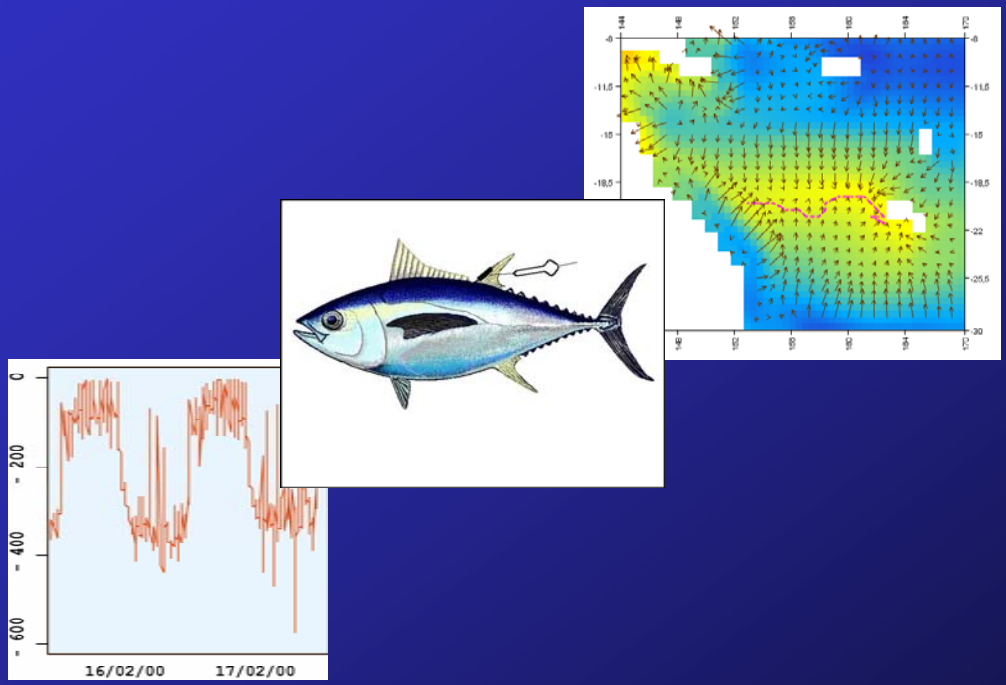
The influence of the environment on horizontal and vertical bigeye tuna movements investigated by analysis of archival tag records and ecosystem model outputs



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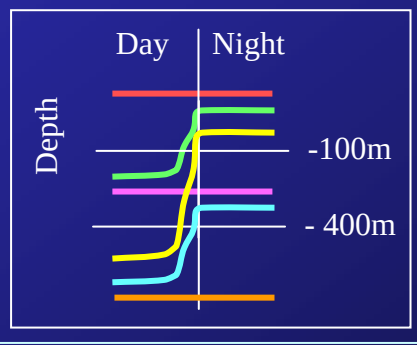
CSIRO
MARINE RESEARCH

Objectives

1. Develop an individually-based model for BET movements where fish will be able to 'swim through' environmental data
2. in order to simulate spatial dynamics from individual to population scale

	Data	Scales
Archival tag records : 17 classic (Coral Sea – CSIRO/SPC), 7 pop-up (PNG, NC, Tonga - SPC)	temperature (water, body) depth light position	minutes to days meters
Ocean models outputs : Physical-biogeochemical model	temperature (0,100,200,400m) light, O_2 chla, pp	10 days 1 month 0.5 to 1° latitude longitude
Ecosystem model (SEAPODYM)	forage biomass : 6 components epipelagic migrant mesopelagic non-migrant mesopelagic highly migrant bathypelagic migrant bathypelagic non-migrant bathypelagic	



investigate relationships (common scale)

build validate IBMs

Horizontal movements

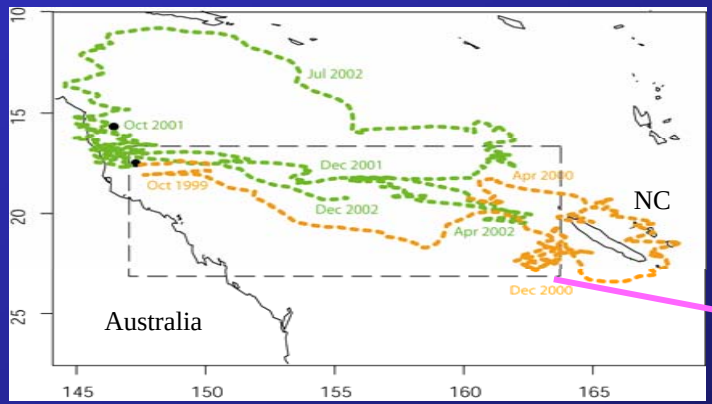
Pop-up archival tags :

- residency in NC waters
- geolocation issues

Archival tags :

- residency in NW Coral Sea

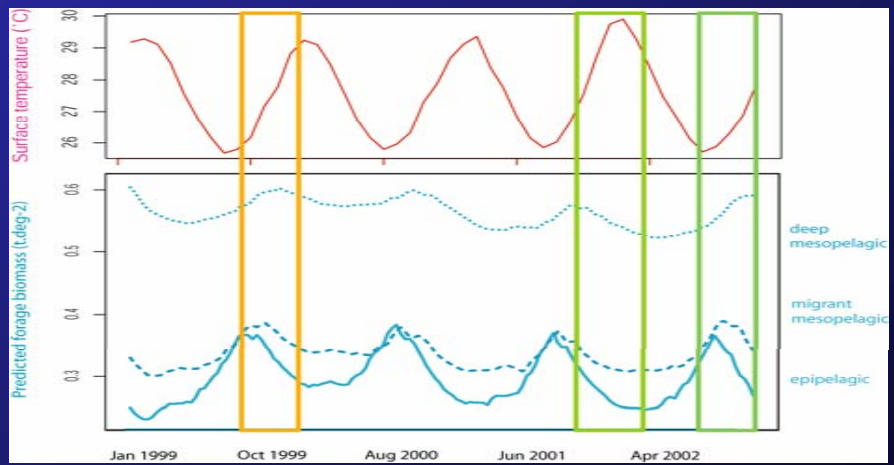
- dispersion / migration timing and routes



Kalman-filtered tracks of 2 tagged individuals

(cf. Sibert et al. 2003)

'Migration route'
= area for data extraction

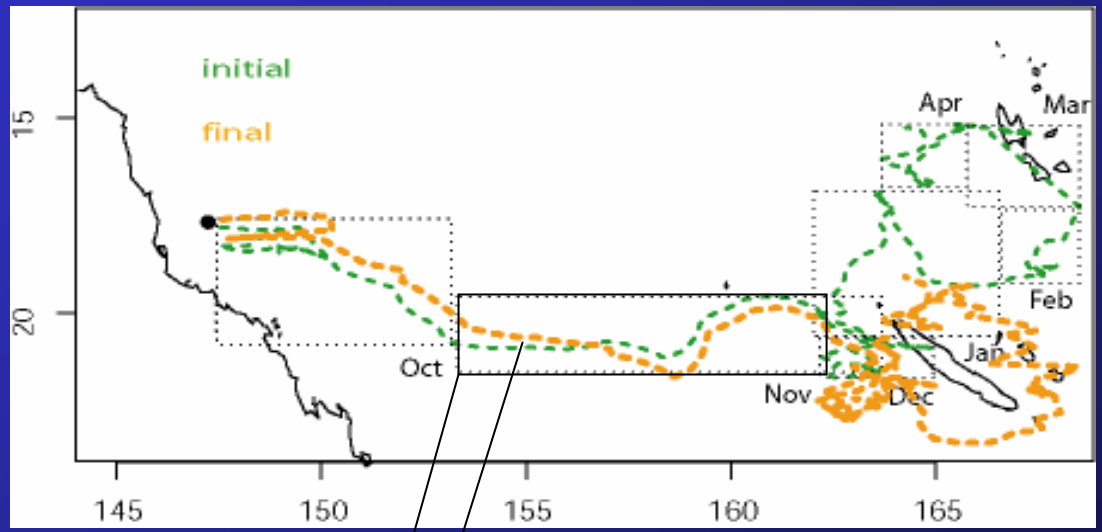


Seasonal evolution of environmental variables in the area

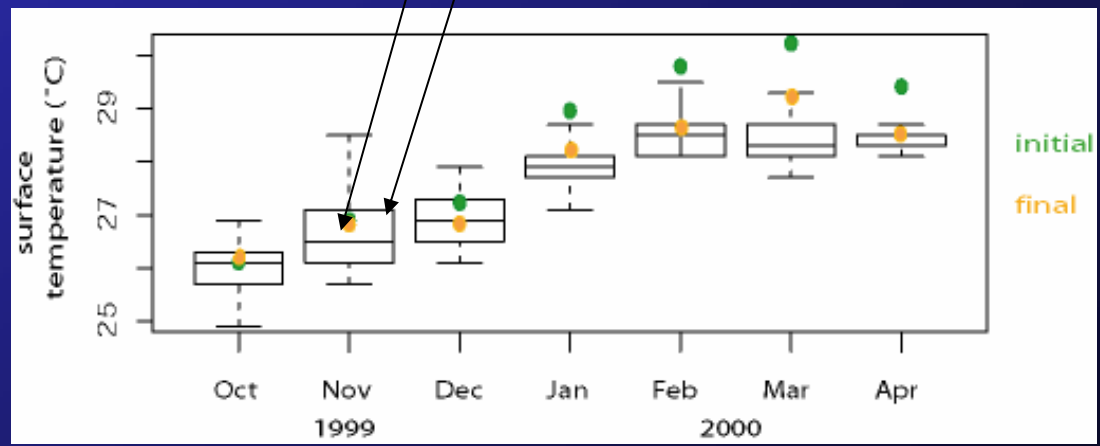
Horizontal movements

On a monthly scale : comparison between tag records and model outputs

1. comparison between surface temperatures :
- recorded by a tag (boxplot)
- extracted from the model (point = space-time average)

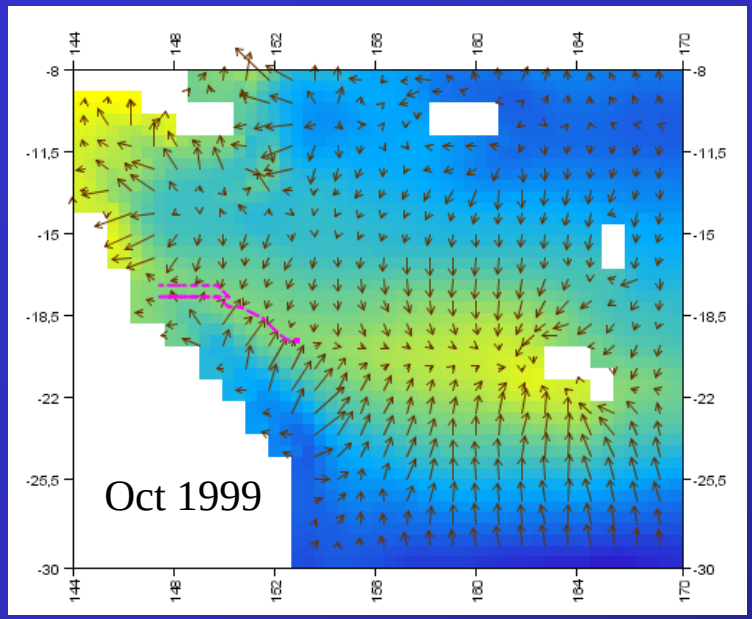


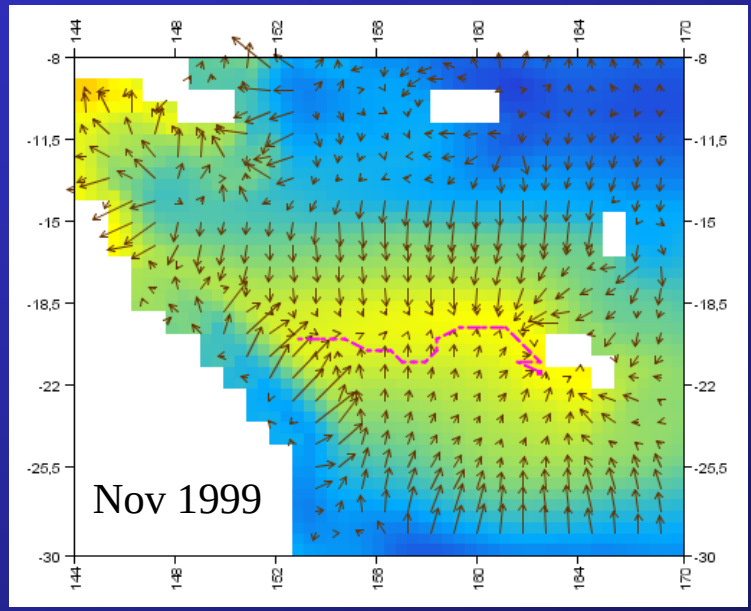
2. Correction of latitude values in order to reduce the discrepancies between tag and model values

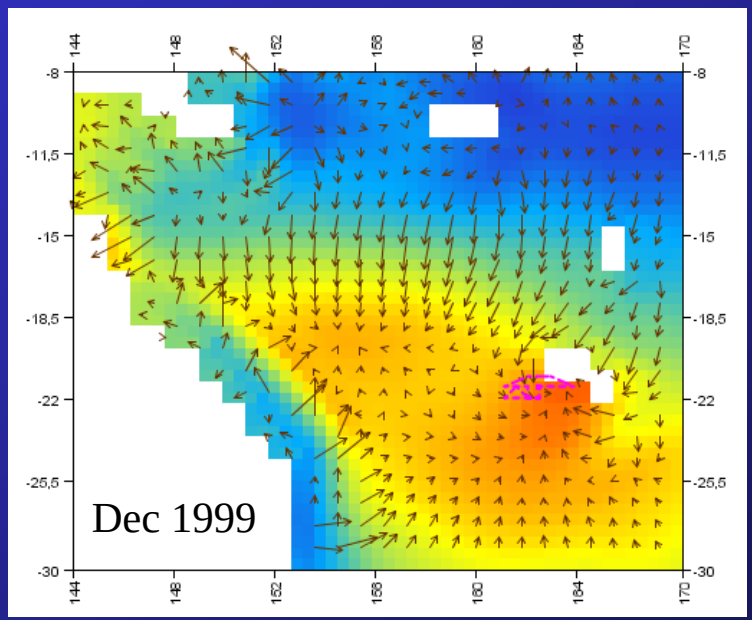


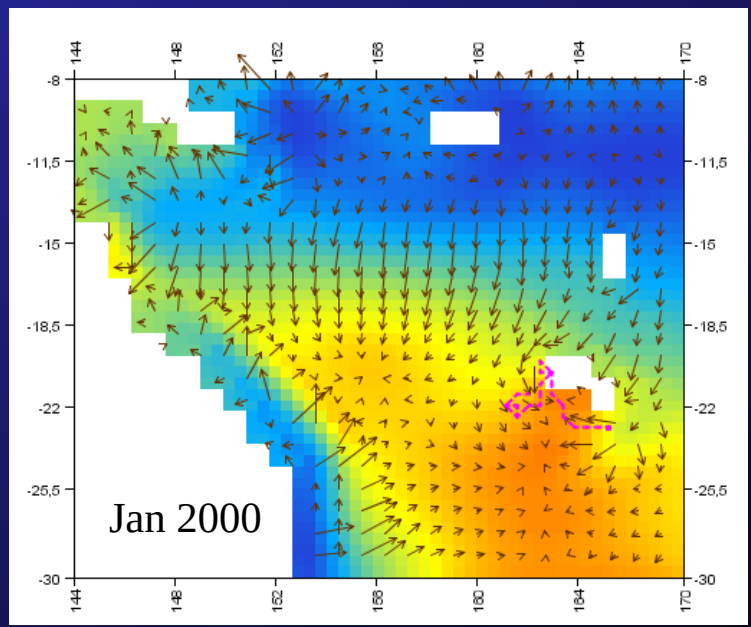
Horizontal movements

validation of ‘bigeye habitat’ in SEAPODYM









Vertical movements

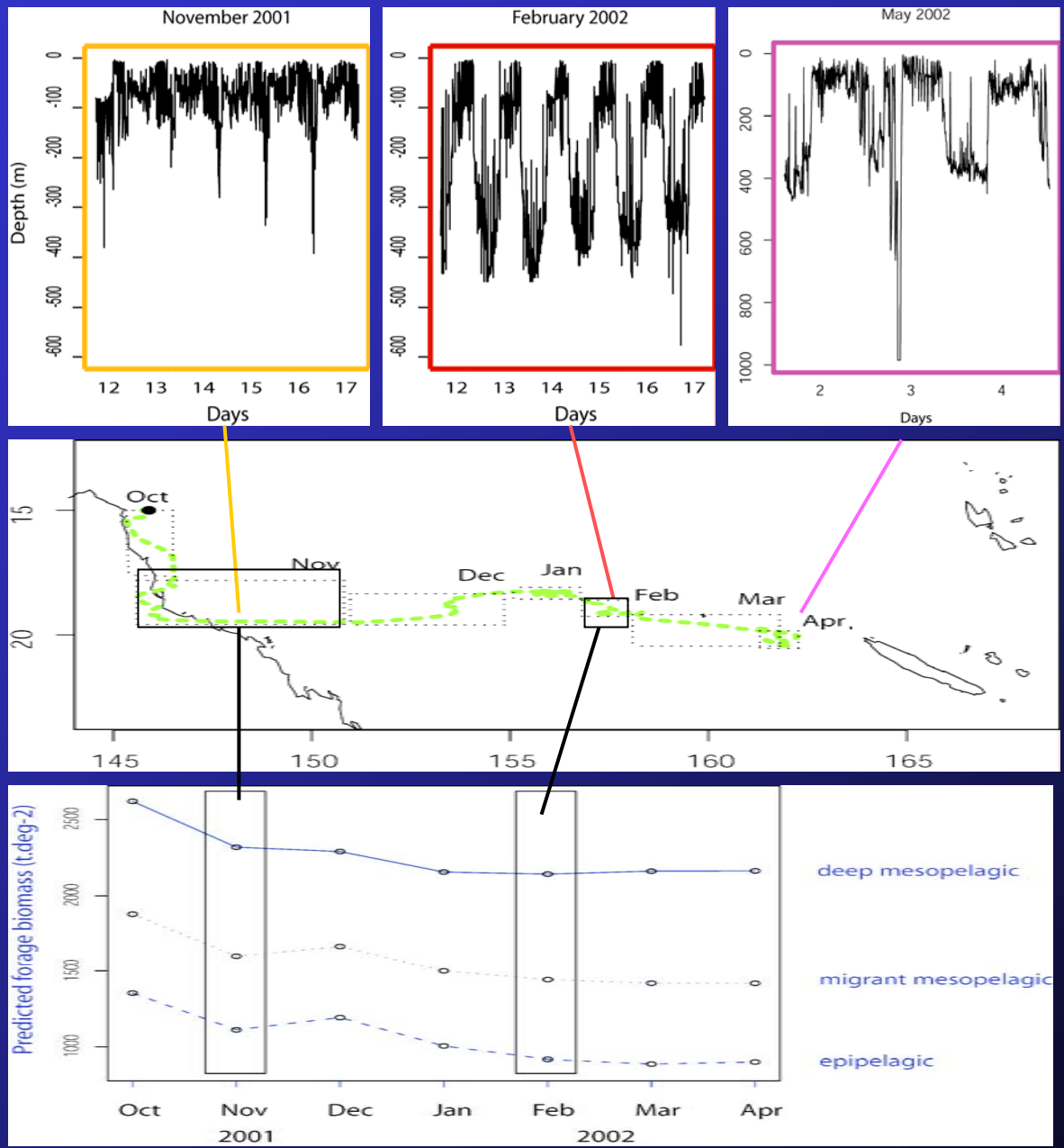
Types of behaviour :

‘classic’ (74%)
‘mixed’ (24%)
‘surface’ (1%)
‘deep dive’ (1%)

cf. Schaefer & Fuller 2002

Track (Kalman-filtered)

Space-averaged monthly values extracted from the ecosystem model



Duration : hours to weeks

Factors :
temperature
light (sun/moon)
food
physiology
age…

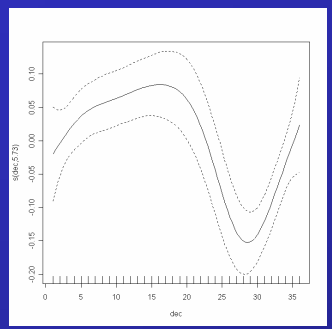
Common scale = 10-day periods

Forage biomass estimations aggregated by layer and day/night

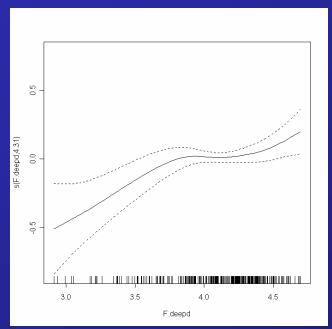
Variables calculated from tag depth records : mean depth during the day
depth variance during the night
% of time spent in the different layers

Generalized Additive Model :
stepwise selection of environmental covariates

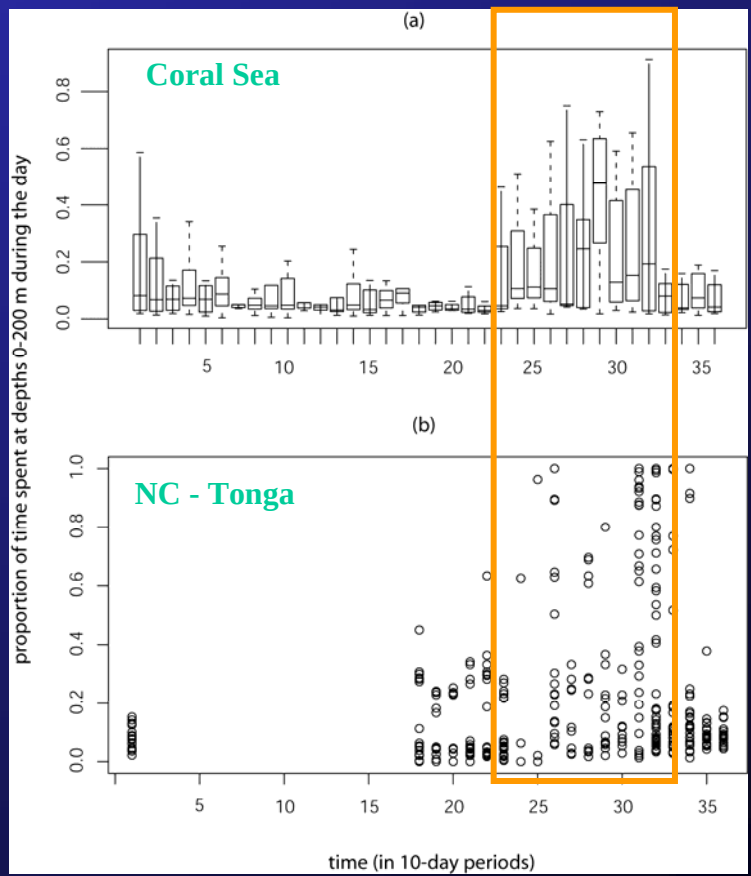
mean depth during the day
- varies with time
- increases with forage biomass in the deep layer



Time



Deep forage



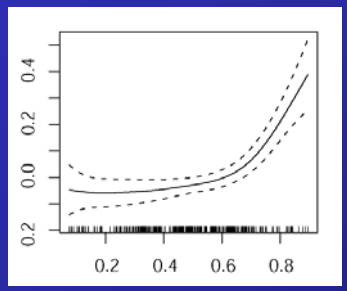
Seasonal shift in vertical behaviour :
more time spent in the surface layer
from August to November

Seasonal change in vertical behaviour :
August - November

- increase in day length and SST
- drop in primary production
- peak in forage biomass in the surface layer
  (cf. aggregations observed in the Coral Sea)

GAM without Time :

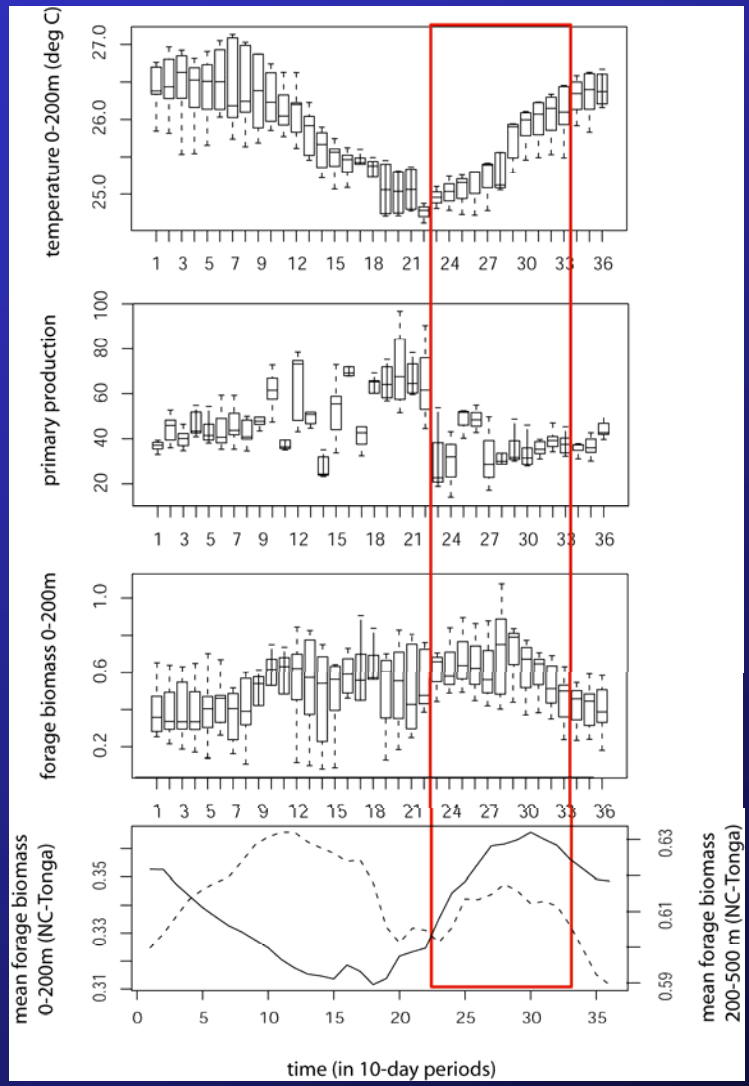
the % of time spent
in the surface layer
increases with
surface forage biomass

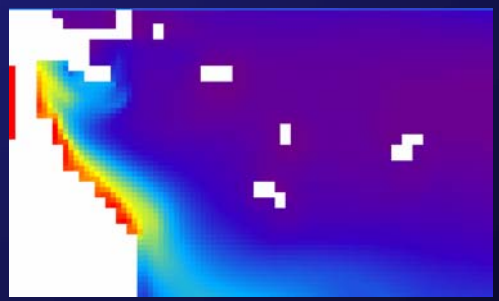


Surface forage

Roles of feeding and reproduction
in this change in vertical behaviour ?
(day + night)

Influence of this vertical change
on horizontal movements
(eastward return migration in the Coral Sea ?)





Surface forage
Biomass

October 2000

Conclusion

Critical points :

- position estimates (i.e. link between tag records and ocean models) especially for PSAT

- gap between tag and model scales

- validation of prey distribution

Perspectives :

- integrate the seasonal change in vertical behaviour into the parameterisation of 'bigeye habitat' in SEAPODYM

- use this approach to build rule-based (or adaptive) IBMs (Allain et al. 2004) / validate more theoretical IBMs (Kirby et al. 2003)

- simulation of BET spatial dynamics from individual to population scale