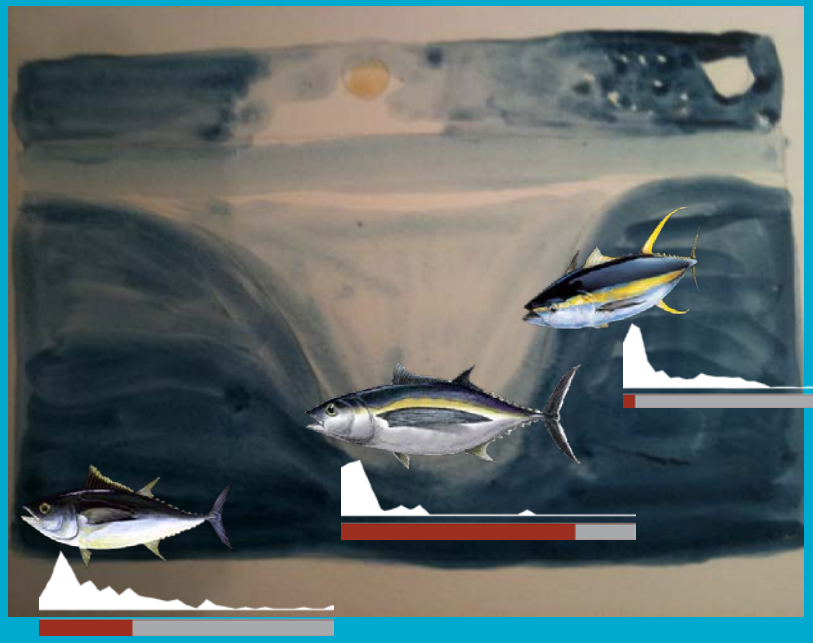


# Trophic understanding of tunas of the Southwest Pacific Ocean

**Jock Young**, Petra Kuhnert, Jessica Farley, Shane Griffiths, Adrian Flynn, Matt Lansdell, Robert Olson

PFRP PI Meeting, University of Hawaii
November 2012

# Tunas and Their Fisheries: Safeguarding Sustainability in the 21st Century

- **What do we know  and where to now?**
- **16 chapters, Chapter 3 on trophic ecology (CLIOTOP Working Group 3)**
  - Trophic ecology
  - Chemical indicators
  - Bioenergetics
  - Niche separation
  - Climate change
  - Research gaps

- Robert Olson, Jock Young, Valerie Allain, John Logan, Nicolas Goni, Frederic Ménard, Michel Potier

# Western subtropical/temperate Pacific: main tuna species

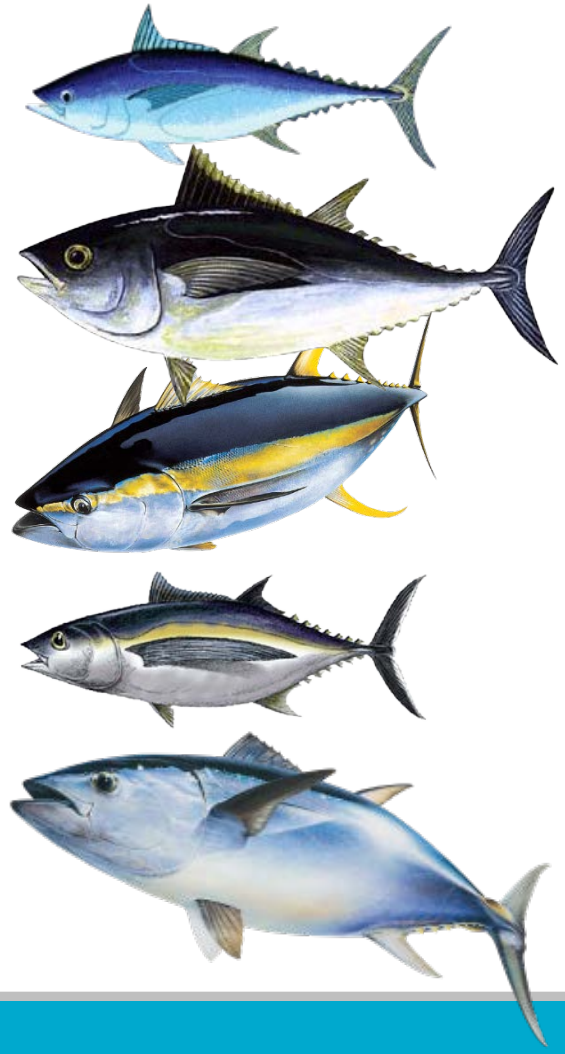
*Thunnus tonggol*

*Thunnus obesus*

*Thunnus albacares*

*Thunnus alalunga*

*Thunnus maccoyii*

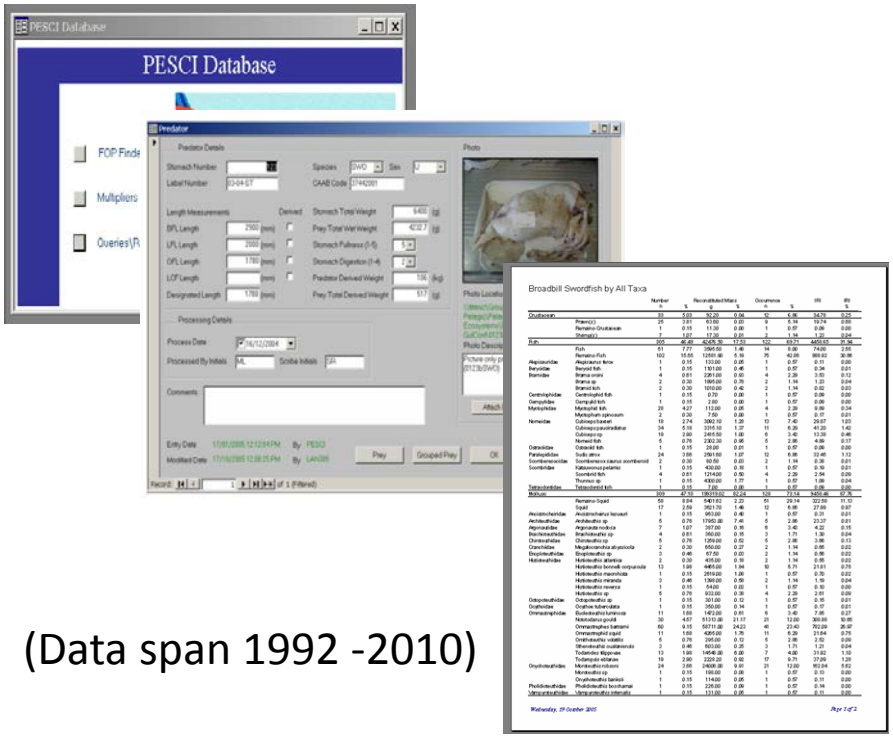


# Western subtropical/temperate Pacific

| Species | SCA | DR | SIA | SFA |
|---|---|---|---|---|
| *Thunnus alalunga* | + | + | + | 0 |
| *Thunnus albacares* | + | + | + | 0 |
| *Thunnus maccoyii* | + | + | + | 0 |
| *Thunnus obesus* | + | + | + | 0 |
| *Thunnus tonggol* | + | + | 0 | 0 |
| *Katsuwonus pelamis* | 0 | 0 | 0 | 0 |

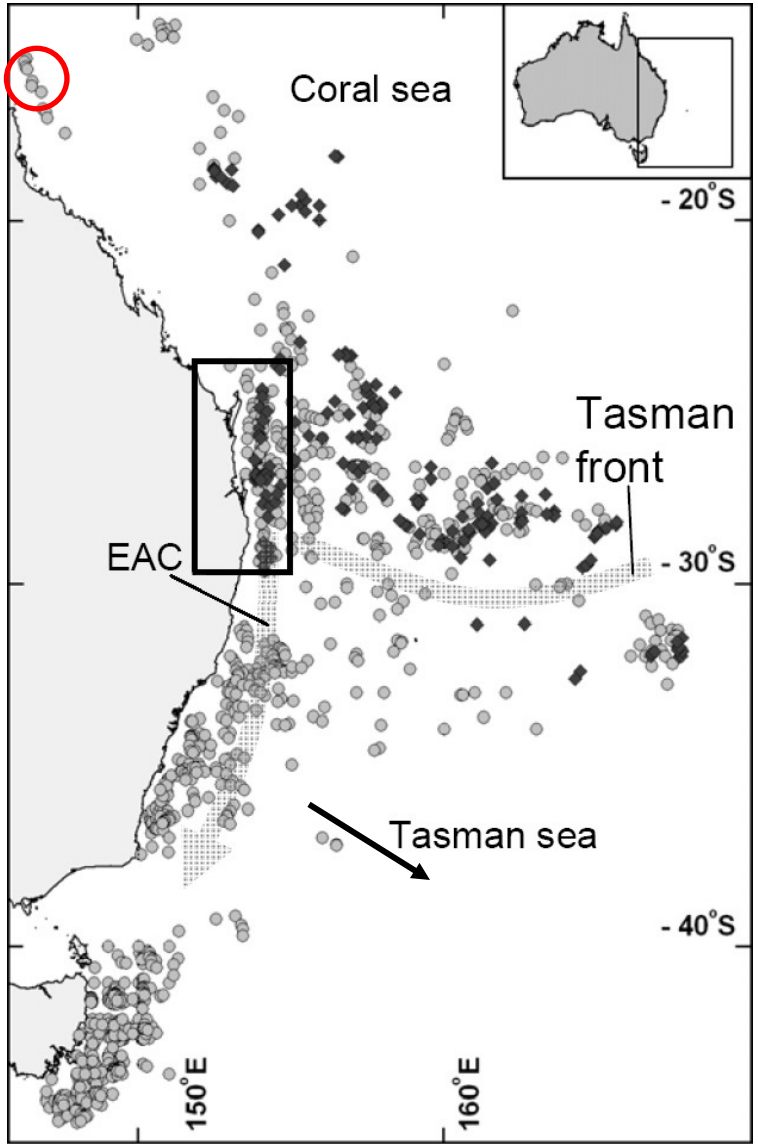
**+ = data exist for this region**
**0 = no data exist for this region**
**NA = this species does not occur in this region**

# SAMPLE COLLECTION

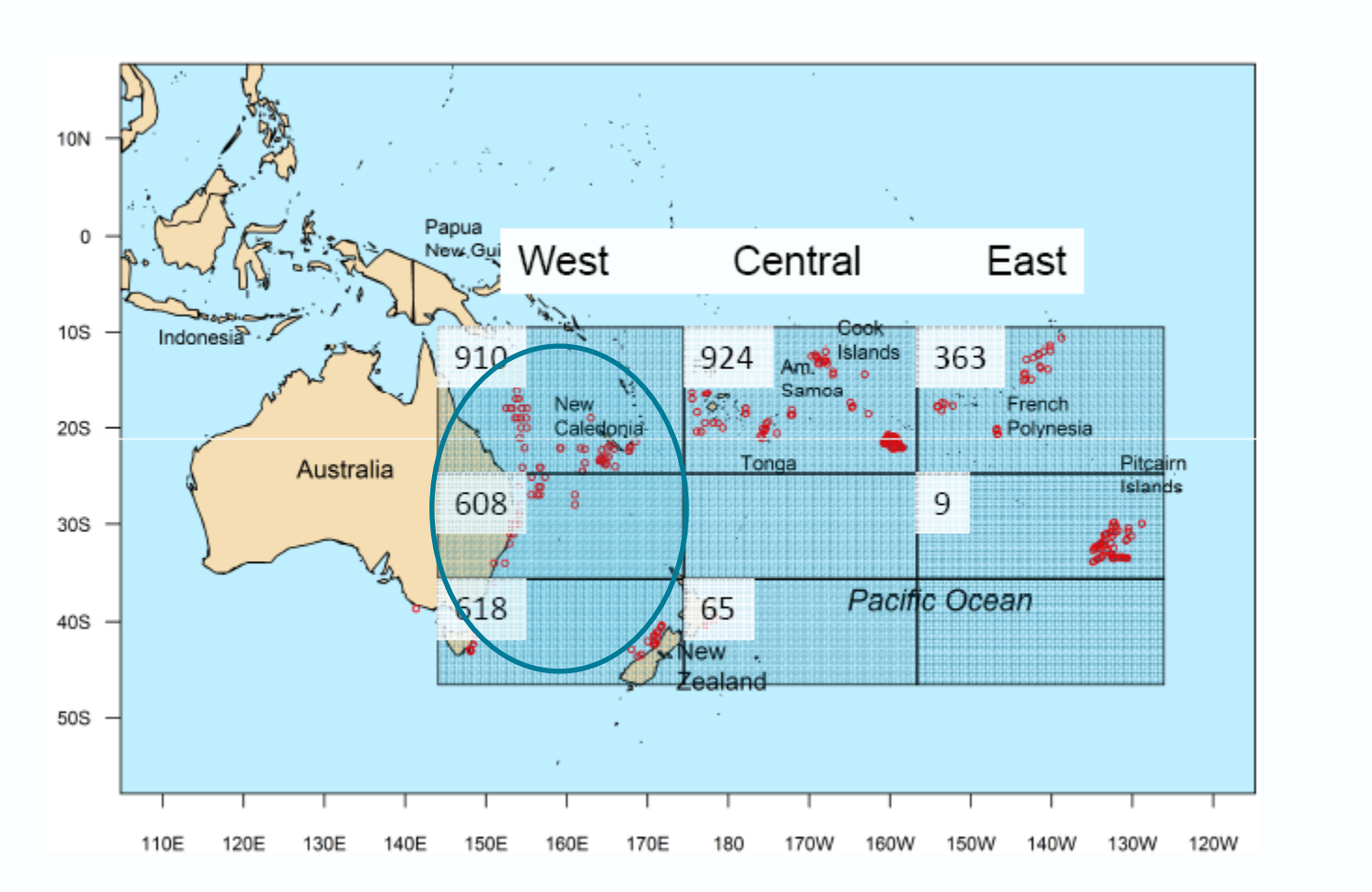



(Data span 1992 -2010)

*Campbell and Young 2012,*
*Flynn and Paxton in press,*
*Griffiths et al 2007*
*Revill et al 2009*
*Young et al 1997,2001, 2010, 2011*



# Albacore sampling (circled n=533) for stable isotopes in the western Pacific




*(Farley et al in press)*

# Trophic understanding of tunas of the Southwest Pacific Ocean

**Trophic ecology**

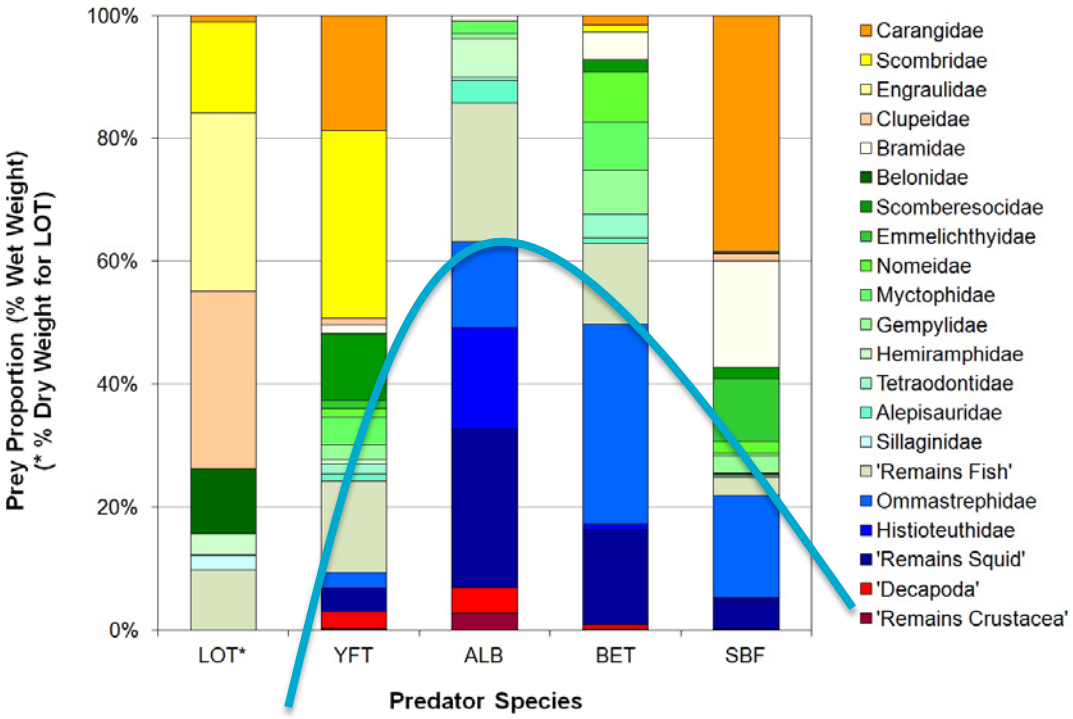
**Chemical indicators**

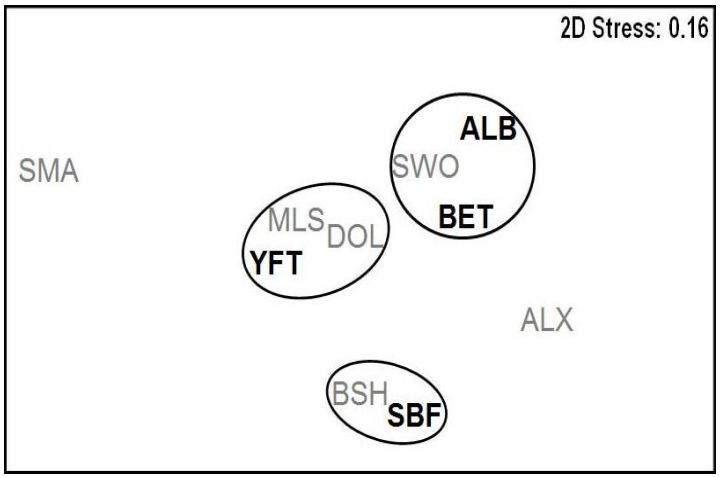
**Bioenergetics**

**Niche separation**

**Climate change**

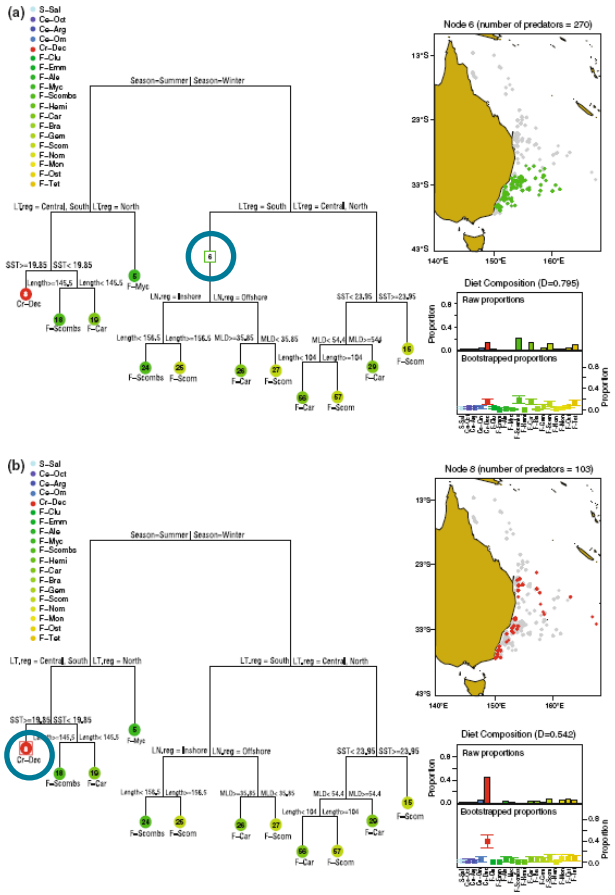
# Diet comparisons




*(Griffiths et al 2007, Young et al 2010)*

# Classification trees to identify relative importance of environmental and biological variables: case study of yellowfin tuna

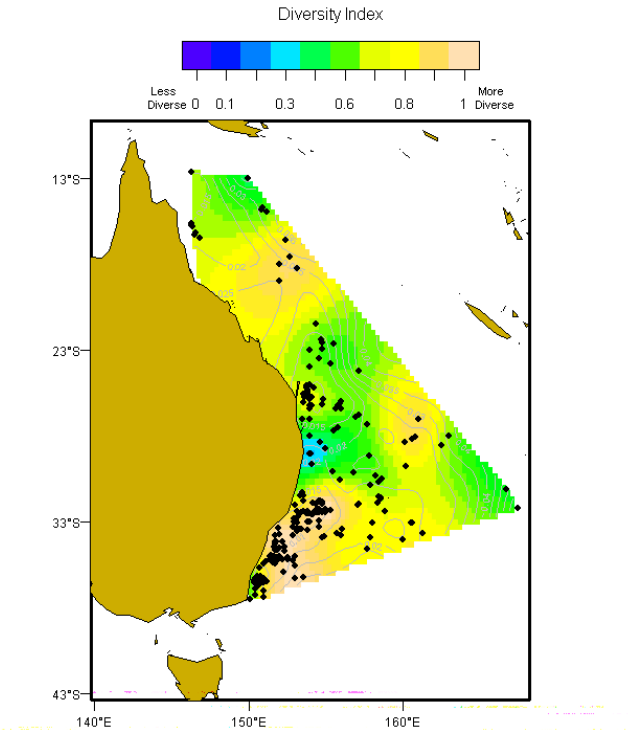


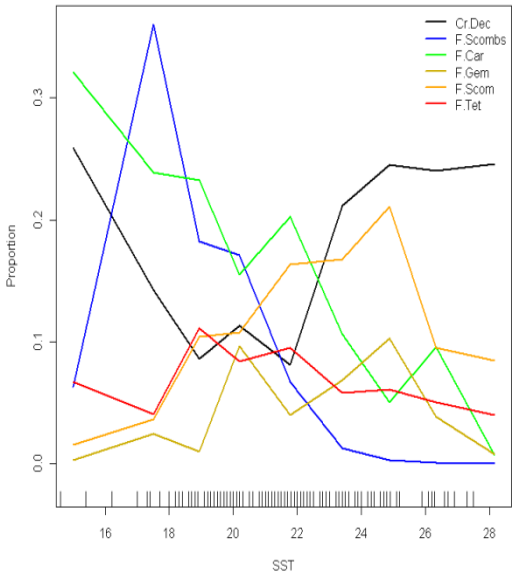

Parameters in order of importance:
**Season, latitude, SST**
Predictive capacity
e.g at node 6 predicts that in winter, in southern waters the diet of yellowfin tuna will be composed of a mix of species.

In contrast, in summer, in mid latitudes at SST> 19C diet of yellowfin tuna composed mainly of crustacean megalopa

*(Kuhnert et al 2012)*

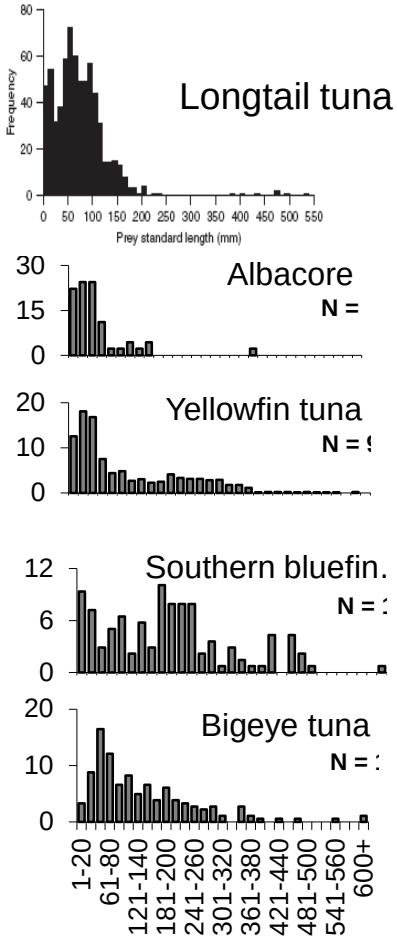
# Other functions: Prey diversity and partial dependence plots



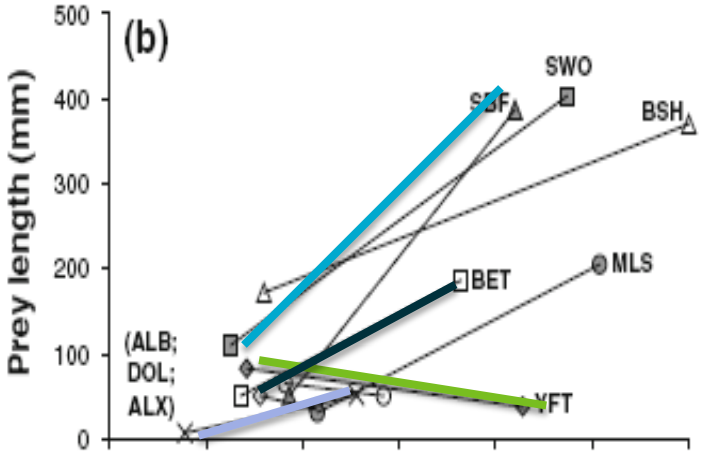




*Kuhnert et al 2012*

# Predator-Prey relationships



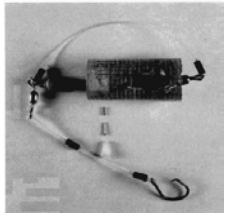

Quantile regression analysis
(Francis Juanes)

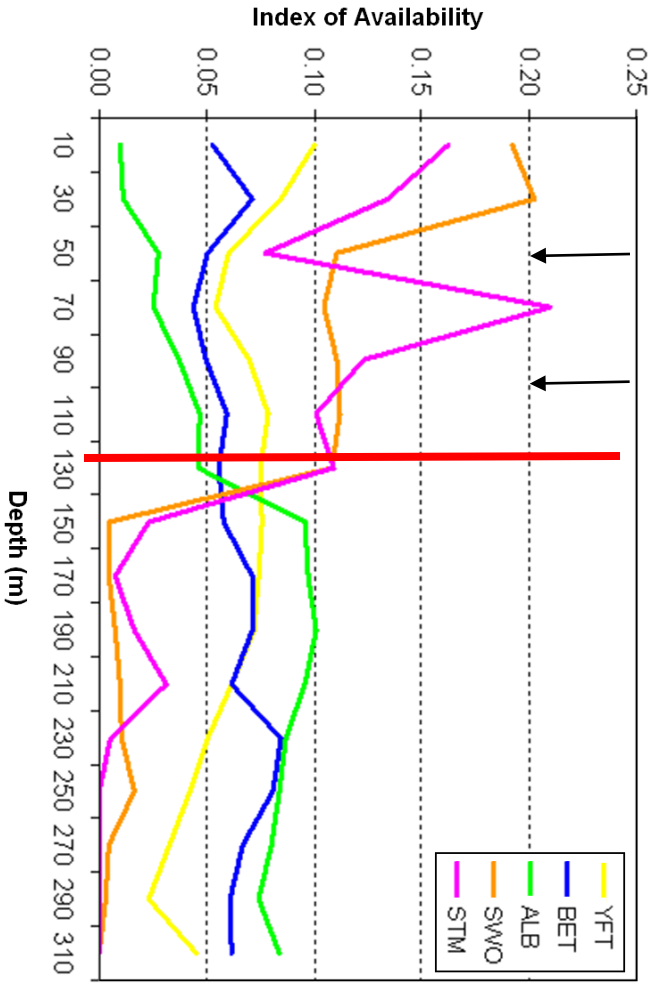


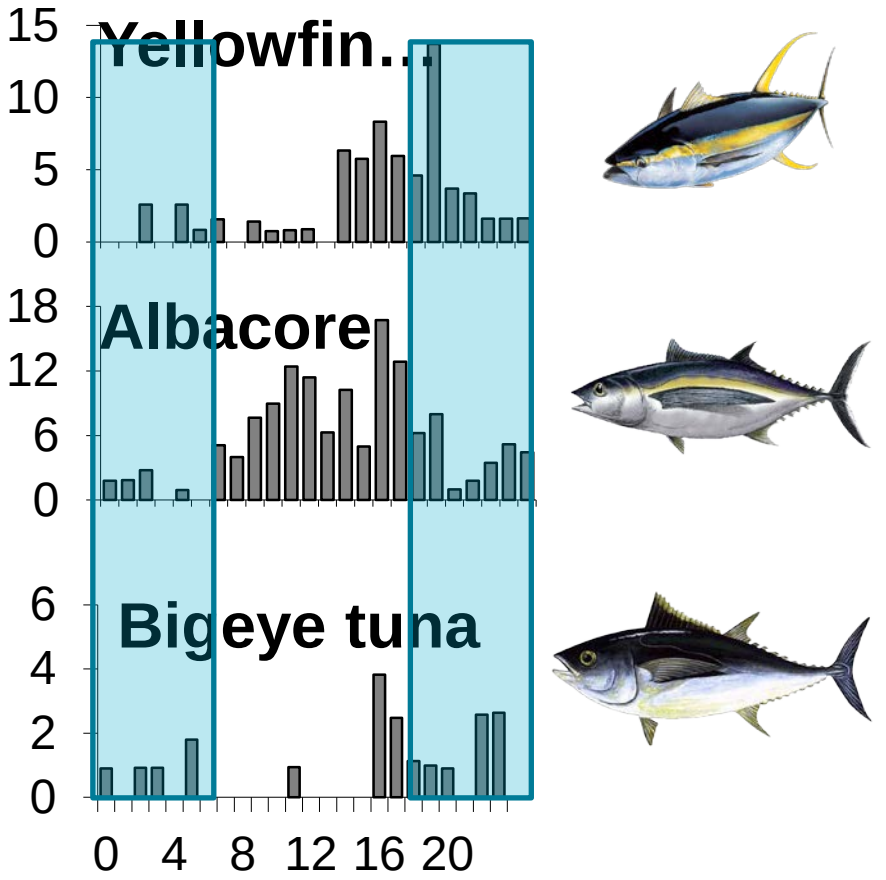

Fish length

(Griffiths et al 2007;
Young et al 2010)

# Vertical distribution and feeding times



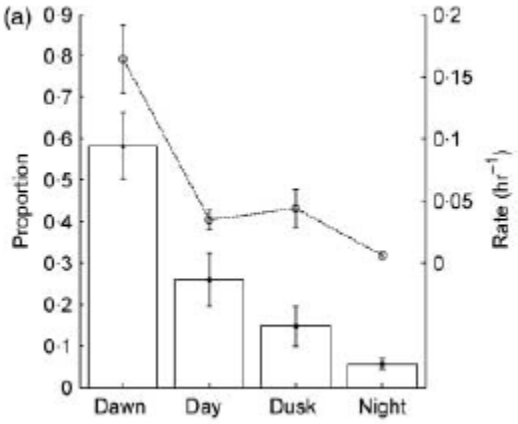


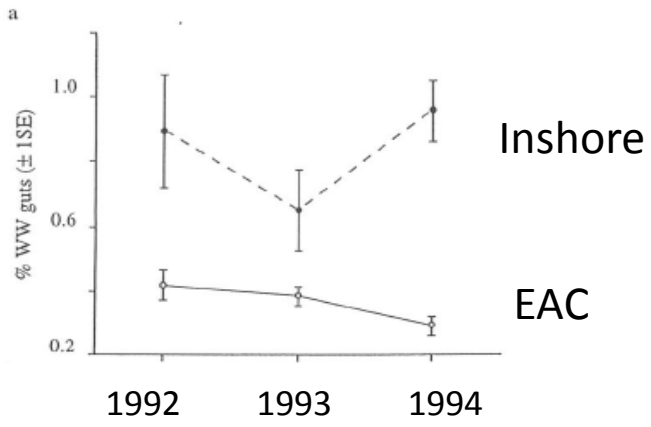

*(Campbell and Young 2012)*

# Southern bluefin tuna feeding

- **Bestley et al 2008, 2010, Young et al 1997**
- Main feeding occurring around dawn. Night feeding, although rare on the full moon




- Multiple-day fasting periods were recorded by most individuals. The majority of these occurred during periods of residency within warmer waters



# Seasonal feeding events

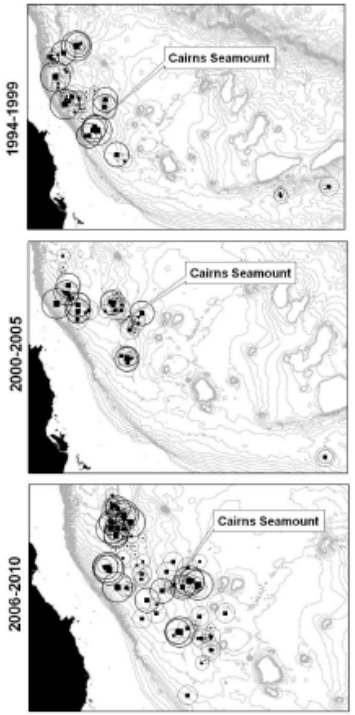
Spawning aggregation of the lanternfish *Diaphus danae* (family Myctophidae) in the northwestern Coral Sea and associations with tuna aggregations

Adrian J. Flynn[A,B,C,D*] and John R. Paxton[E]


6

7 **Fig. 4.** *Diaphus danae* ventral view of dissected female trawled from the Coral Sea aggregation,

8 106.5 mm SL (Specimen M727-1, see Table 5).




1017

1018 **Fig. 6.** Location of commercial tuna handline catches of 50 or more bigeye tuna. Size of circles

1019 represents relative number of bigeye tuna at each location to represent a proxy for aggregation

1020 intensity.

*(Flynn and Paxton in press)*

# Trophic understanding of tunas of the Southwest Pacific Ocean

Trophic ecology

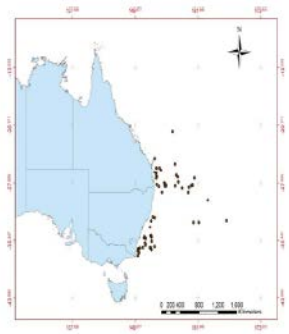
Chemical indicators

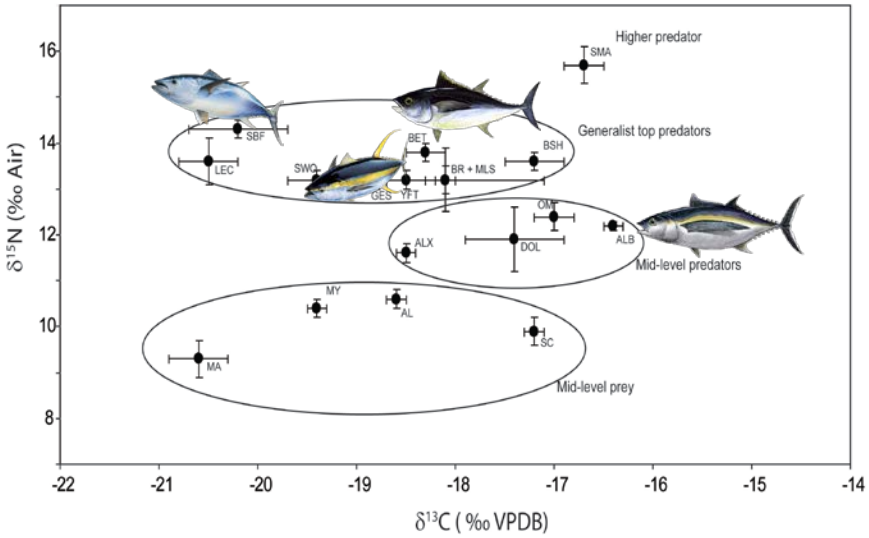
Bioenergetics

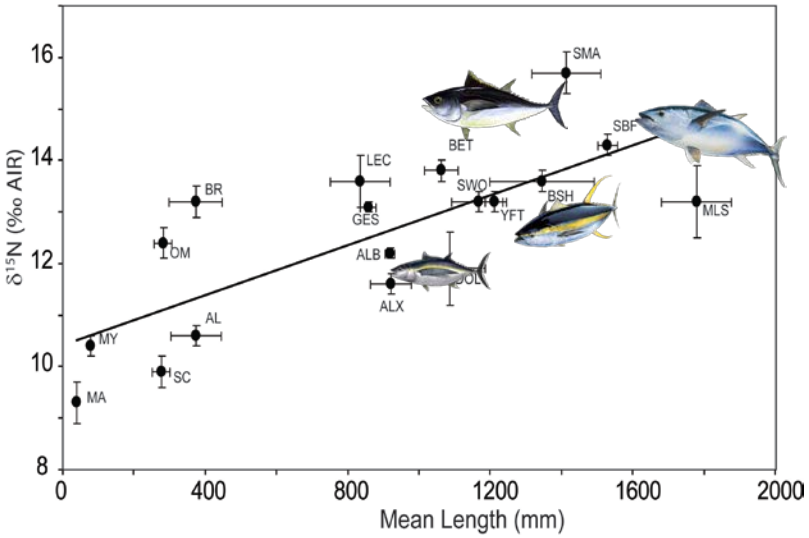
Niche separation

Climate change

# Trophic groupings off eastern Australia

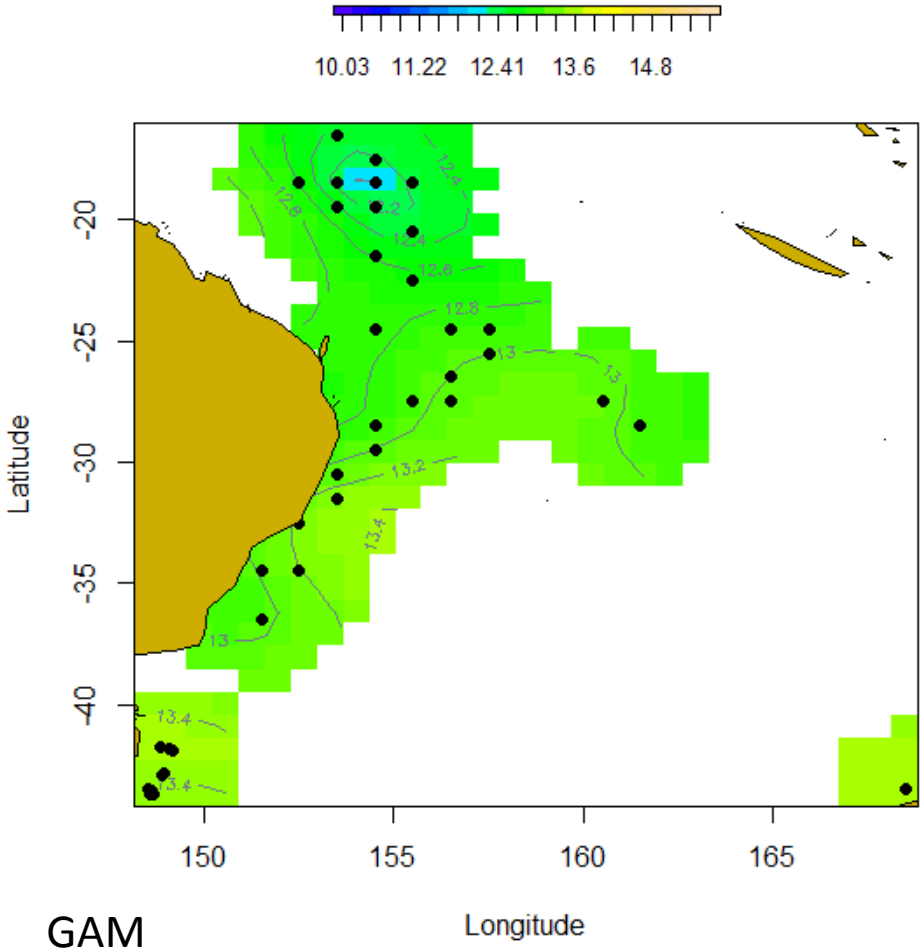


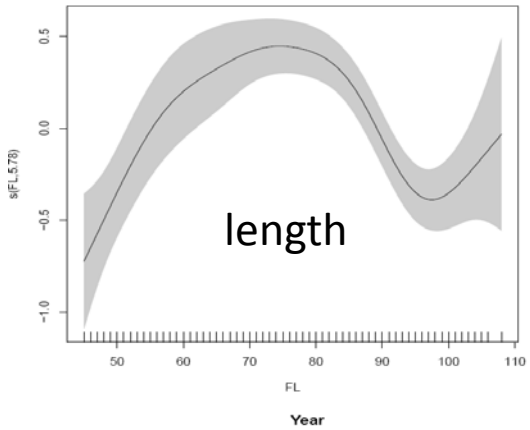


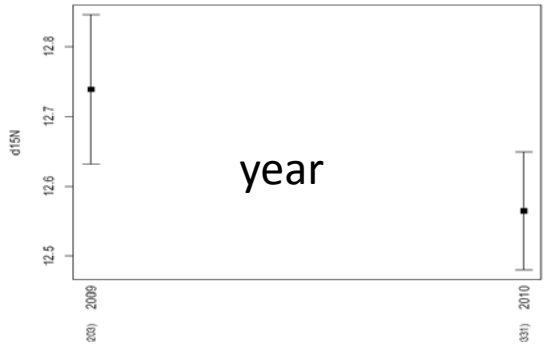



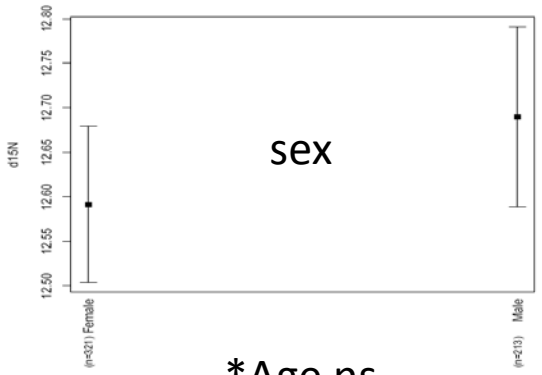

*(Revill et al 2009)*

# Albacore $\delta^{15}N$ (533 fish sampled)



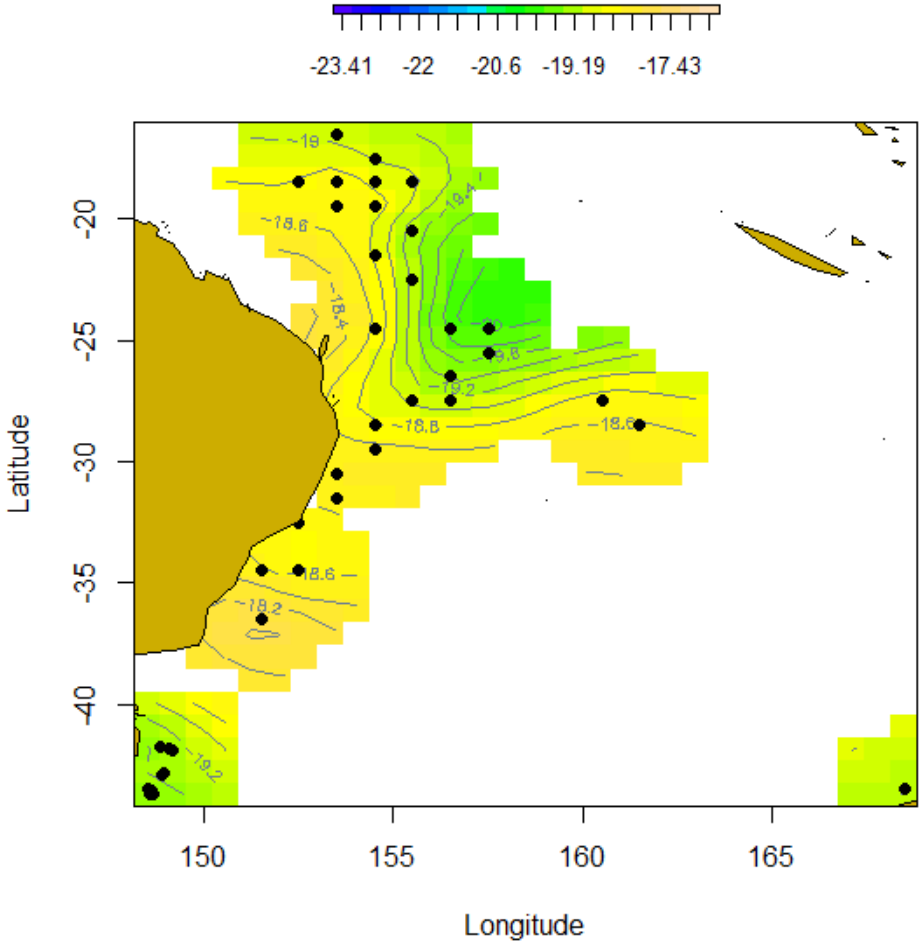

GAM

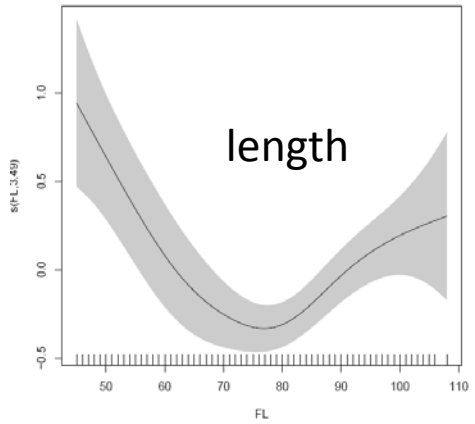
Best model included Year, Sex, length, long and lat. Age ns (explained 55% Variation).

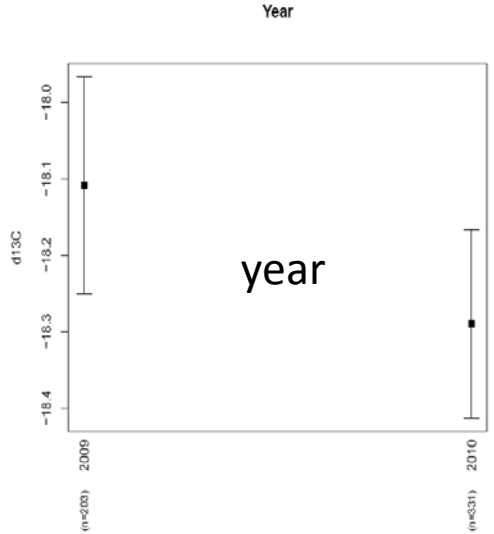
*Age ns

*(Kuhnert et al CSIRO unpubl.)*

# Albacore $\delta^{13}C$ (533 fish sampled)



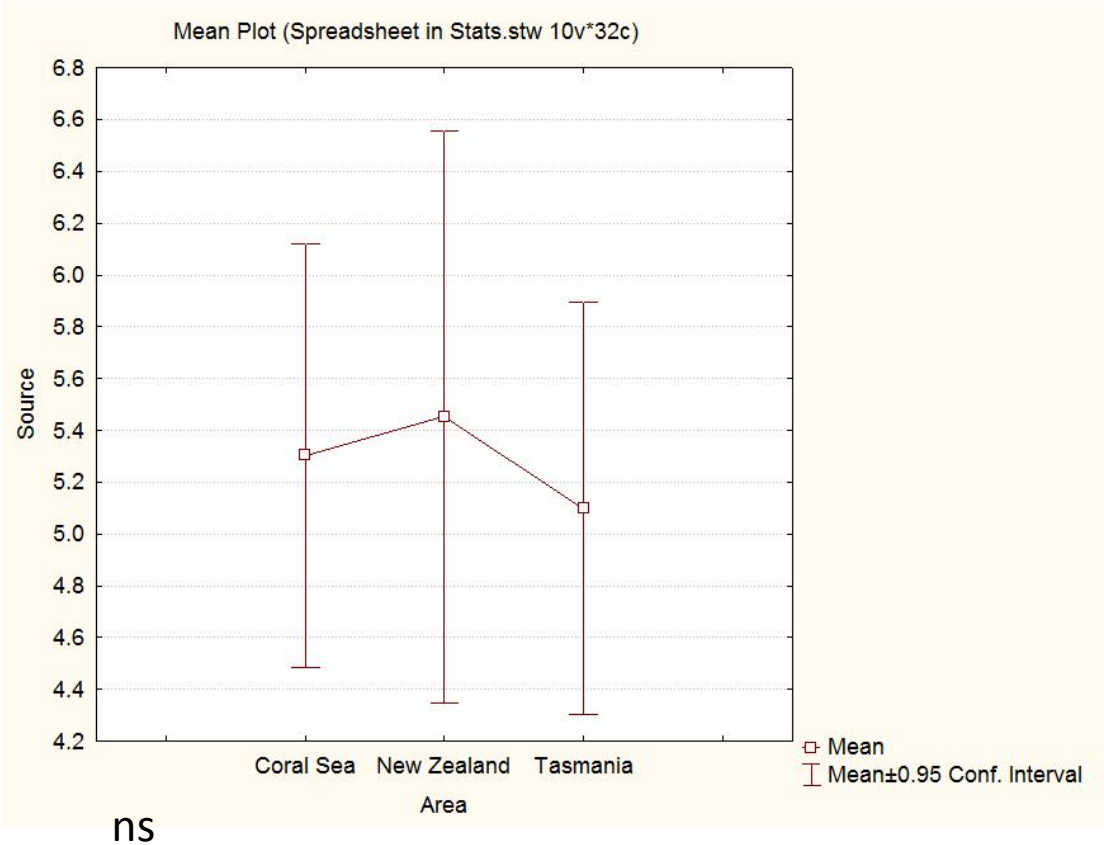




GAM model included Year, Age, length, long and lat (explained 47% of the variation)

*(Kuhnert et al CSIRO unpubl.)*

# Compound specific amino acids of albacore from the south western Pacific (n=30)

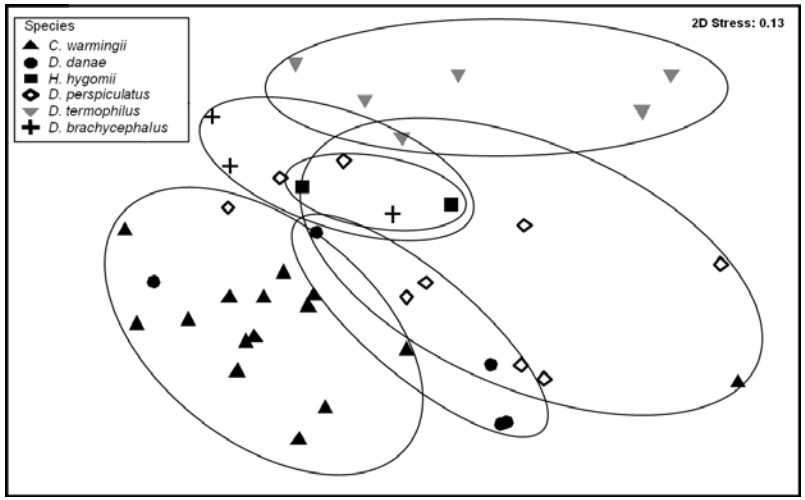
Source amino acid




ns

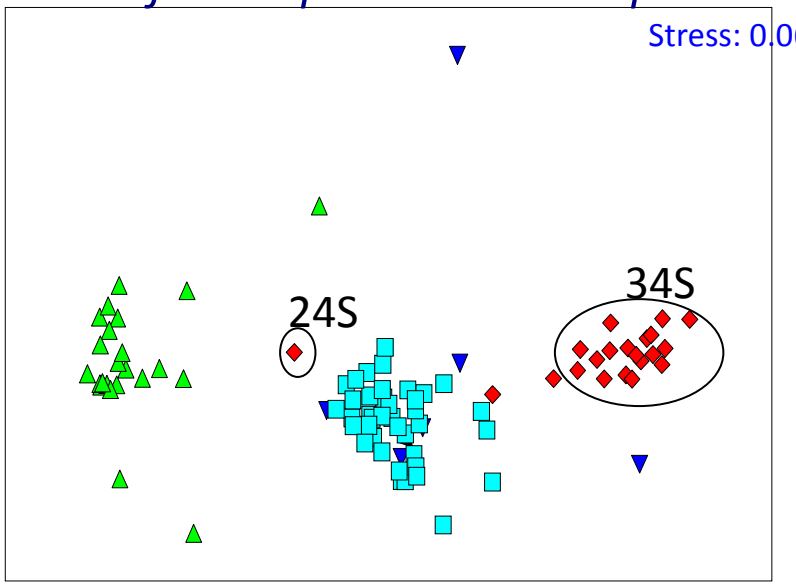
*(Revill et al CSIRO unpubl.)*

# Signature fatty acids (swordfish only)




***Myctophid prey***

*Swordfish trophic relationships:*




***Swordfish & prey***

*Young et al. Prog. Oceanog. (2010)*

*FA data %, not transformed or standardised, based on a Bray Curtis similarity matrix*

# Trophic understanding of tunas of the Southwest Pacific Ocean

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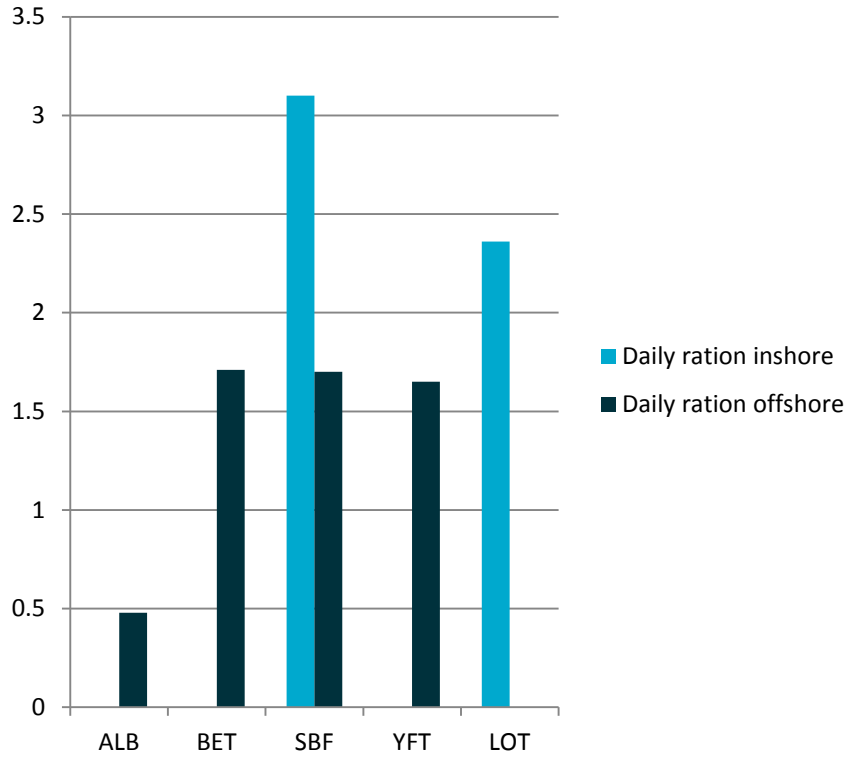
# Daily Ration

| SPECIES | DAILY RATION (%) | REF |
|---|---|---|
| *Thunnus alalunga* | 0.48 | Young et al 2010 |
| *Thunnus albacares* | 1.65 | Young et al 2010 |
| *Thunnus obesus* | 1.71 | Young et al 2010 |
| *Thunnus tonggol* | 2.36 | Griffiths et al 2007 |
| | | |
| *Thunnus maccoyii* | 1.70 | Young et al 1997 |

- Energy consumption and daily ration needed for Q/B ratio in ecosystem models

# Daily ration (%BW per day)

- Variability within and between species
- Variability between sizes
- Variability bw regions
- Variability between inshore and offshore waters




*SBF 0.75 Kg per fish
*(Bestley et al 2008)*

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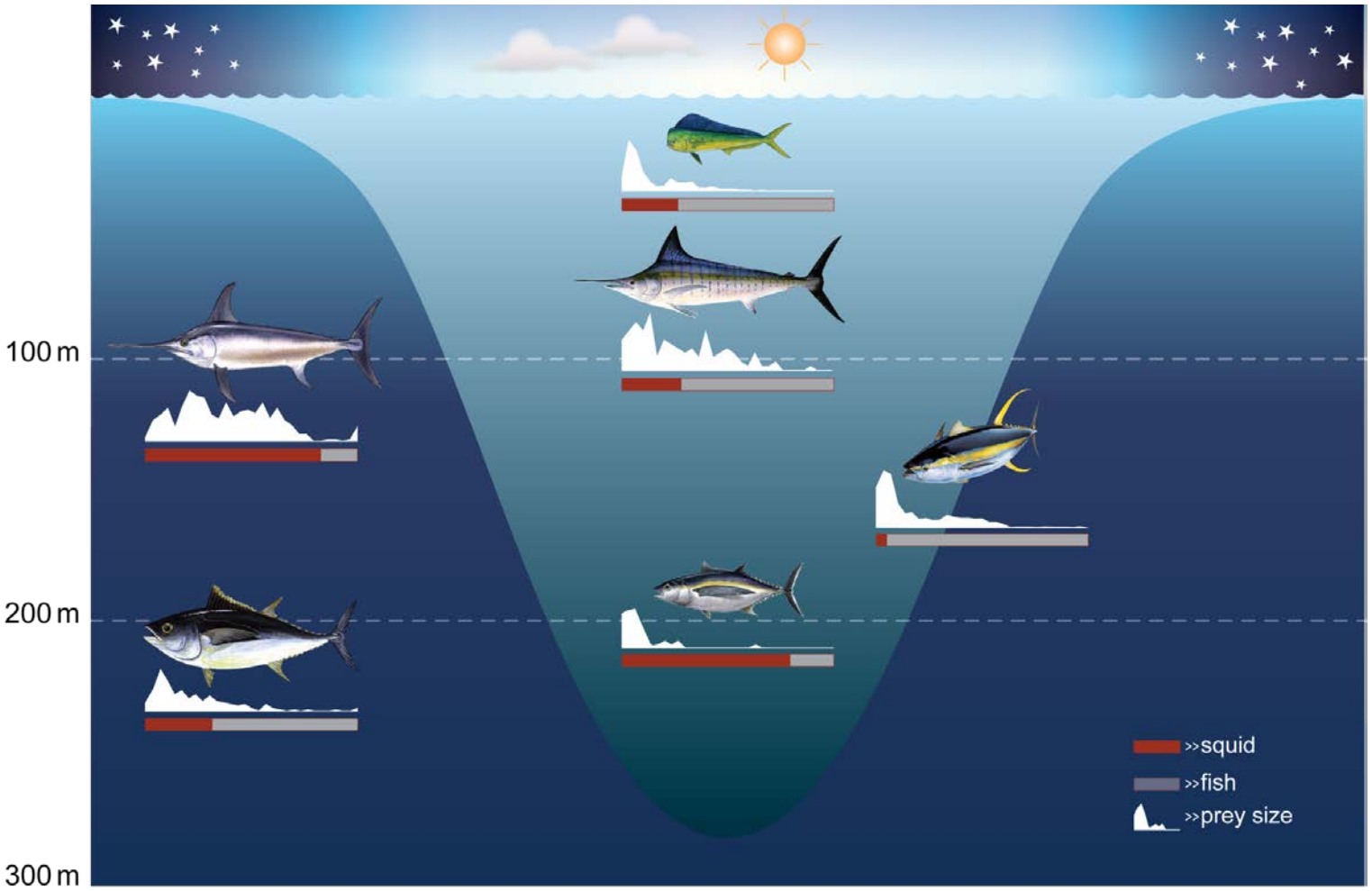
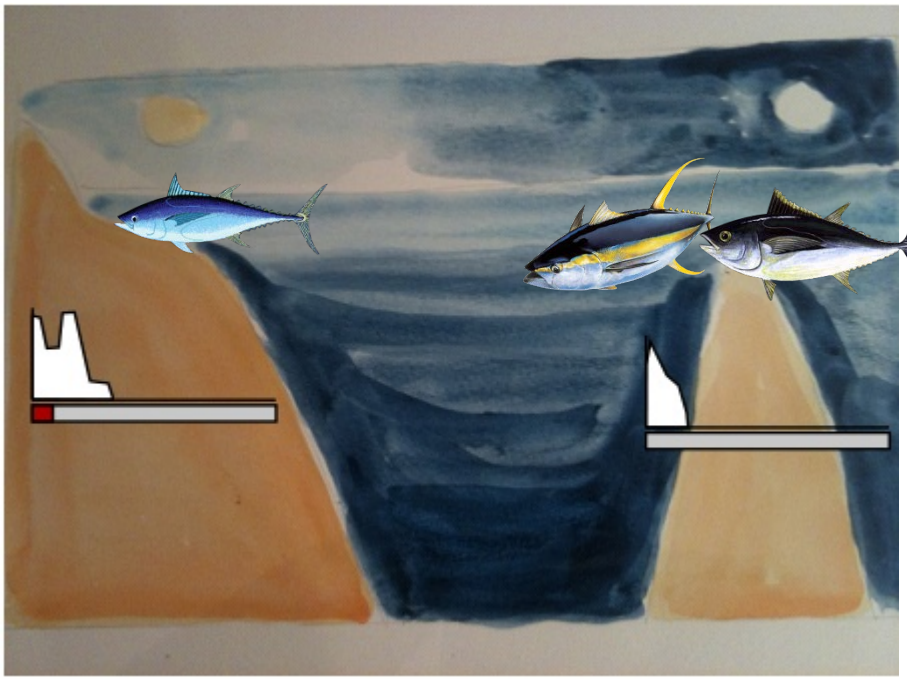
# Segregated feeding niches – time of day, depth, prey type and size




Young et al 2010

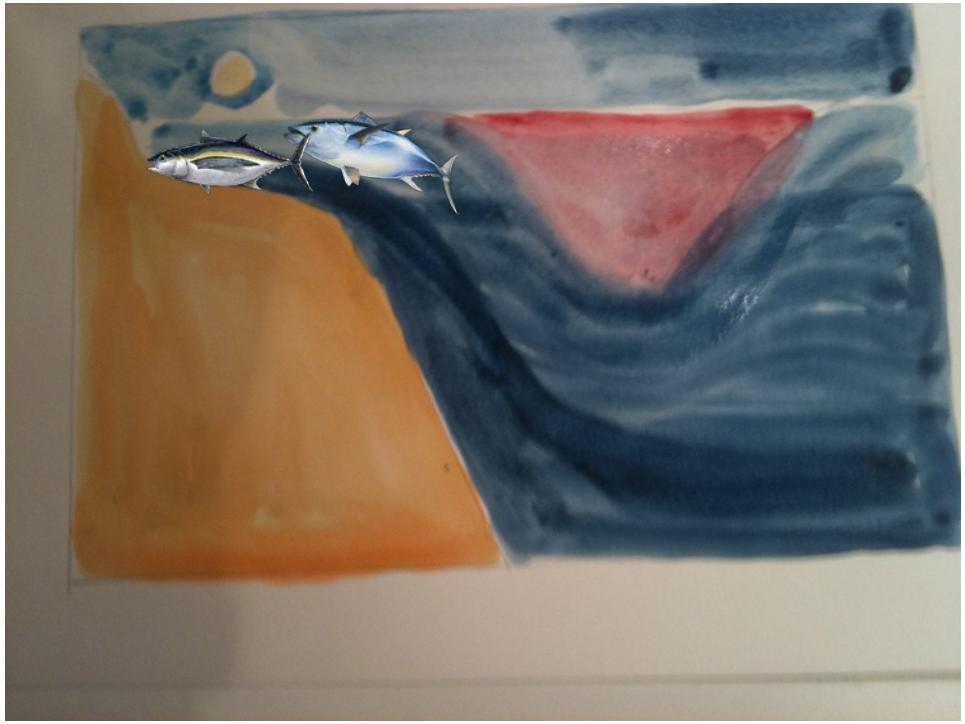
# Tropical tunas

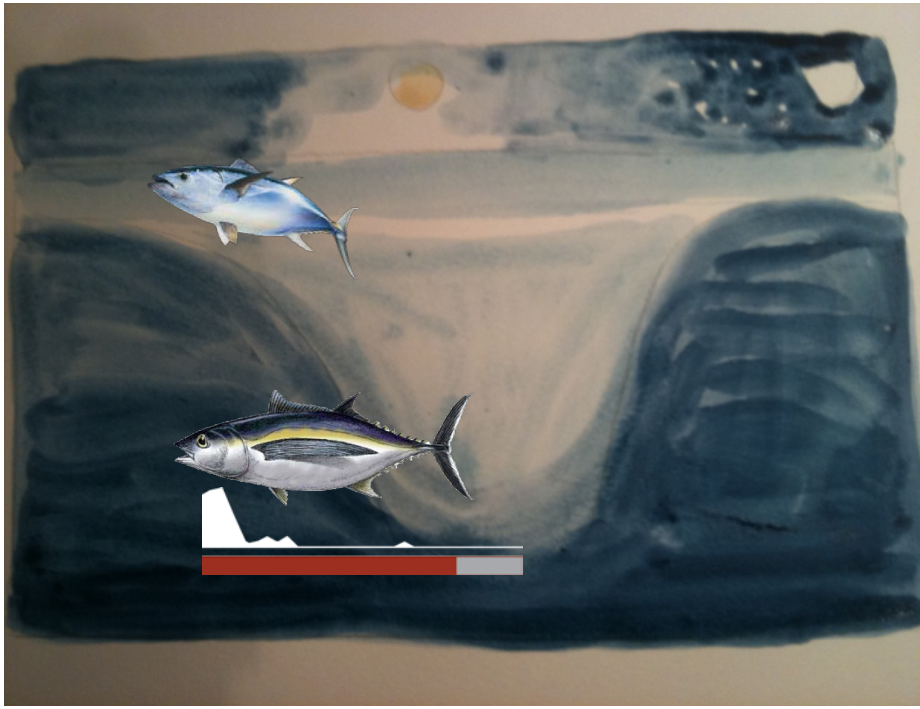
Inshore



Offshore

# Temperate tunas





(work in progress)

# Trophic understanding of tunas of the Southwest Pacific Ocean

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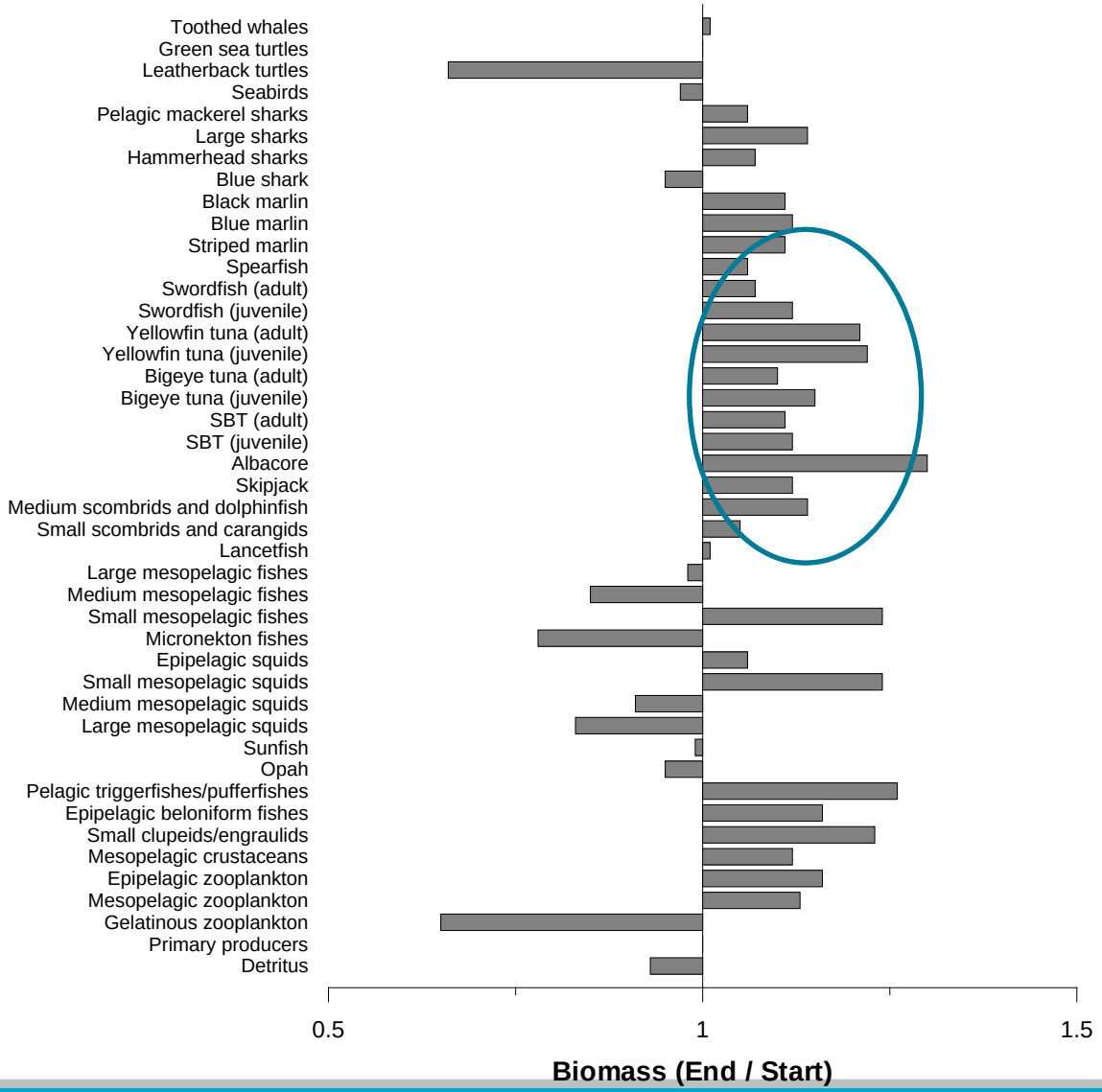
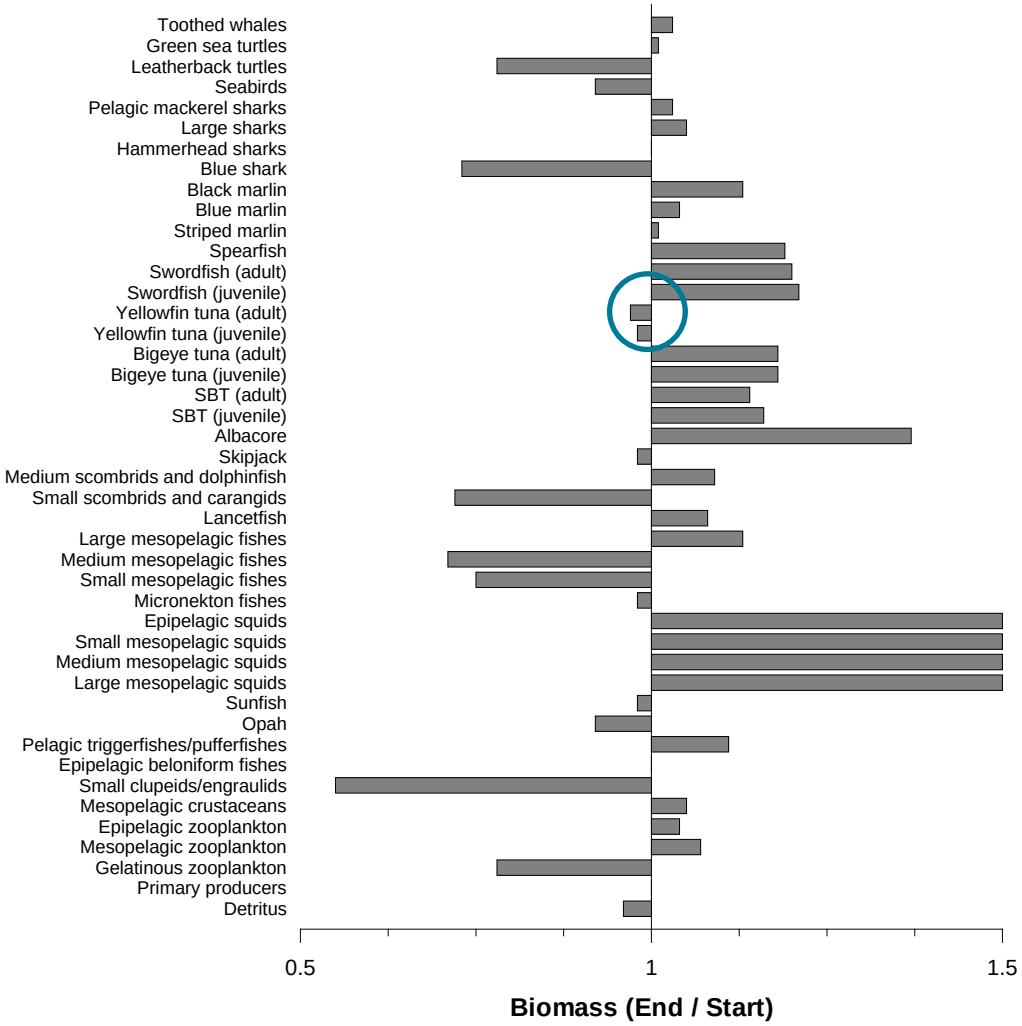
# Climate change – 20% decrease in micronekton fishes



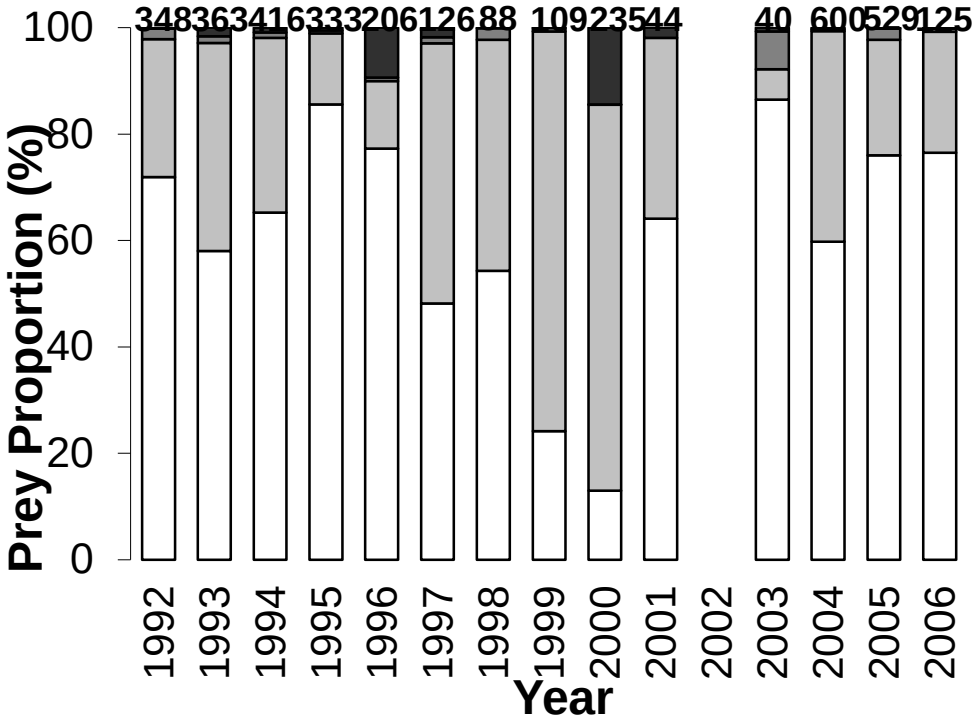

*Griffiths et al 2010*

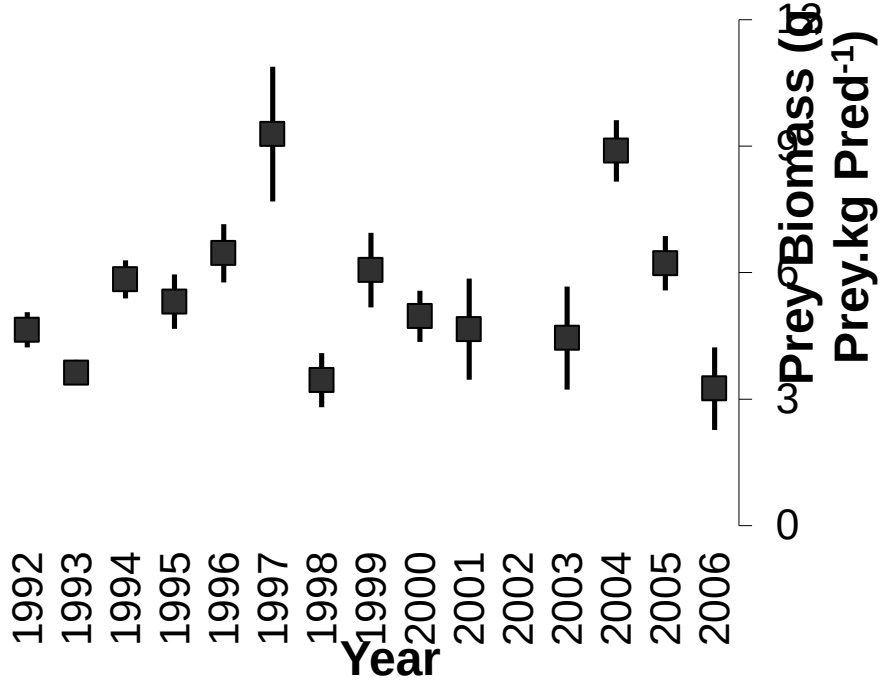
# Climate change – 50% increase in squids (4 groups)




*Griffiths et al 2010*

# Interannual variations in prey composition




*(Young et al 2010)*

# SUMMARY

- General understanding of trophic relations of tuna in the southwest Pacific with exception of skipjack
- Development of statistical techniques to quantify the importance of environment and biology in tuna diets
- The potential for using chemical indicators as part of “typical” measures (e.g. age, reproduction) of tuna life history
- Importance (and lack of) interannual studies and their application to ecosystem models
- Need for spatially and temporally rigorous collections of appropriate samples to support wider life history collections (see Allain et al 2012, Nicol et al 2012)

# Thank you

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**Division of Marine and Atmospheric Research**