



National Environmental  
Research Program

MARINE BIODIVERSITY *hub*



Australian Government

Geoscience Australia



UTAS



Yellowfin tuna (*Thunnus albacares*). Photo credit: David Valencia

**Finding big fish in a big pond:**  
Continental-scale models of pelagic  
predator hotspots around Western Australia

Phil Bouchet, Jessica Meeuwig, Zhi Huang, Tom Letessier, Scott Nichol, Reg Watson

**AUGUST 2014**  
Update seminar



THE UNIVERSITY OF  
WESTERN AUSTRALIA

## Background

1. Background
2. Geoscience
3. Study objectives
4. Data analysis
5. Fish hotspots
6. Marine reserves
7. Take home

- Pelagic predators **face numerous threats and pressures**  
Overfishing, bycatch, targeted culls, pollution, competition for resources, ocean acidification, vessel traffic, etc.
- They are **important species**
- They are also **data-deficient**  
> 25% of all sharks and rays
- Opportunities for pelagic conservation **in national waters**  
Poor global MPA performance






Photo credit: National Geographic

## The role of geoscience

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**BIOLOGICAL  
REVIEWS**  
Biol. Rev. (2014), pp. 000–000.  
doi: 10.1111/brv.12130

Cambridge  
Philosophical Society

# Topographic determinants of mobile vertebrate predator hotspots: current knowledge and future directions

Phil J. Bouchet<sup>1\*</sup>, Jessica J. Meeuwig<sup>1,2</sup>, Chandra P. Salgado Kent<sup>3</sup>,  
Tom B. Letessier<sup>2</sup> and Curt K. Jenner<sup>4</sup>

<sup>1</sup>The UWA Oceans Institute, School of Animal Biology, The University of Western Australia, Crawley, Western Australia 6009, Australia  
<sup>2</sup>Centre for Marine Futures, The University of Western Australia, Crawley, Western Australia 6009, Australia  
<sup>3</sup>Centre for Marine Science and Technology, Curtin University, Perth, Western Australia 6845, Australia  
<sup>4</sup>Centre for Whale Research (WA) Inc., Fremantle, Western Australia 6959, Australia

## Aims and input data

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**Aim 1**   Location of **fish hotspots**

**Aim 2**   **Role of seabed topography** in driving continental-scale patterns of pelagic fish biomass

**Aim 3**   **Congruence** between hotspots and the network of marine reserves






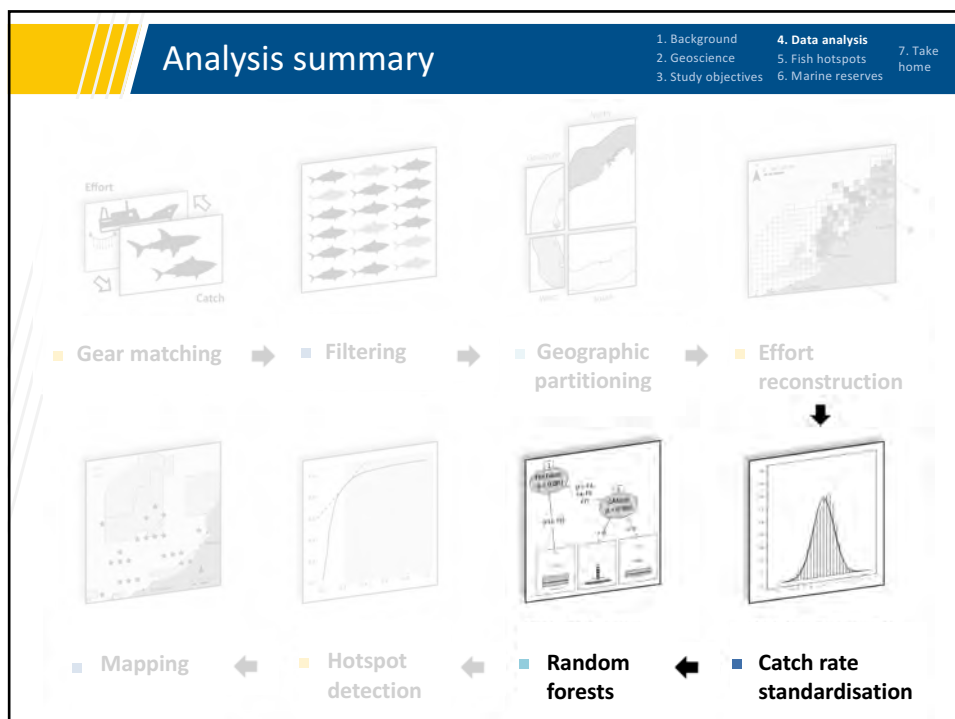
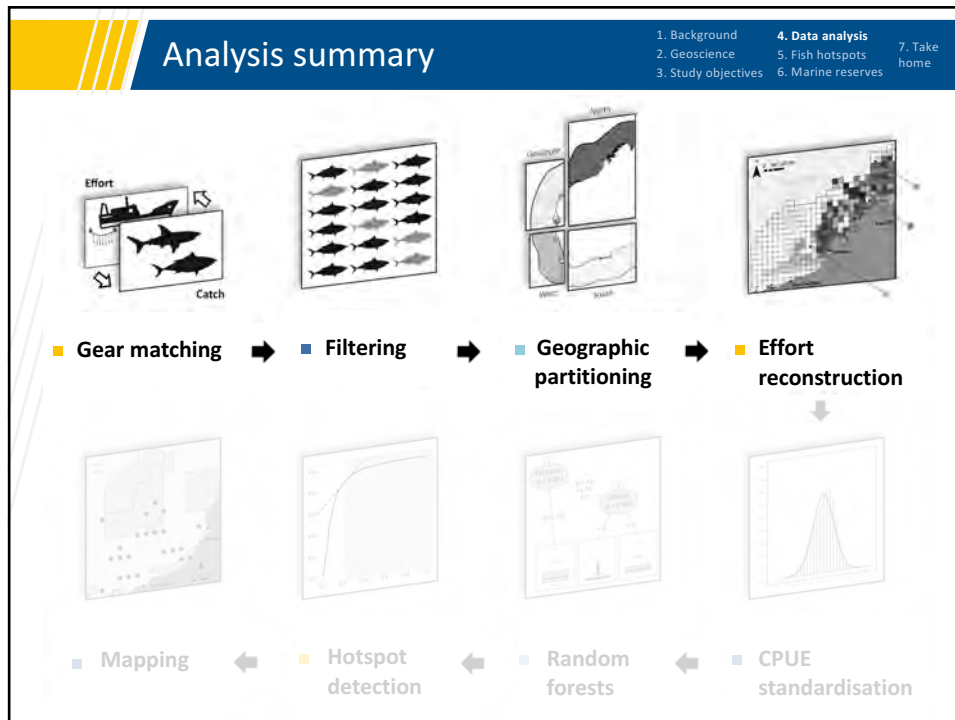
Photo credits: National Geographic

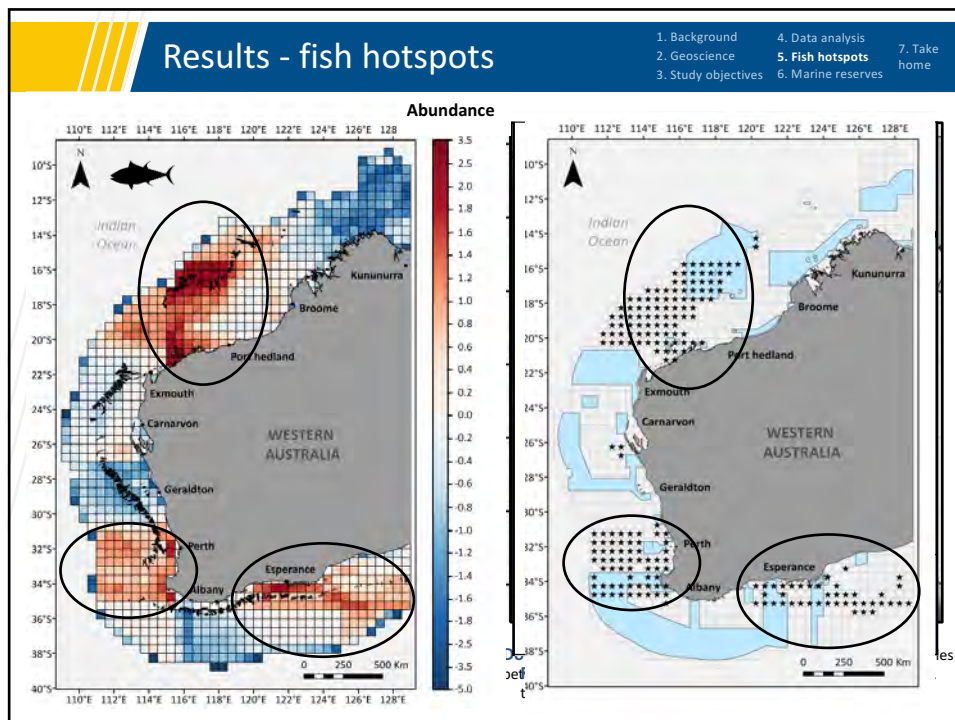
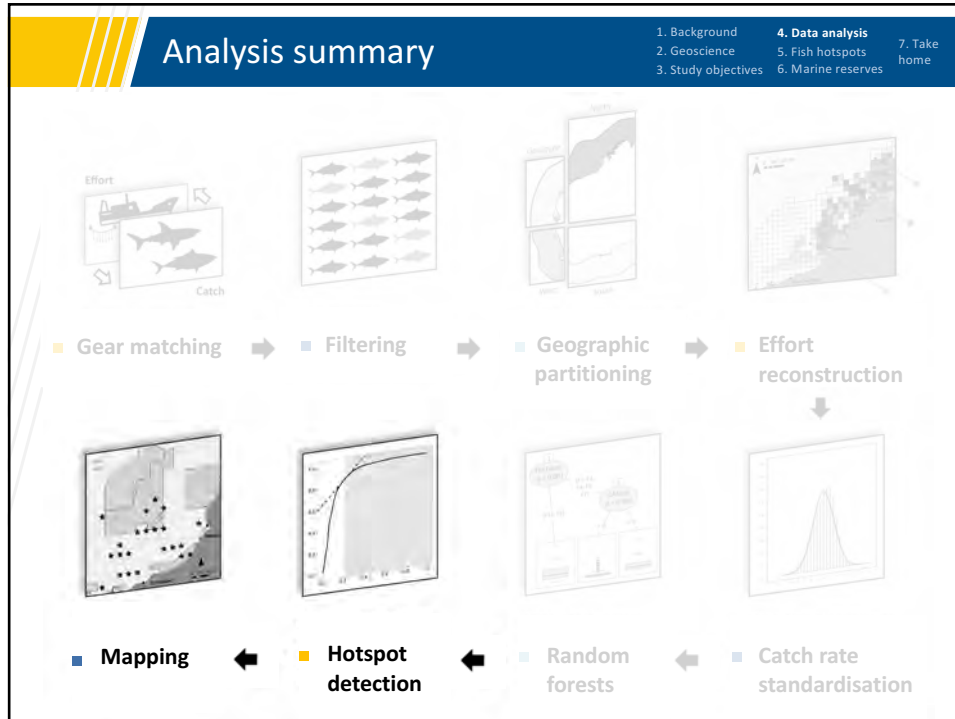


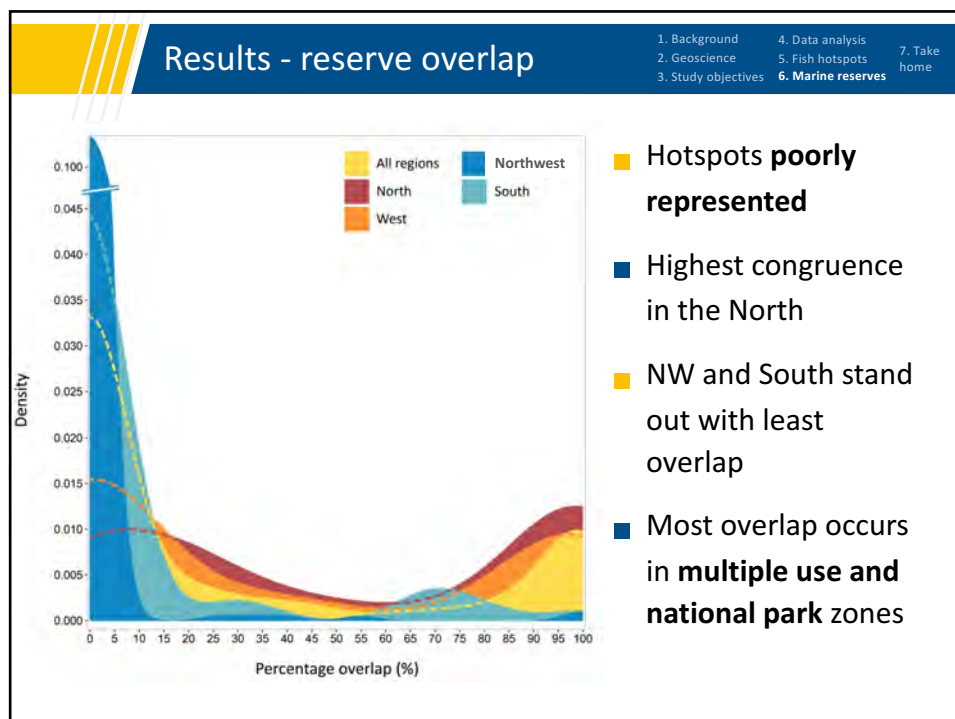
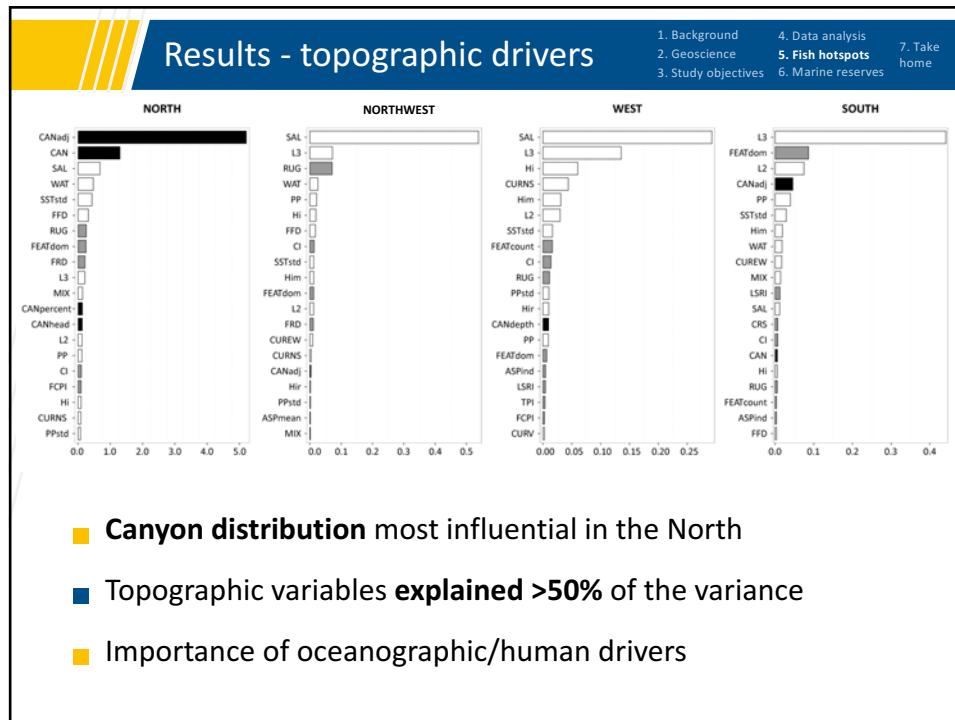
- 1950–2006
- $5.6 \times 10^6$  entries
- 111 species/taxa
- $3.35 \times 10^6 \text{ km}^2$
- $3.1 \times 10^6$  Tonnes

- 38 variables
- Geomorphometrics ( $n=20$ )
- Oceanographic ( $n=14$ )
- Anthropogenic ( $n=3$ )
- Geographic ( $n=1$ )









## Let's recap

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- Pelagic predators **are hard to study**
- Catch data are challenging **but can be informative**
- **Three broad-scale hotspots**
  - Hotspot 1: **North**, Barrow Is. -> Scott Reef
  - Hotspot 2: **Southwest**, Perth -> Cape Leeuwin
  - Hotspot 3: **South**, Bremer -> GA Bight
- The hotspot concept **is relevant**
- Hotspots are dynamic ... but relate **well to static features**

➡

Use topography as a **blueprint for spatial planning**






Photo credit: National Geographic

Photo credit: Centre for Marine Futures, UWA

## Acknowledgements

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**Prof. Reg Watson**  
Sea Around Us Project  
University of Tasmania





National Environmental Research Program





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*divine international Landrover*





**Scholarships**  
Scholarship for International Research Fees (SIRF)  
UWA Postgraduate Award (UPAIS)  
UWA Top-up scholarship





## Additional information



## Responding to a global crisis

- |                     |                    |              |
|---------------------|--------------------|--------------|
| 1. Background       | 4. Data analysis   | 7. Take home |
| 2. Geoscience       | 5. Fish hotspots   |              |
| 3. Study objectives | 6. Marine reserves |              |

### Predatory fishes

#### Giant Marine Reserve Created in South Pacific

Brian Handwerk  
for National Geographic News  
March 29, 2006

The Republic of Kiribati in the South Pacific has designated an enormous swath of Pacific atolls, coral reefs, and deep ocean to become one of the world's largest marine reserves.

The Phoenix Islands Protected Area safeguards some of the planet's most pristine coral reef ecosystems. The new marine park is the world's third largest, topped only by Australia's Great Barrier Reef and the Northwestern Hawaiian Islands.



Enlarge Photo

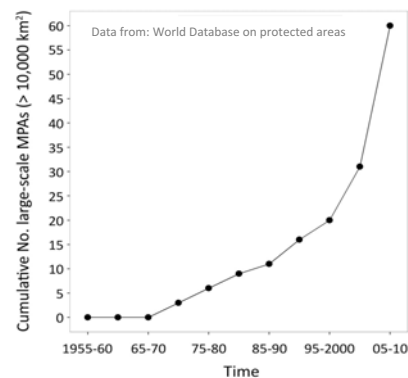
(Read a *National Geographic* magazine feature on the Northwestern Hawaiian Islands.)

The protected region spans some 73,800 square miles (184,700 square kilometers)—a stretch of ocean twice the size of Portugal—and includes eight virtually uninhabited coral atolls.

Christensen *et al.* (2003). Hundred year decline of North Atlantic predatory fishes.

- Worldwide declines in marine top predators

### Protected areas



Letessier *et al.* (In review). Sampling mobile oceanic predators: Implications for fisheries and conservation.

- Exponential rise in marine spatial planning (high-seas)

## Drawing the line

1. Background

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6. Marine reserves

7. Take home


Global crisis ➡ Global response ➡ Data needs



MARINE PROTECTED AREA  
STATE MARINE RESERVE



NO FISHING OR COLLECTING  
C.C.R. TITLE 14, SECTION 632



## The role of geoscience

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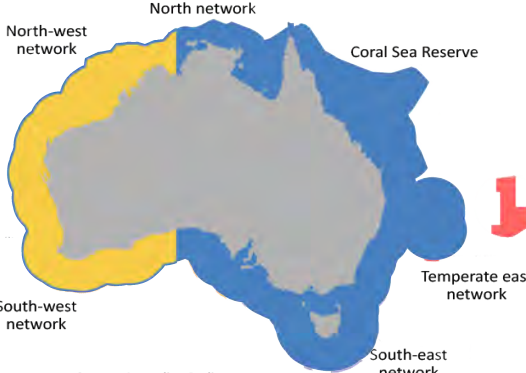
6. Marine reserves

7. Take home

- High number & diversity of **submarine canyons**
- MPA design guided by available **geomorphic data**
- Vast marine estate, unlikely to ever be sampled in its entirety

**Fisheries catch records**

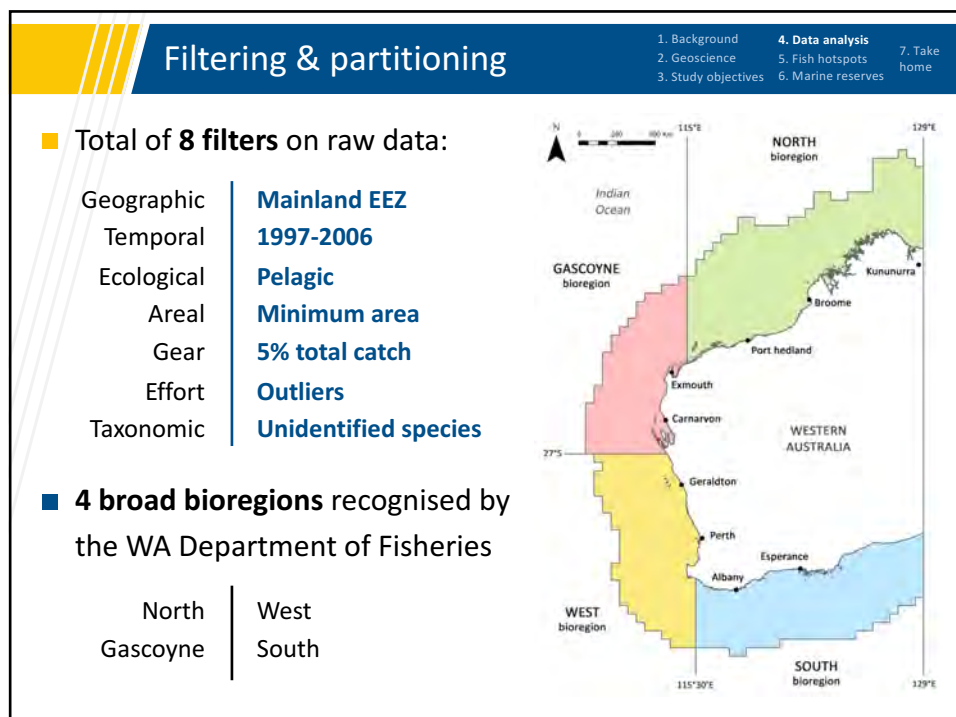
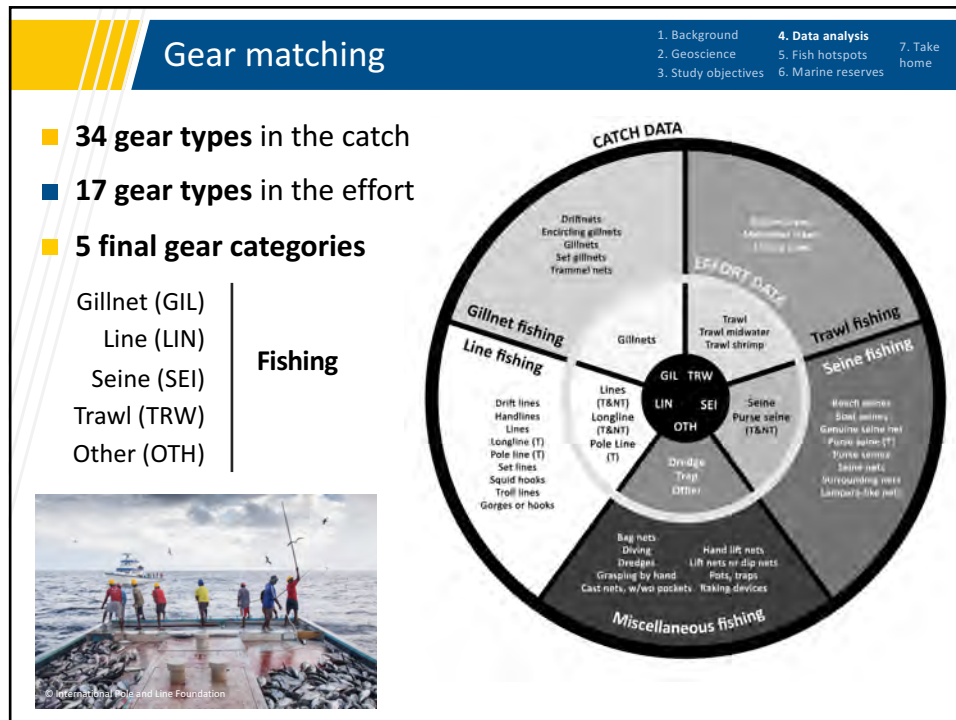


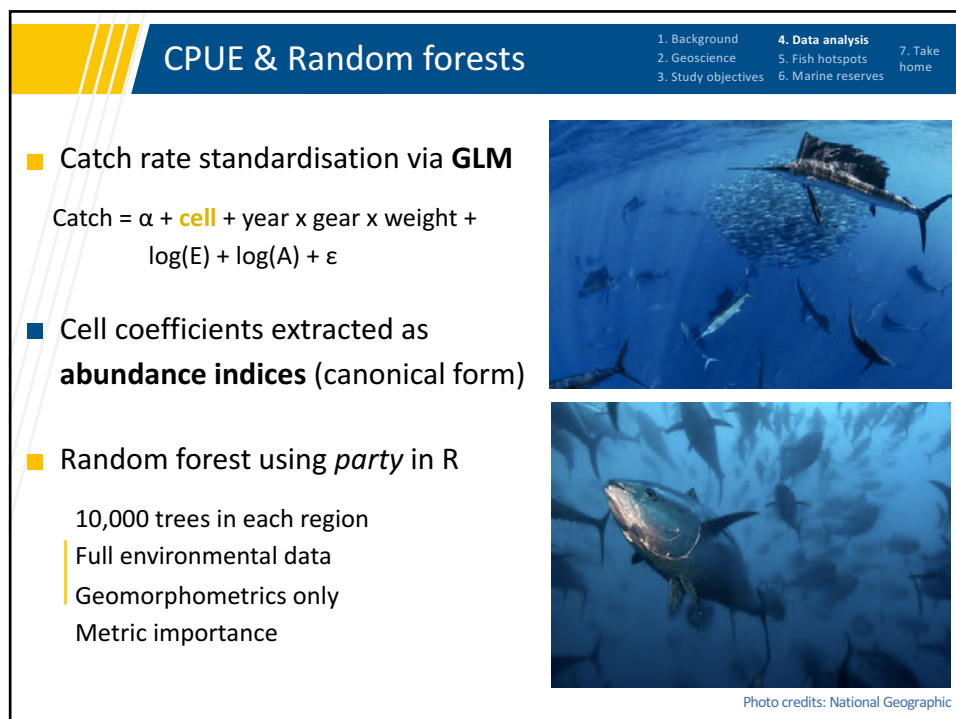
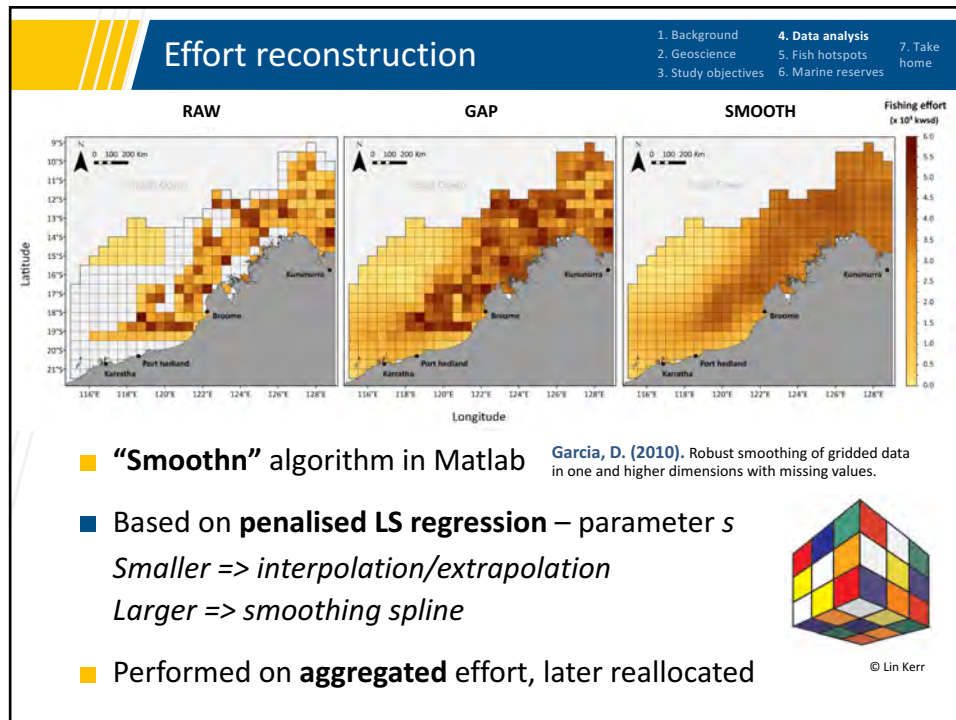


Source: Australian Parliament  
Huang *et al.* (In press). A national mapping and classification of submarine canyons of the Australian margin.

Australia (mainland)	6.9 million km <sup>2</sup>
Western Australia (mainland)	2.3 million km <sup>2</sup>







## Hotspot detection & mapping

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- Two detection methods:
  - Type S: Spatial Bartolino *et al.* (2011). A frequency distribution approach to hotspot identification
  - Type T: Temporal Suryan *et al.* (2012). New approach for using remotely sensed chlorophyll a to identify seabird hotspots
- Type S from 3 candidate **growth models**

Von Bertalanffy Morgan-Mercer Logistic	Solving 1 <sup>st</sup> derivative equation
----------------------------------------------	---------------------------------------------
- Type T from **year-specific GLMs**
  - 25% persistence = T1
  - 50% persistence = T2
- **Overlay analysis** in ArcGIS

