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Pilbara Marine Conservation Partnership

Fish, Behaviour and Connectivity in the Pilbara

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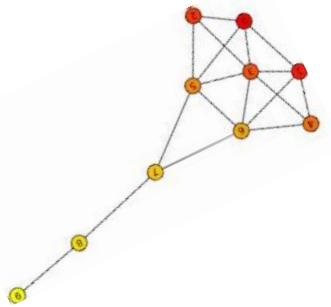
Background

"Connectivity links the fates of distant reefs"



Important Applied Questions

- Contributions of marine reserves to non-reserve habitat?
- Dependencies of marine reserves on non-reserve habitat?

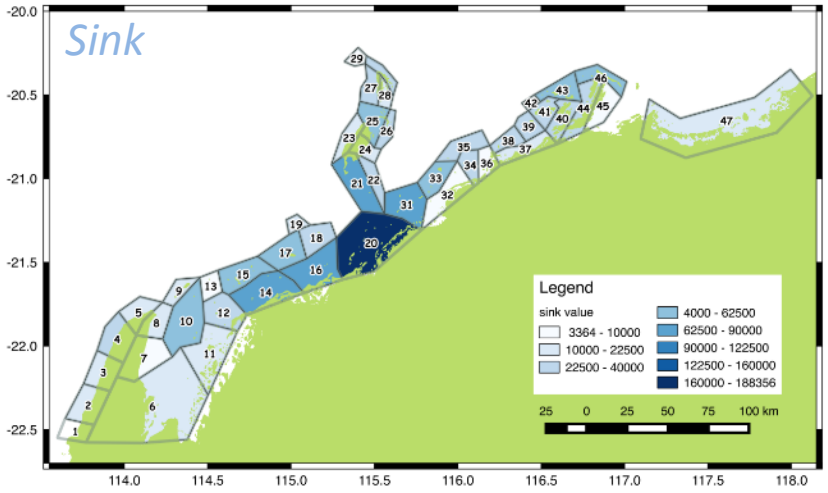
Experimental Framework | Modelling Connectivity

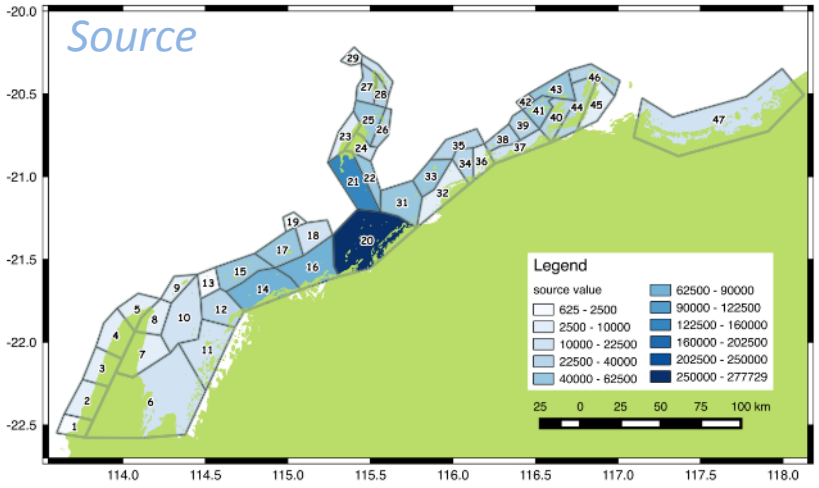
- Particle tracking simulations within a custom 1km^2 hydrodynamic model
- Coral – habitat forming, simple larval life-history (e.g. *Acropora millepora*)
- **Fish – harvested, complex larval life-history (e.g. *Lethrinus nebulosus*)**

Connectivity in Corals

What we have learnt

- Significant spatial and temporal variation in larval supply (~60%).
- Transport predominantly southwards.
- Mean self-seeding 22% (range 99% to < 1%).
- The 5 most important sources were outside existing marine parks.
- Marine parks contained regions with high retention.





Feng *et al* . 2016 Ocean circulation drives variation in coral recruitment and connectivity on the North West Shelf of Australia. *Journal of Marine systems* **164**:1-12.

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Connectivity in Fish

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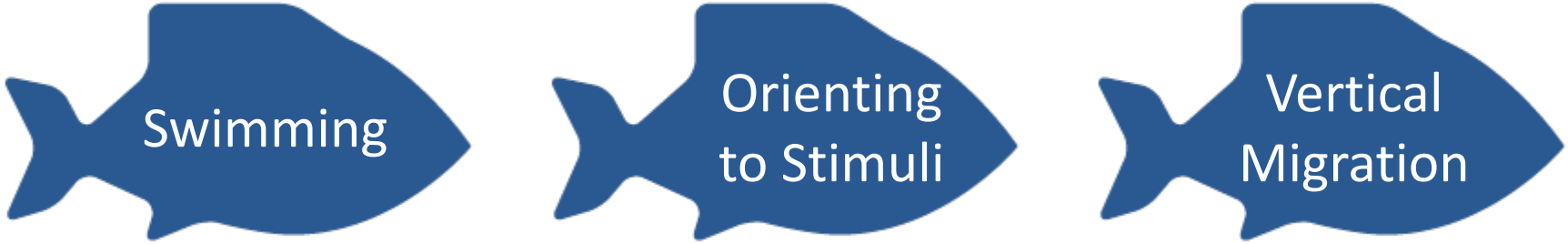
Fish are complicated



How does that influence connectivity?

Effects of Behaviour

"Behaviour can influence, if not control, dispersal trajectories"

Leis, 2007

Vol. 489: 43–59, 2013
doi: 10.3354/meps10432

MARINE ECOLOGY PROGRESS SERIES
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Published August 28

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Consequences of the life history traits of pelagic larvae on interisland connectivity during a changing climate

Matthew S. Kendall[1,*], Matthew Poti[1,2], Timothy T. Wynne[3], Brian P. Kinlan[1,2], Laurie B. Bauer[1,2]

Journal of Marine Research, 71, 317–350, 2013

Influence of larval behavior on transport and population connectivity in a realistic simulation of the California Current System

by Patrick T. Drake[1,2], Christopher A. Edwards[1], Steven G. Morgan[3,4] and Edward P. Dever[5]

But what about the Pilbara?

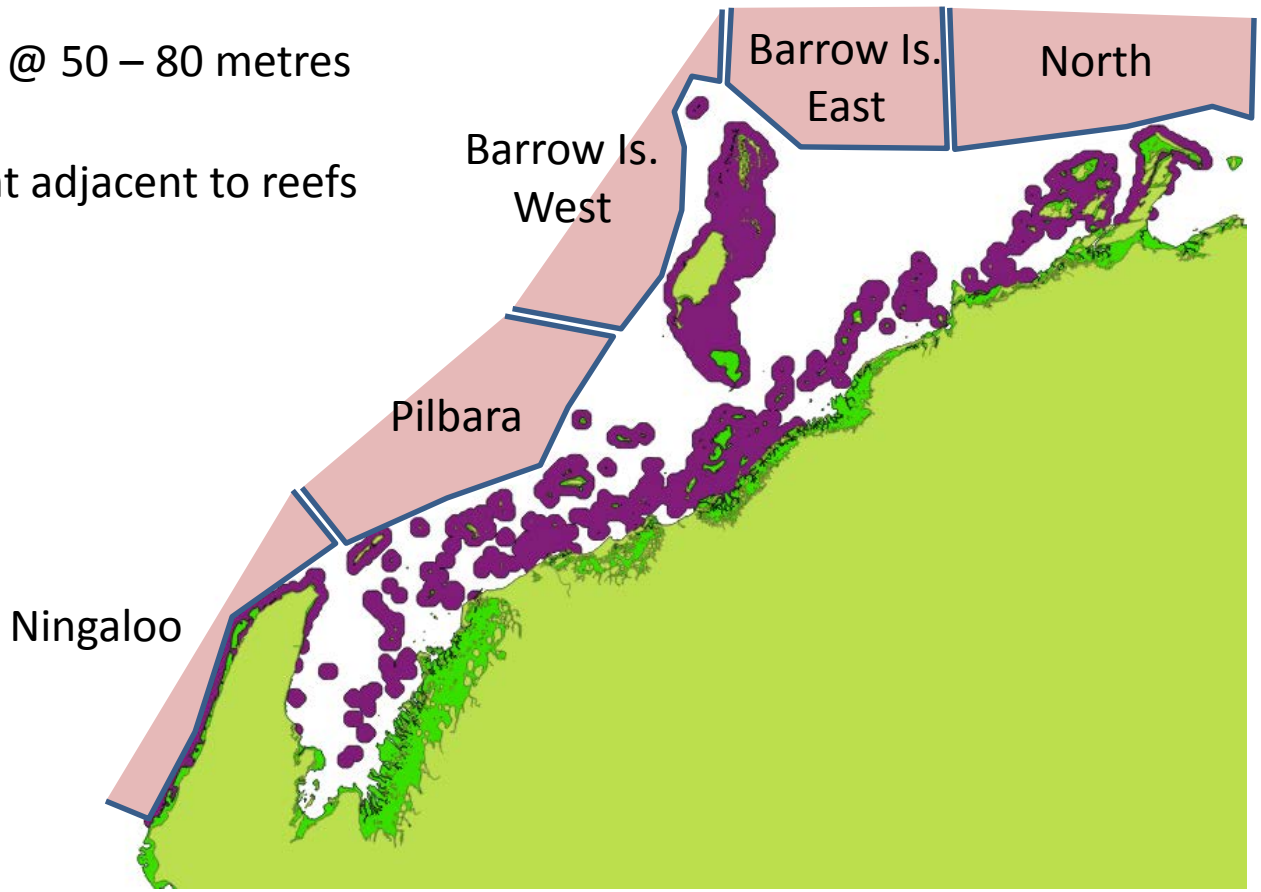
Connectivity in Fish

- *"Lethrinus nebulosus".*
- Spawn offshore at the surface.
- *c*. 35-40 days as eggs then larvae
- Recruit to seagrass beds and other habitat adjacent to coral reefs.

Fishes: Sources and Destinations

Spawning @ 50 – 80 metres

Settlement adjacent to reefs



Connectivity in Fish

- *"Lethrinus nebulosus".*
- Spawn offshore at the surface.
- *c*. 35-40 days as eggs then larvae
- Recruit to seagrass beds and other habitat adjacent to coral reefs.
- Three modelled scenarios:
  - "Passive",
  - "Vertical Migration",
  - "Swimming and Homing"

The behaviour of a larval fish

Vertical	N/A	Yes (shallow)	Yes (mid-depth)	Yes (deeper)
Stage	1. Egg	2. Early larva	3. Mid larva	4. Late larva
Swim	No	Weak	Moderate	Strong
Sense	N/A	Y	Y	Y
Time	0-5 days	6-10 days	11-20 days	21-40 days
Vertical	N/A	Yes (shallow)	Yes (mid-depth)	Yes (deeper)

Connectivity in Fish
The effects of larval behaviour

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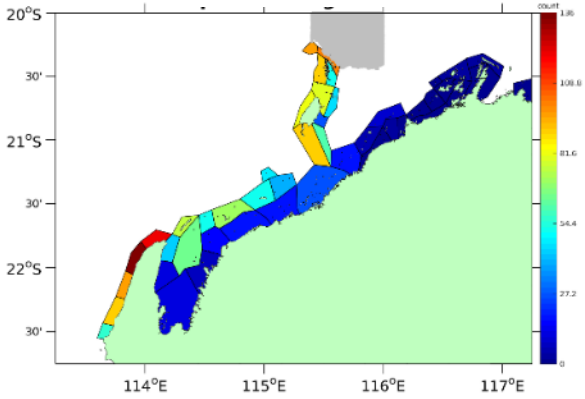
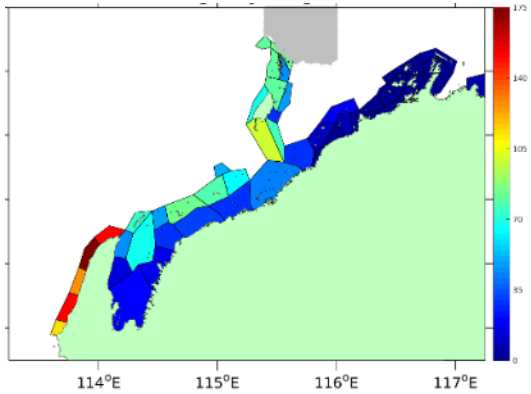
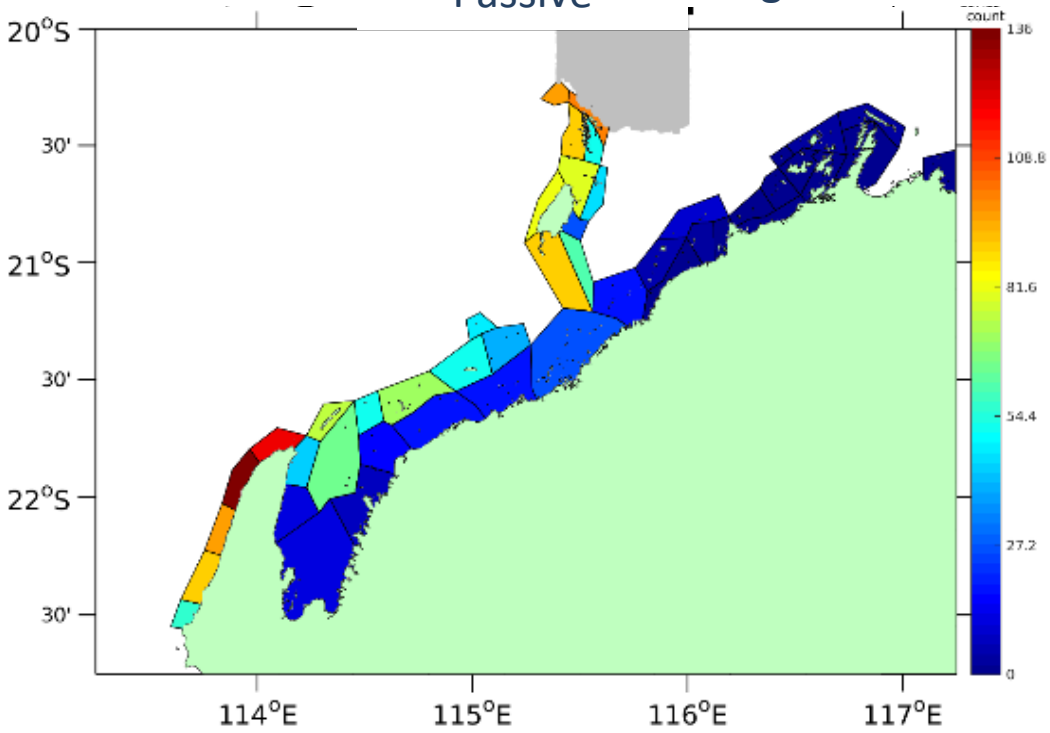
Passive



Vertical migration



S Passive ming



Connectivity in Fish
The effects of larval behaviour

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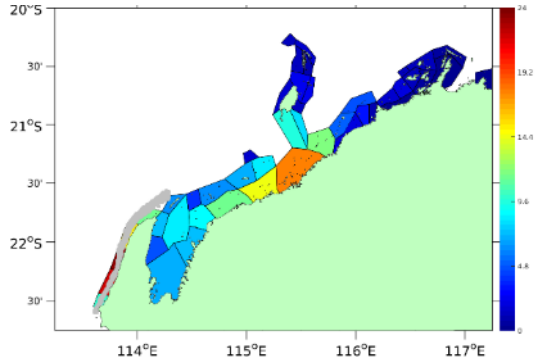
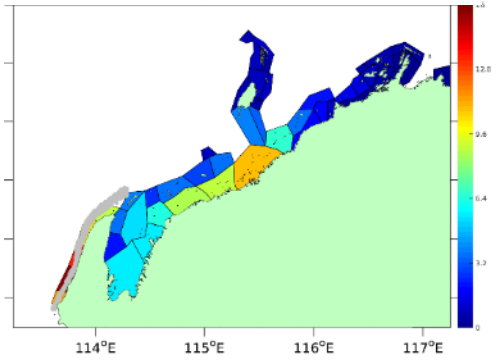
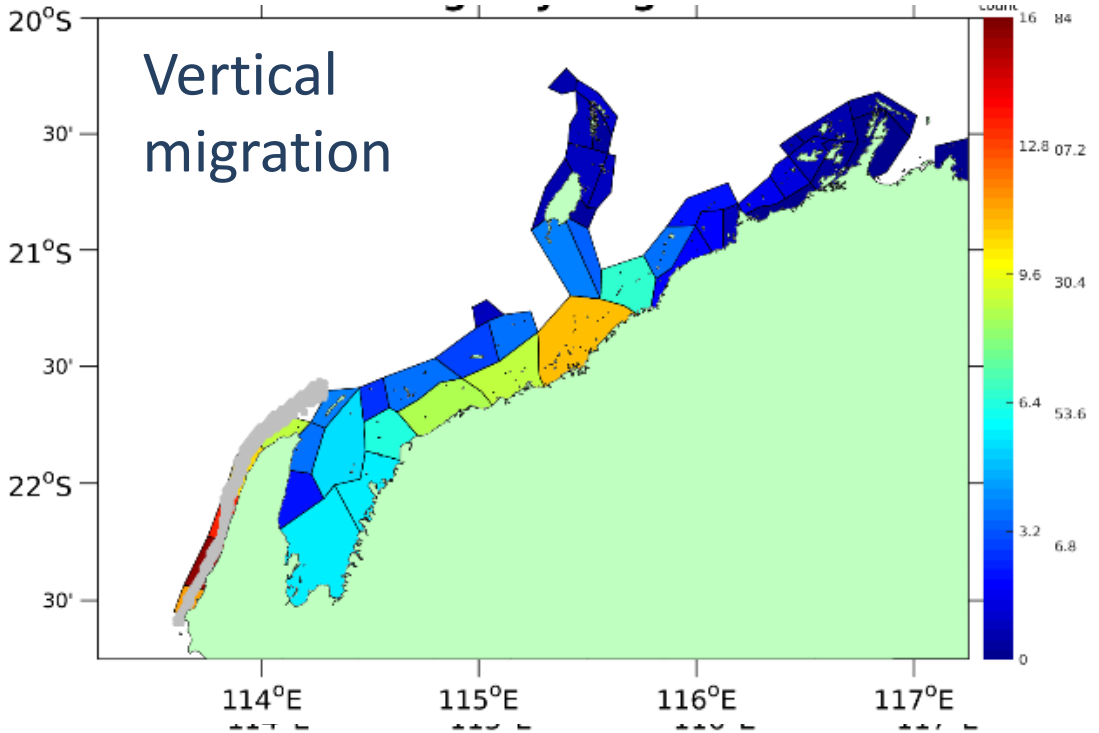
Passive



Vertical migration





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Visualising of the effects of behaviour

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Connectivity in Fish
Different spawning regions contribute to different nursery habitats

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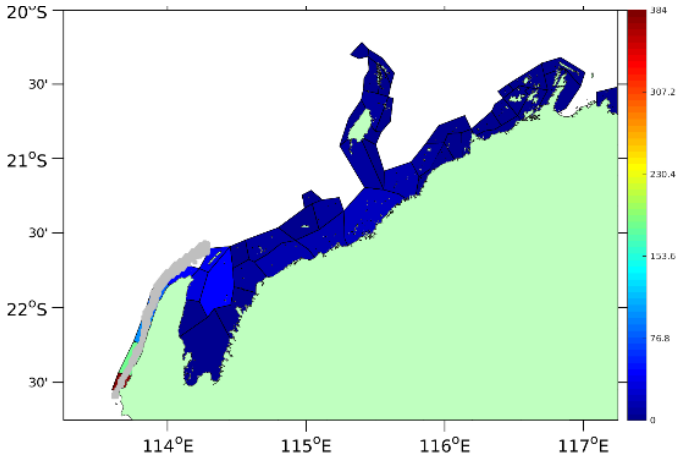

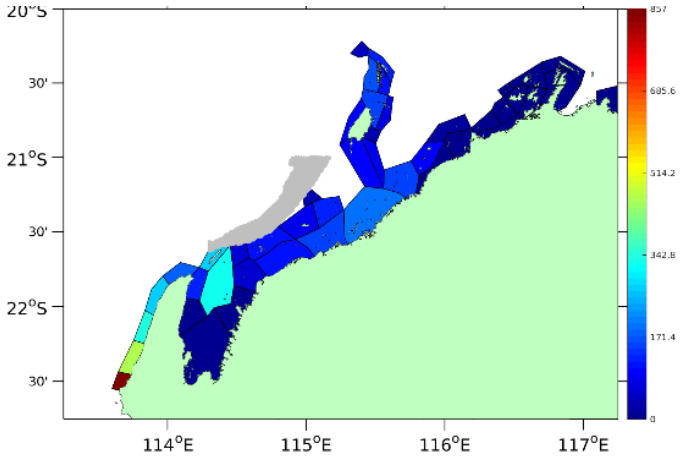

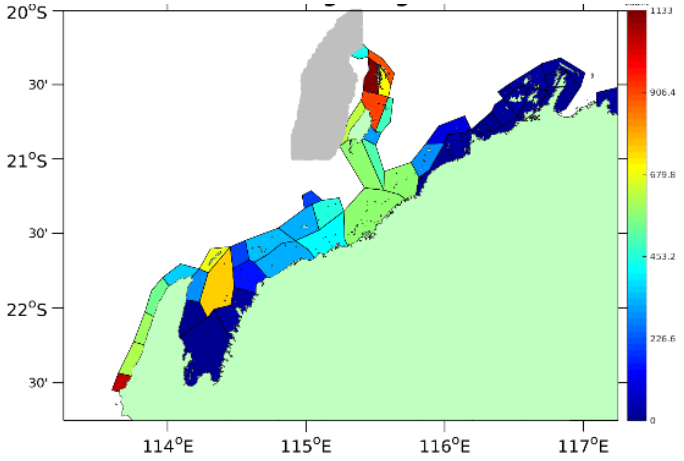

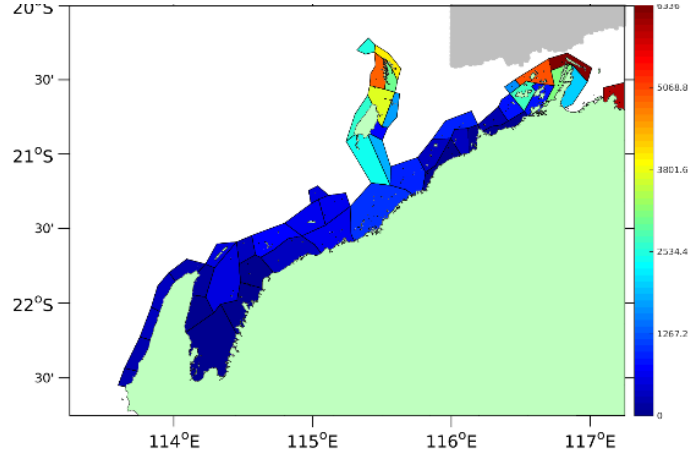

Take-home messages

- Behaviour has a profound effect on where and whether larvae are likely to settle
  - Increased settlement in absolute terms
  - Proportionally greater local recruitment

- Spawning sites differ in their contributions
  - In absolute terms
  - Spatially

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What next?

- Evaluate empirical evidence for spatial variation in levels of recruitment.
- Inter-annual variation in recruitment – how does it compare to corals?
- Network analyses – quantify the inter-dependencies of different regions.

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Acknowledgements

Gorgon Barrow Island
Net Conservation Benefits Fund
www.ncb.org.au