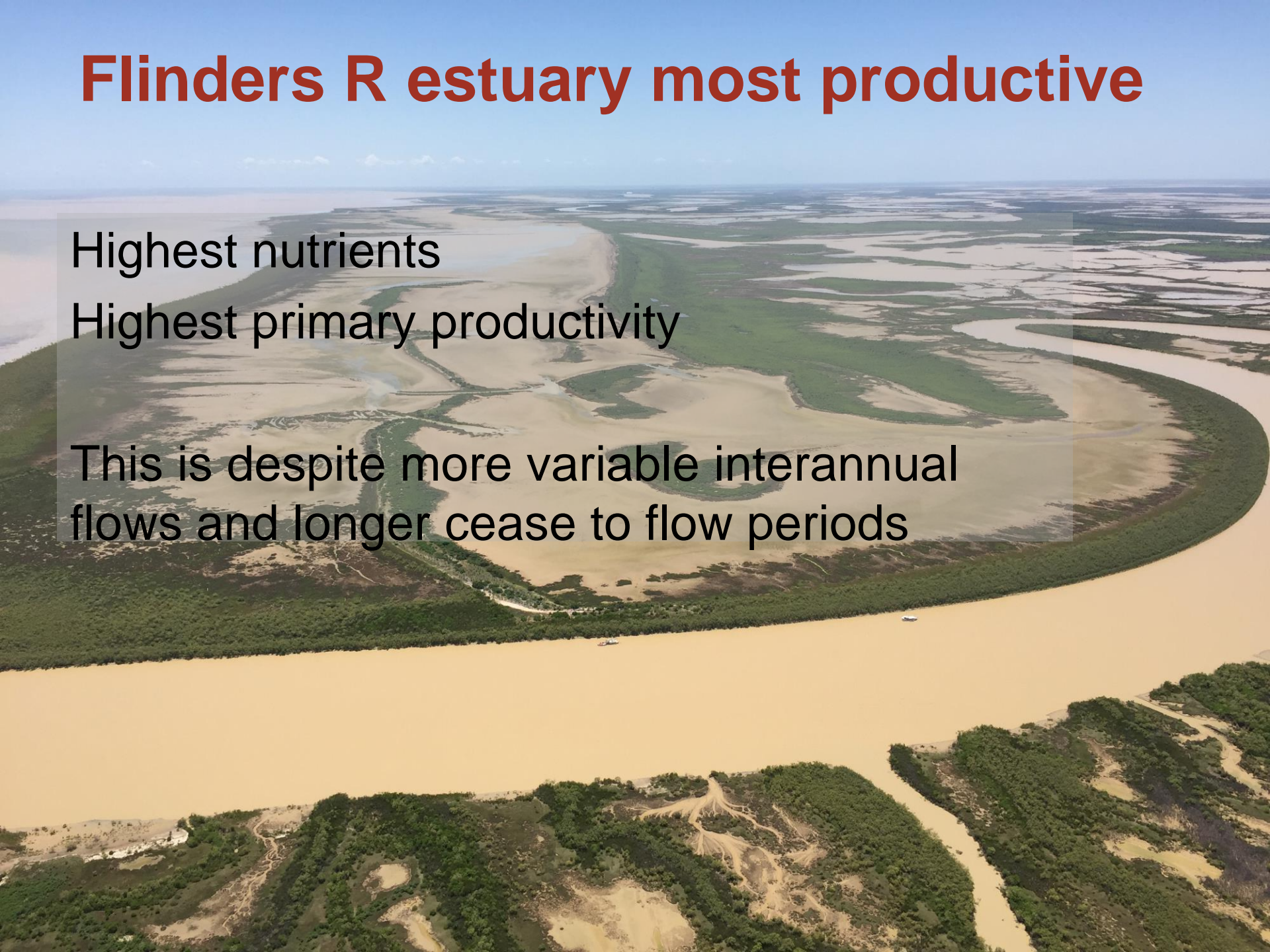


Flinders R estuary most productive

Highest nutrients

Highest primary productivity

This is despite more variable interannual flows and longer cease to flow periods



Gilbert & Mitchell R

Internationally significant (>1%)

Black-tailed Godwit

Nationally significant (>0.1%)

Black Tailed Godwit

Red Neck Stint

Bar-Tailed Godwit

Greater Sandplover

Lesser Sandplover

Sharpe-tailed Sandpiper

Whimbrel

Eastern Curlew



Flinders River estuary & surrounds



Internationally significant

Great Knot

Red Knot

Black tailed Godwit

Bar Tailed Godwit

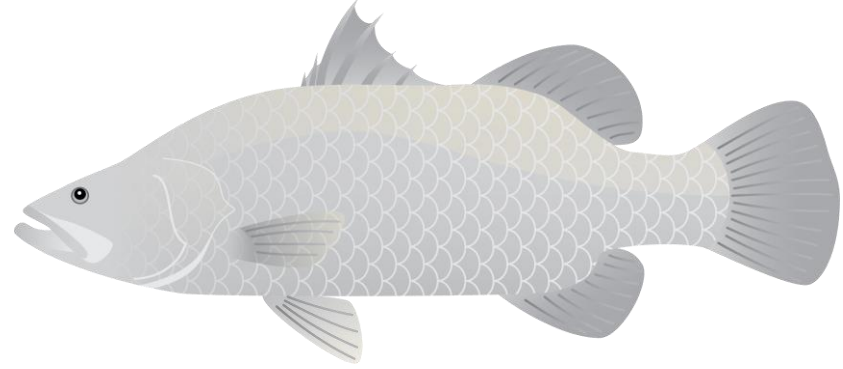
Curlew sandpiper

Eastern Curlew

Greater & Lesser Sand Plovers

Carpentaria Land Council Aboriginal Corporation

Barramundi findings



- Sequential pattern of river flow over multiple years is an important driver of barramundi population dynamics
- Therefore long term effects of extraction important
- Growth rates linked to flow. More extraction equals smaller fish
- All rivers important to barramundi stocks
- Economic modelling shows that water extraction will affect profitability of fishery

McMahon et al. 2020 NESP report
Robins et al. 2020 NESP report

What is the relative importance of each estuary for juvenile banana prawns??





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How many prawns in each estuary in Nov 2016?

Mitchell

1.96 million



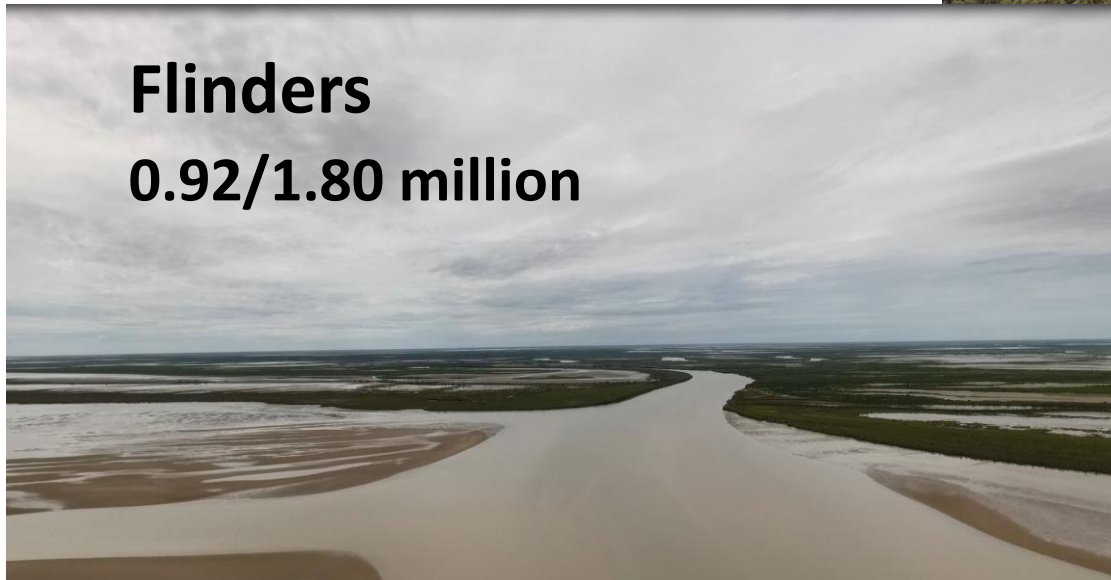
Gilbert

0.64 million



Flinders

0.92/1.80 million



How many prawns in each estuary in Nov 2017?

Mitchell

1.96 million

0.75 million



Gilbert

0.64 million

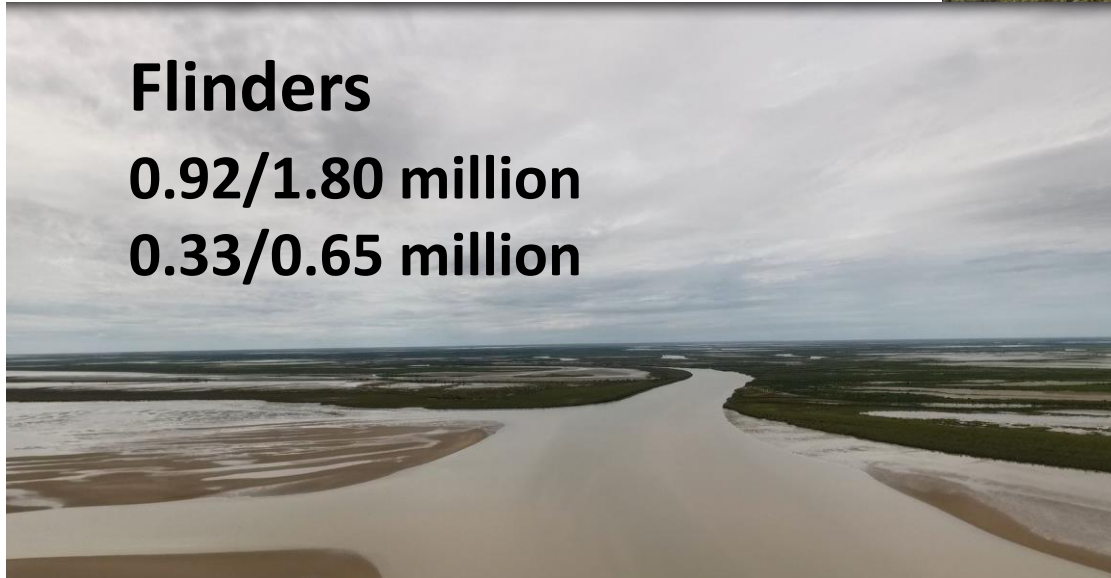
1.55 million



Flinders

0.92/1.80 million

0.33/0.65 million



New knowledge on long term benefits of floods

Short term effects of floods on prawn fishery

Interannual prawn numbers in estuaries varies substantially

No differences between estuaries overall

Long term

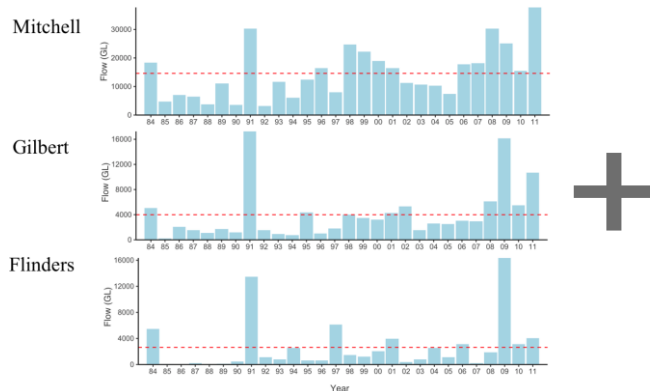
Nutrients and sediment from floods critical to fuel estuarine & coastal productivity

Water extraction will reduce nutrient & sediment loads, and in the longer term will affect the productivity

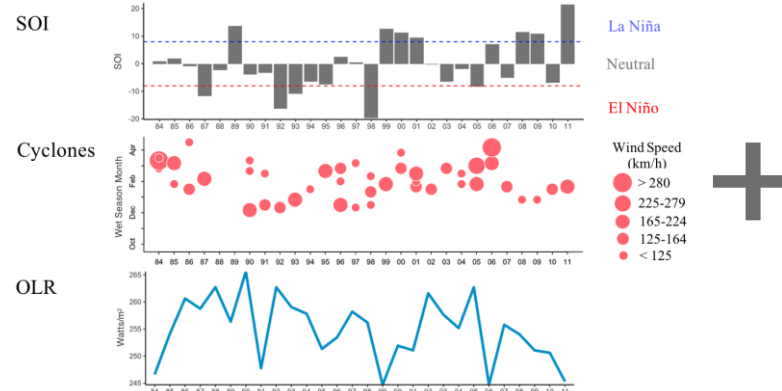
Modelled drivers of banana prawn catch



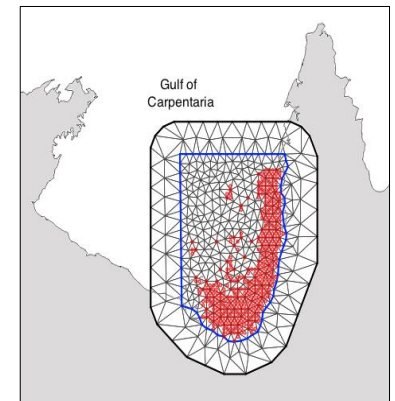
River flows



Climate indices



Spatial effect



Predicting impacts of extractions

Scenario	Flinders	Gilbert	Mitchell	1900- 2011	%	1984- 2011	%
1	low	low	low	25	22	5	18
2	low	low	medium	11	10	4	14
3	high	high	high	10	9	3	11
4	low	medium	high	7	6	3	11
5	medium	medium	medium	13	12	2	7
6	low	medium	low	6	5	2	7
7	medium	high	high	6	5	2	7
8	medium	medium	high	5	4	2	7
				83	74	23	85

Extraction scenarios modelled

Impact of three extraction scenarios on banana prawn catch were modelled:

Scenario A: Granted entitlements

Scenario B: Planned allocations + Granted entitlements

Scenario C: Mitchell in-stream dams + Planned allocations + Granted entitlements

Predicted declines in catch: Scenario A

Granted entitlements

Flow pattern	Flinders		Gilbert		Mitchell		Decline in catch	
	Flow	Change in mean flow (GL)	Flow	Change in mean flow (GL)	Flow	Change in mean flow (GL)	%	Tonnes (CI 95%)
1	Low	540-334	Low	1,221-1,100	Low	4,975-4,955	4.9	52.2 (45.3-59.9)

Low-low-low
18% of the time

Broadley, A., Stewart-Koster, B., Kenyon, R.A., Burford, M.A., Brown, C.J. 2020. *Ecosphere*, 11, e03194

Predicted declines in catch: Scenario B

Planned allocations + Granted entitlements

Flow pattern	Flinders		Gilbert		Mitchell		Decline in catch	
	Flow	Change in mean flow (GL)	Flow	Change in mean flow (GL)	Flow	Change in mean flow (GL)	%	Tonnes (CI 95%)
1	Low	540-274	Low	1,221-732	Low	4,975-4,905	17.3	184.5 (161.7-209.9)

Predicted declines in catch: Scenario C

Mitchell dams + Planned allocations + Granted Entitlements

Flow pattern	Flinders		Gilbert		Mitchell		Decline in catch	
	Flow	Change in mean flow (GL)	Flow	Change in mean flow (GL)	Flow	Change in mean flow (GL)	%	Tonnes (CI 95%)
1	Low	540-274	Low	1,221-732	Low	4,975-1,550	53.2	568.5 (498.8-646.3)

Summary – modelling fishery effects

- Years of low flow in all three rivers lead to greatest impact on catch
- Highlights importance of multiple rivers to support fishery
- Key knowledge gap on actual end of system flows (and limited gauging throughout these rivers)



Late dry season

Hot conditions, estuaries increasingly hypersaline, no nutrients from catchment

Sandflats dominated by bivalves, mudflats dominated by polychaete worms

Postlarval prawns entering estuaries & feeding

Barramundi feeding in estuaries & rivers

Migratory birds arriving & feeding, some continuing south

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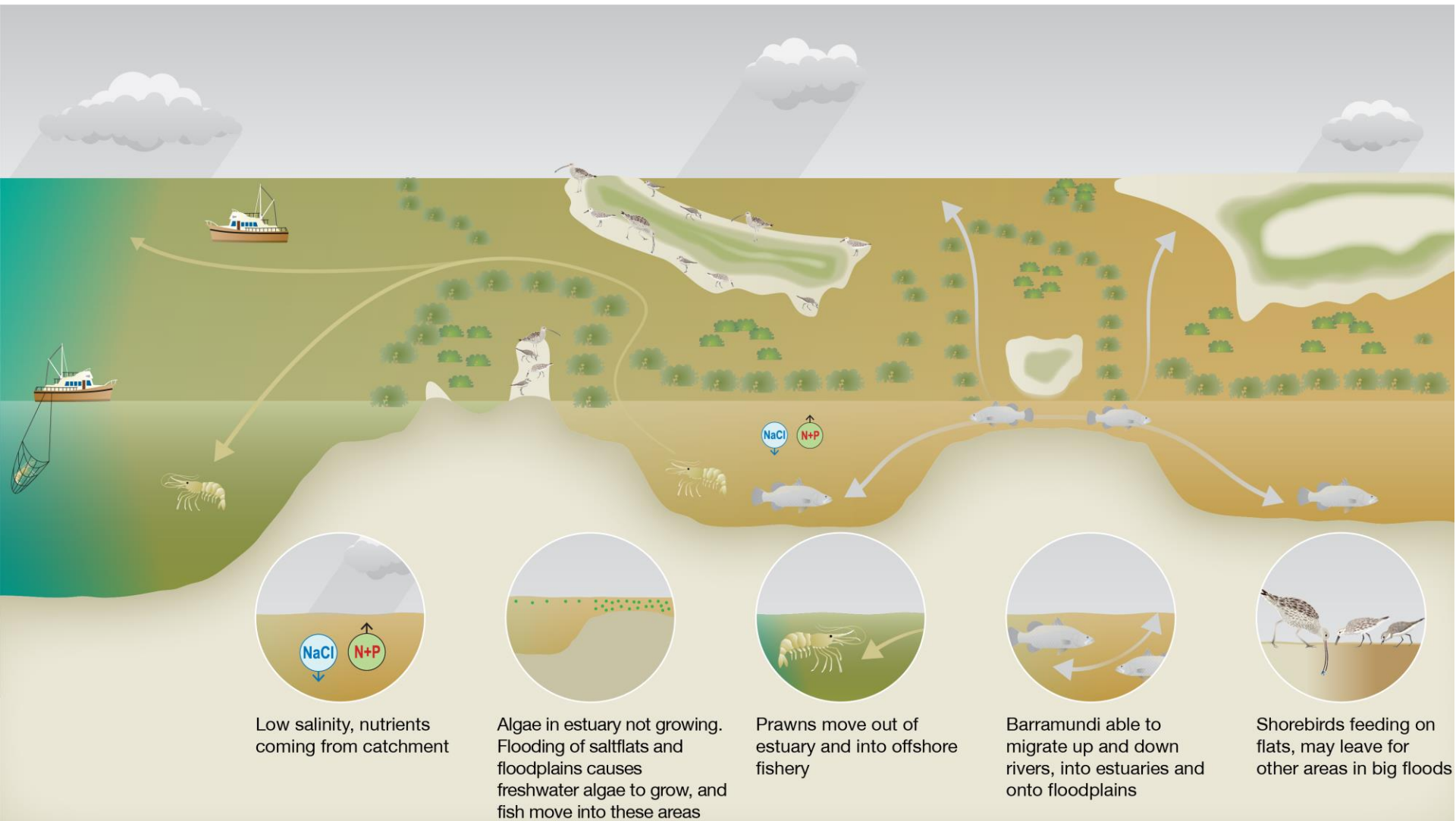
A circular diagram representing a landscape. The top half is light blue with a yellow sun in the upper right. The bottom half is green. In the center of the green area, there are two circles. The left circle is blue with the text 'NaCl' and a blue arrow pointing upwards. The right circle is green with the text 'N+P' and a black arrow pointing downwards.



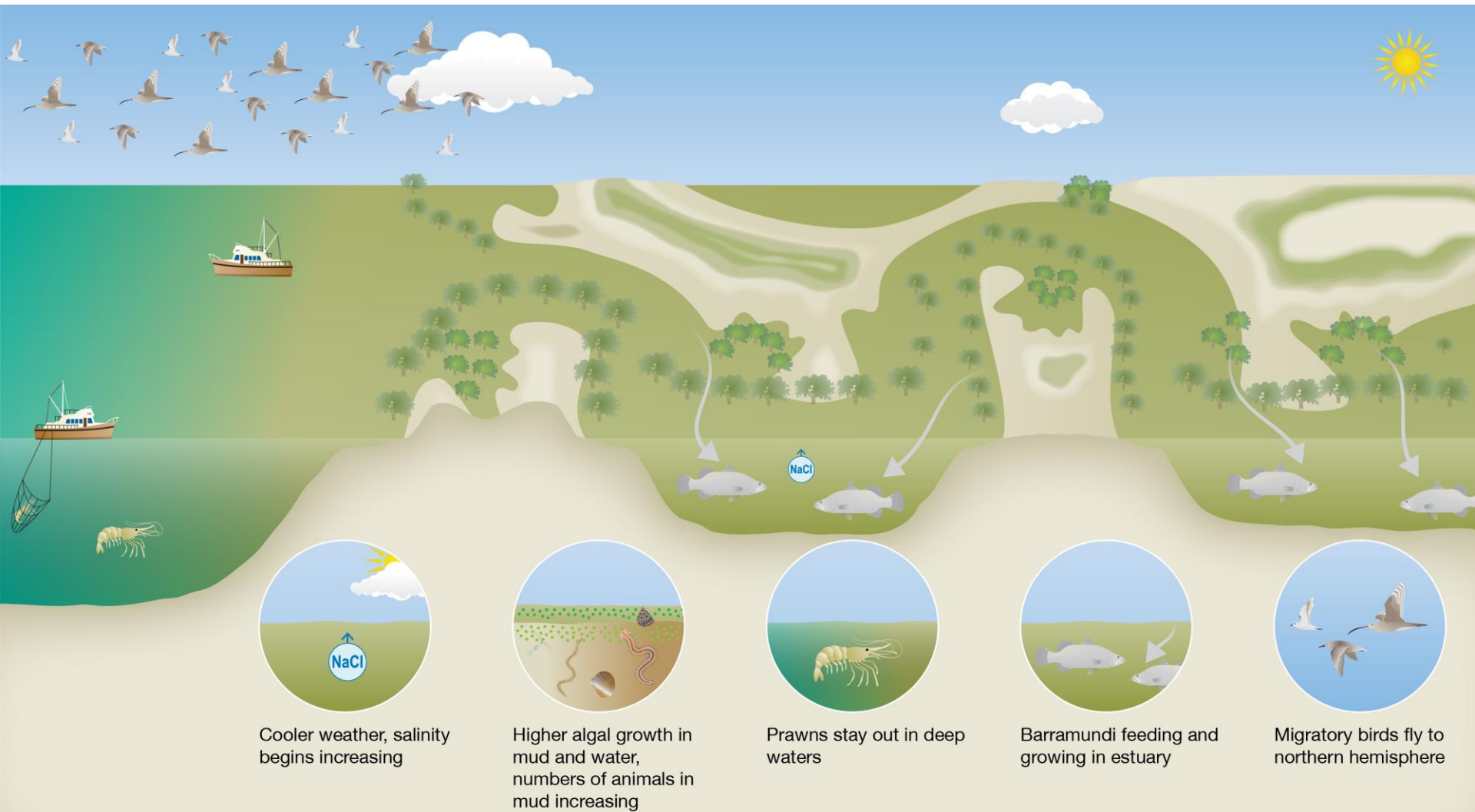
A circular illustration showing two fish swimming in a green body of water under a light blue sky. The fish are depicted in a simple, stylized manner.

A circular graphic with a light blue background. Inside the circle, three white birds with long necks and wings are flying in a circular pattern. One bird is at the top left, one at the top right, and one at the bottom center.

Wet season



Post wet season





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Queensland
Government



www.nespnorthern.edu.au

Carpentaria Land Council Aboriginal Corporation – Flinders shorebird counts

January 2019

15,090

March 2019

2513

September 2019

12,591

April 2020

1,130*

***COVID-19 restrictions**