Toward a 3D approach of top predator foraging habitat and migrations through stable isotopes and mercury

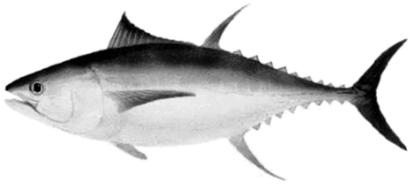
Anne Lorrain

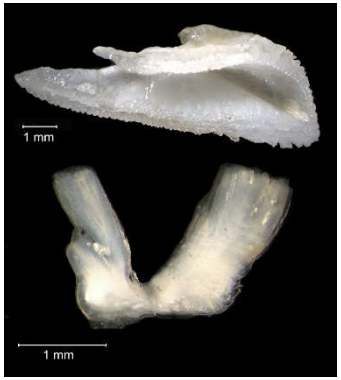
Houssard P, Allain V, Tremblay-Boyer L, Receveur A, Vourey E
Menkes C, Pethybridge H, Point D
and the CLIOTOP group

Pacific Community
Communauté du Pacifique

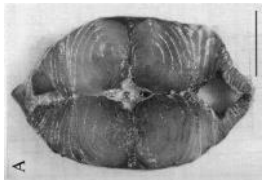
Institut de Recherche pour le Développement
FRANCE

Biochemical markers = naturals tags

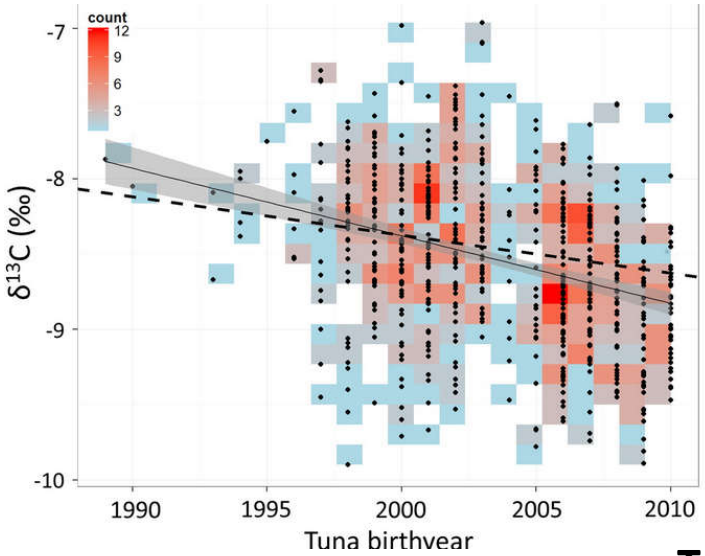


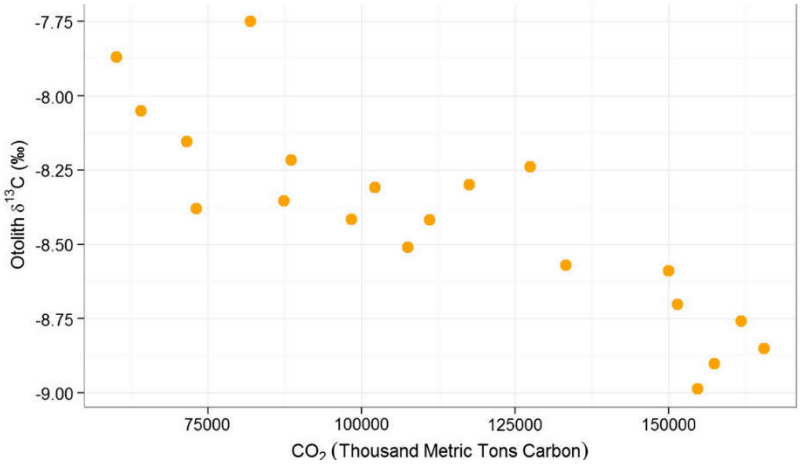


Otoliths = life history, inert material,
reflect of seawater chemical composition



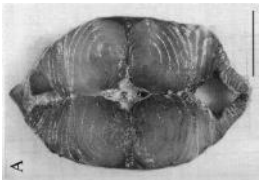
Muscle = metabolically active tissue
tissue turnover time 1 year
reflect assimilated food and the environment

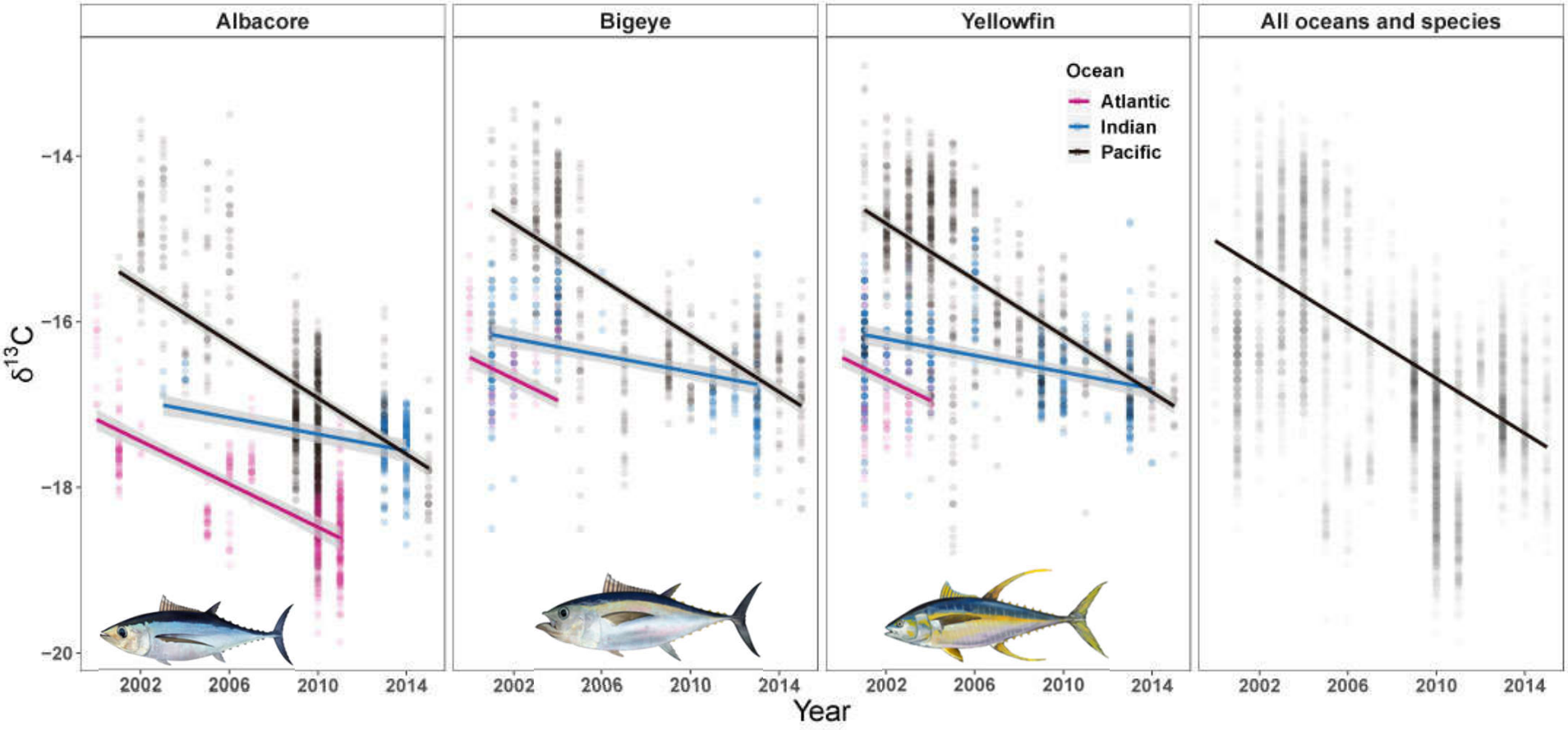




Tuna are tracking fossil fuel derived CO_2 (Fraile et al. 2016)

Trends in tuna carbon isotopes reflect global changes in fossil fuel CO_2 and pelagic phytoplankton communities





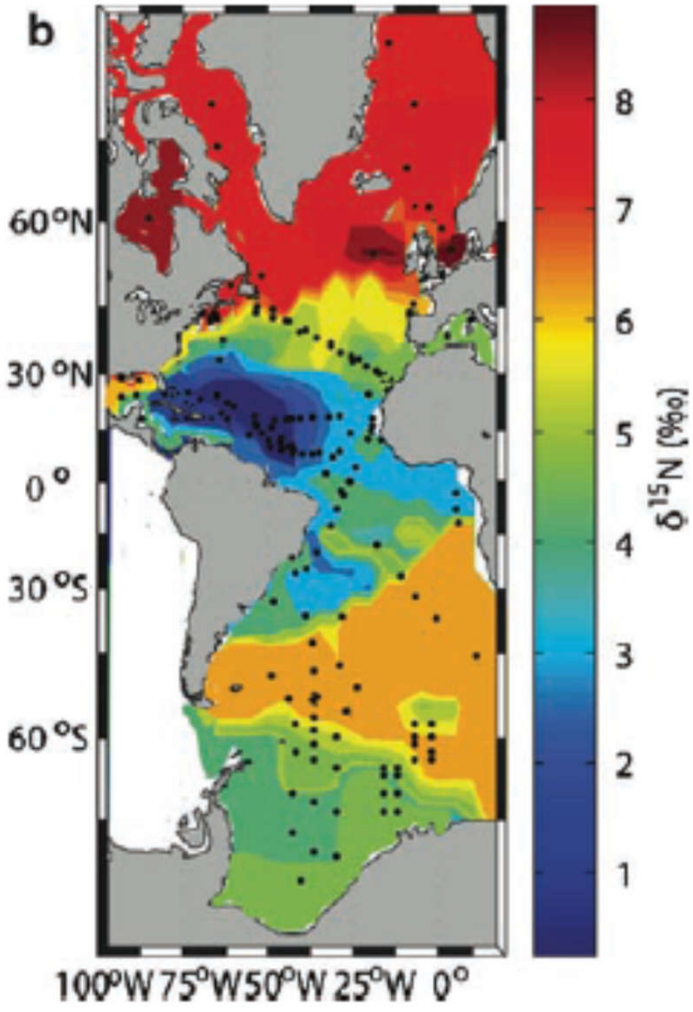
Lorrain et al., CLIOTOP group

Biochemical markers = naturals tags

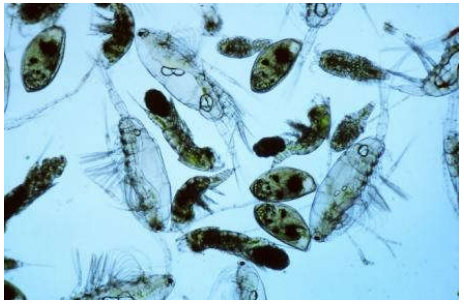
- Isotope techniques (C & N) can **trace trophic status and migratory patterns of predators** in the open ocean.

→ *Isoscapes*

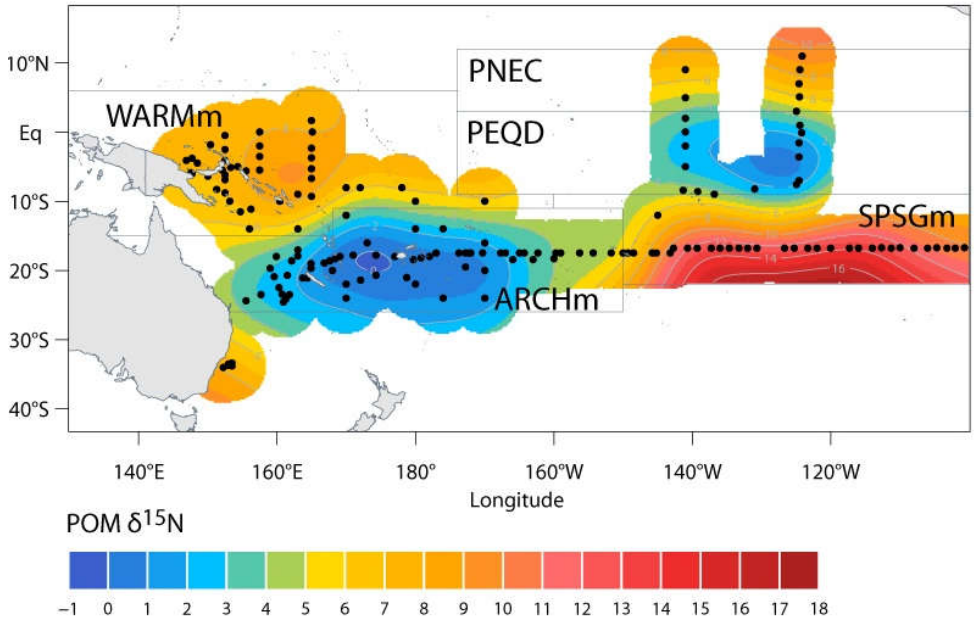
- Added value of Hg to monitor **foraging habitat in 3D?**



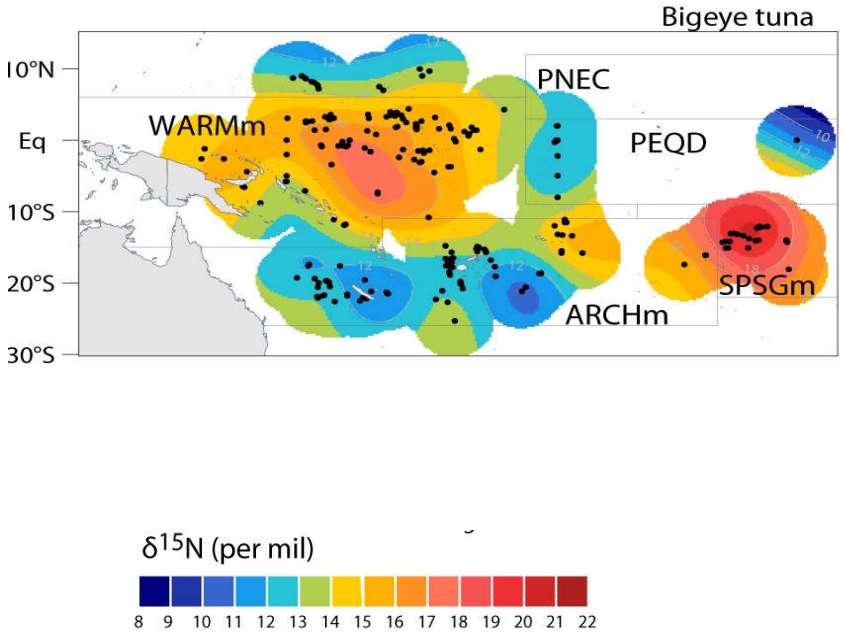
Graham et al., 2010



PACIFIC ISOSCAPES - $\delta^{15}N$



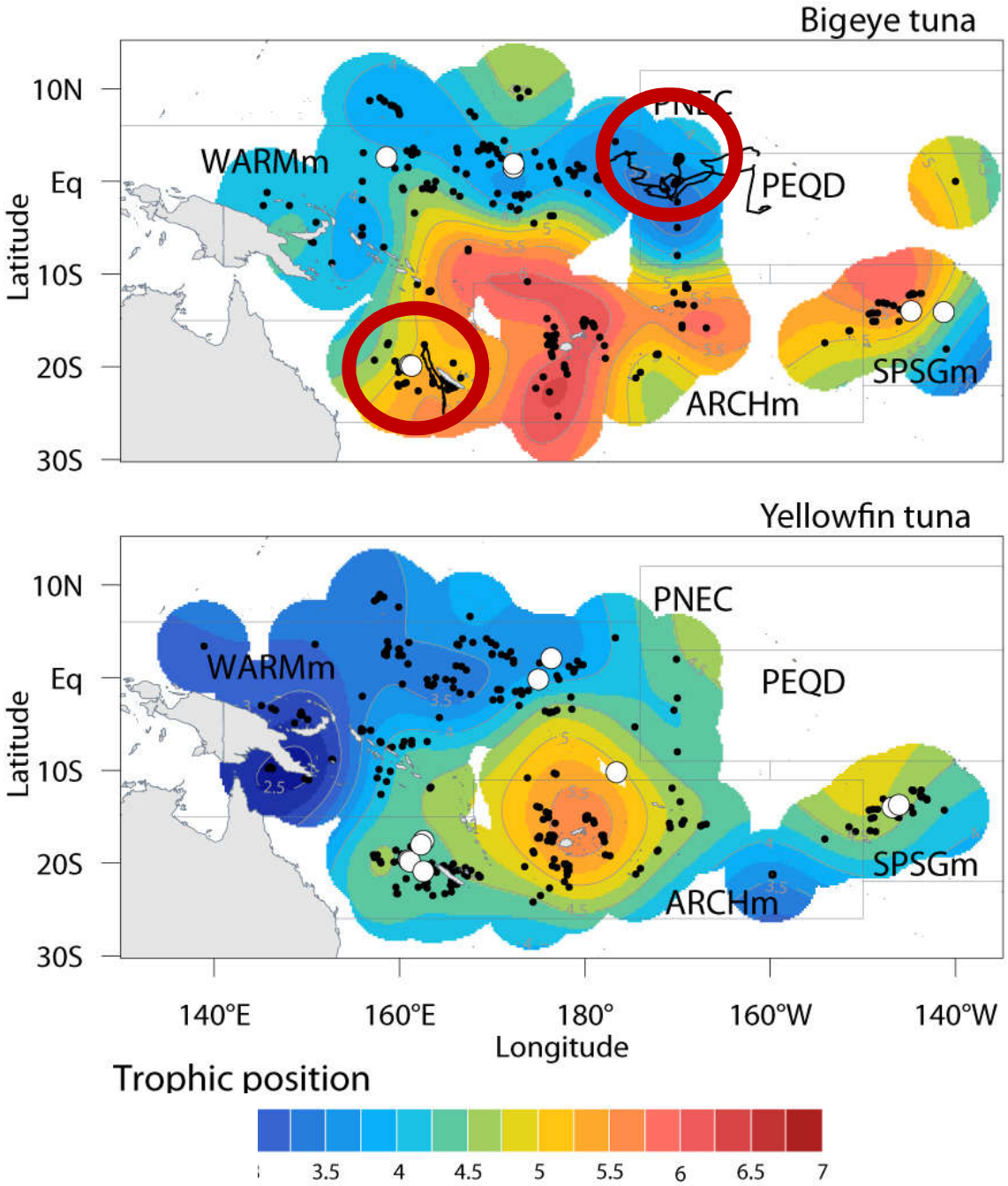
POM ISOSCAPE N = 165



Tuna ISOSCAPE N = 416,
size corrected (100cm)

Tuna are resident, low % of migrants
10°S limit: small latitudinal movements

Houssard et al. 2017

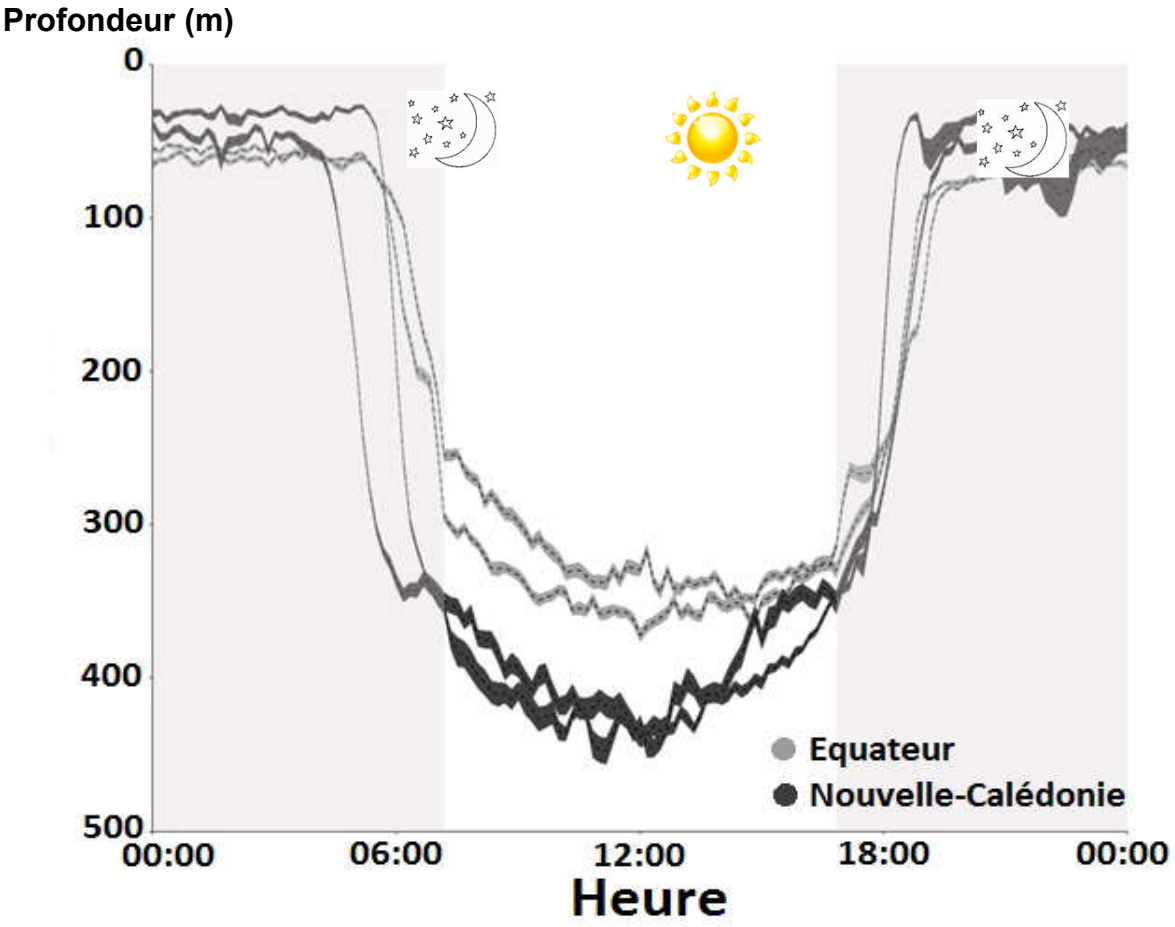


Link with thermocline depth

electronic tagging

Houssard et al. 2017

Spatial variations of their vertical habitat



Electronic tagging

- 4 BET

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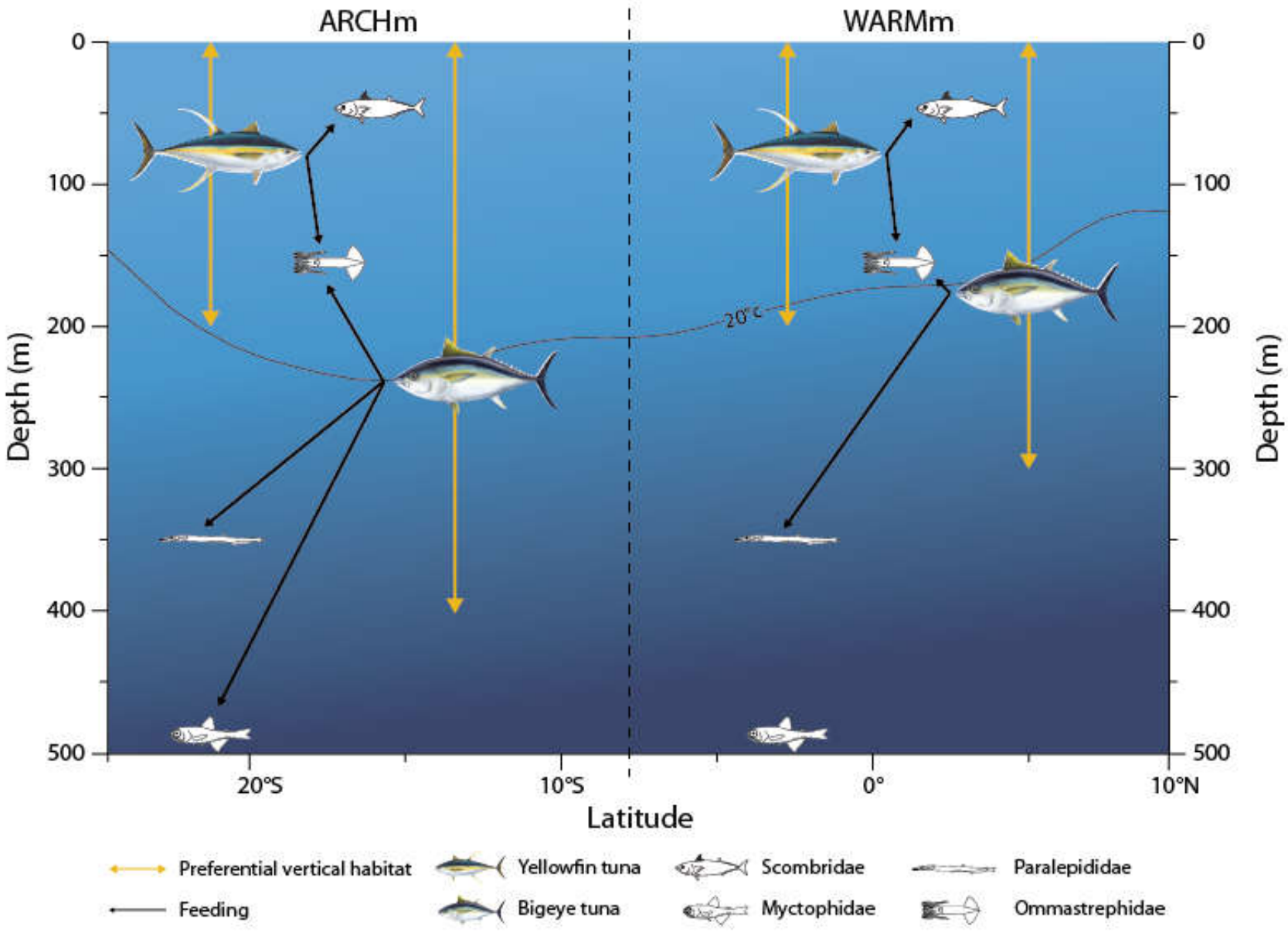
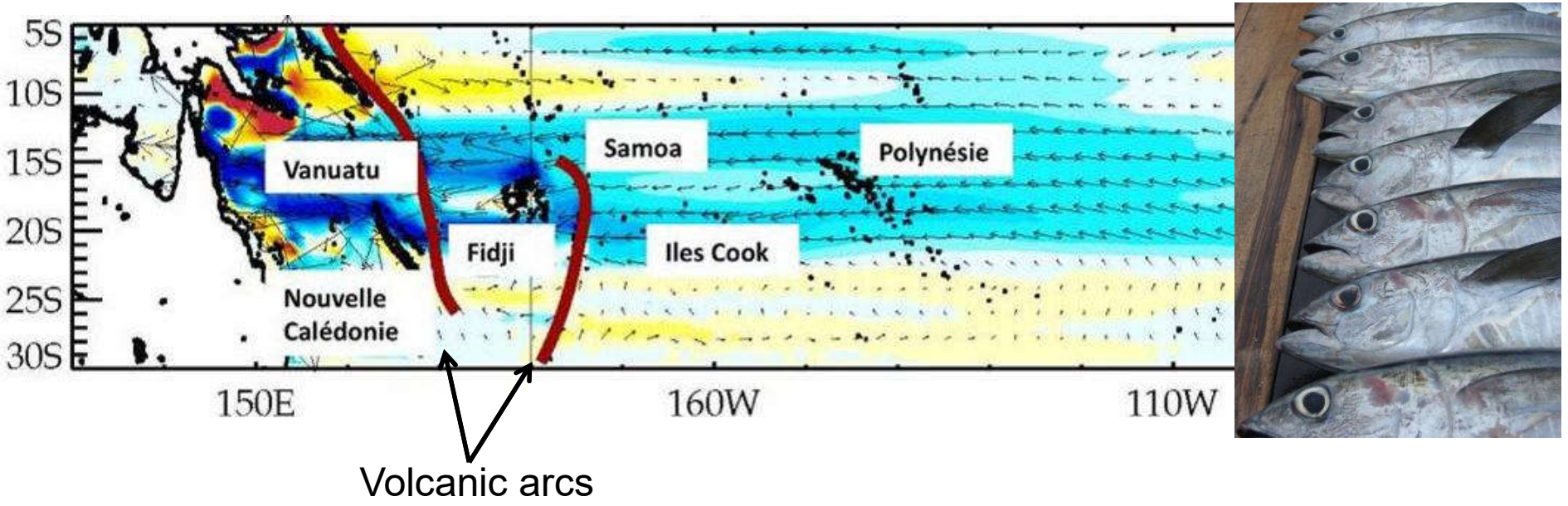
thermocline influences tuna vertical habitat

Different vertical habitat



Track migrations, trophic ecology and mercury contamination in tuna from the WCPO

VACOPA Project (2013-2017): spatial variations in tuna mercury concentrations



Biogeochemistry

Chemical markers

(C, N, Hg)

Ecology

Migration

Foraging

Habitat

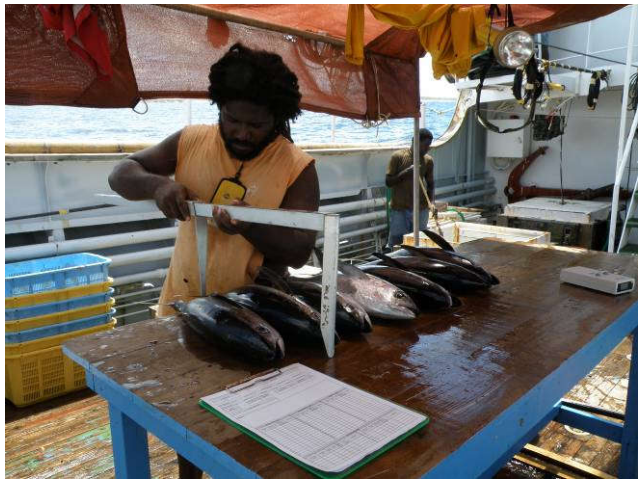
Oceanography

temperature

oxygen

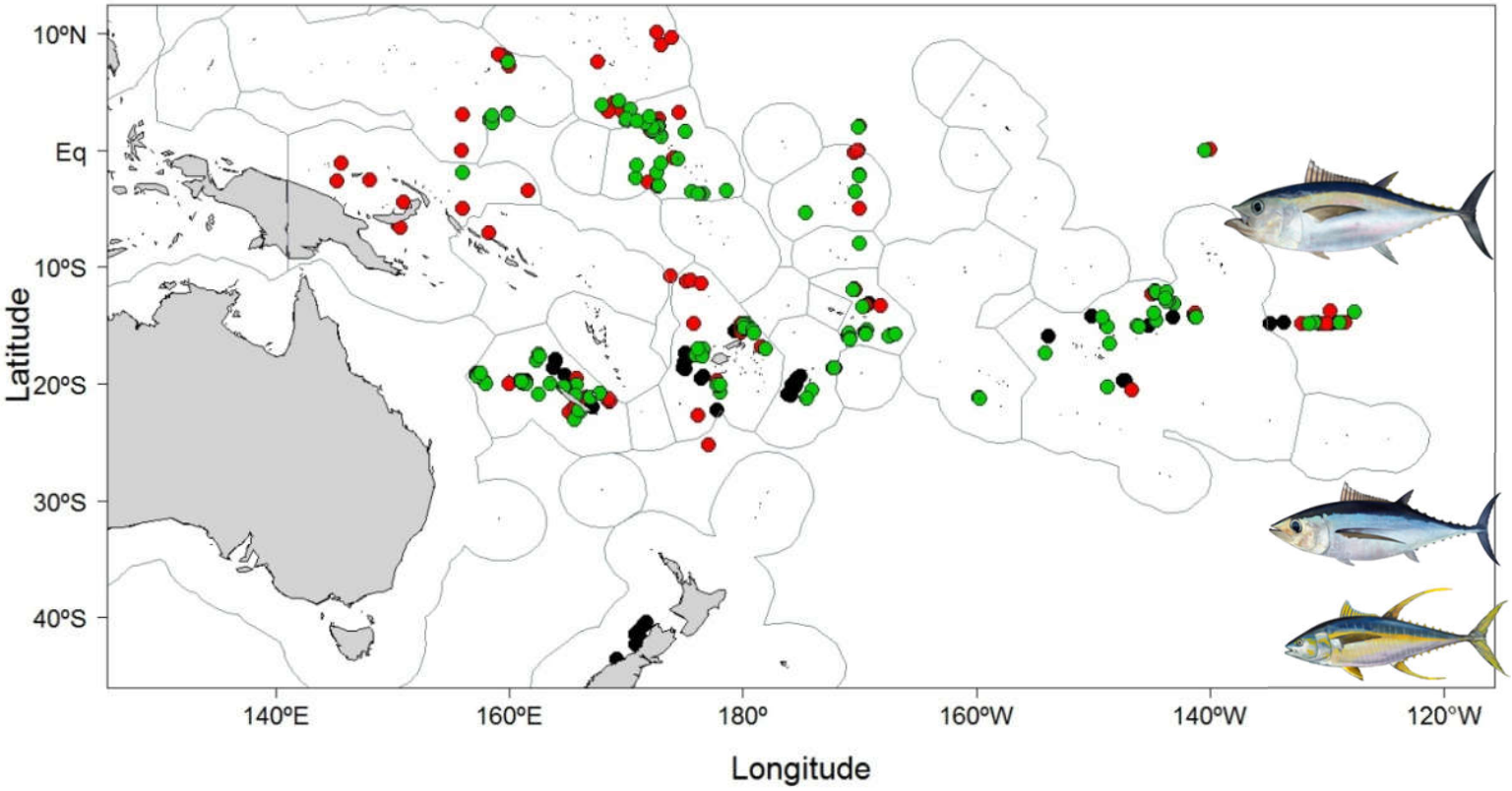
Productivity

SPC Tuna Tissue Bank Samples (2001-On going)

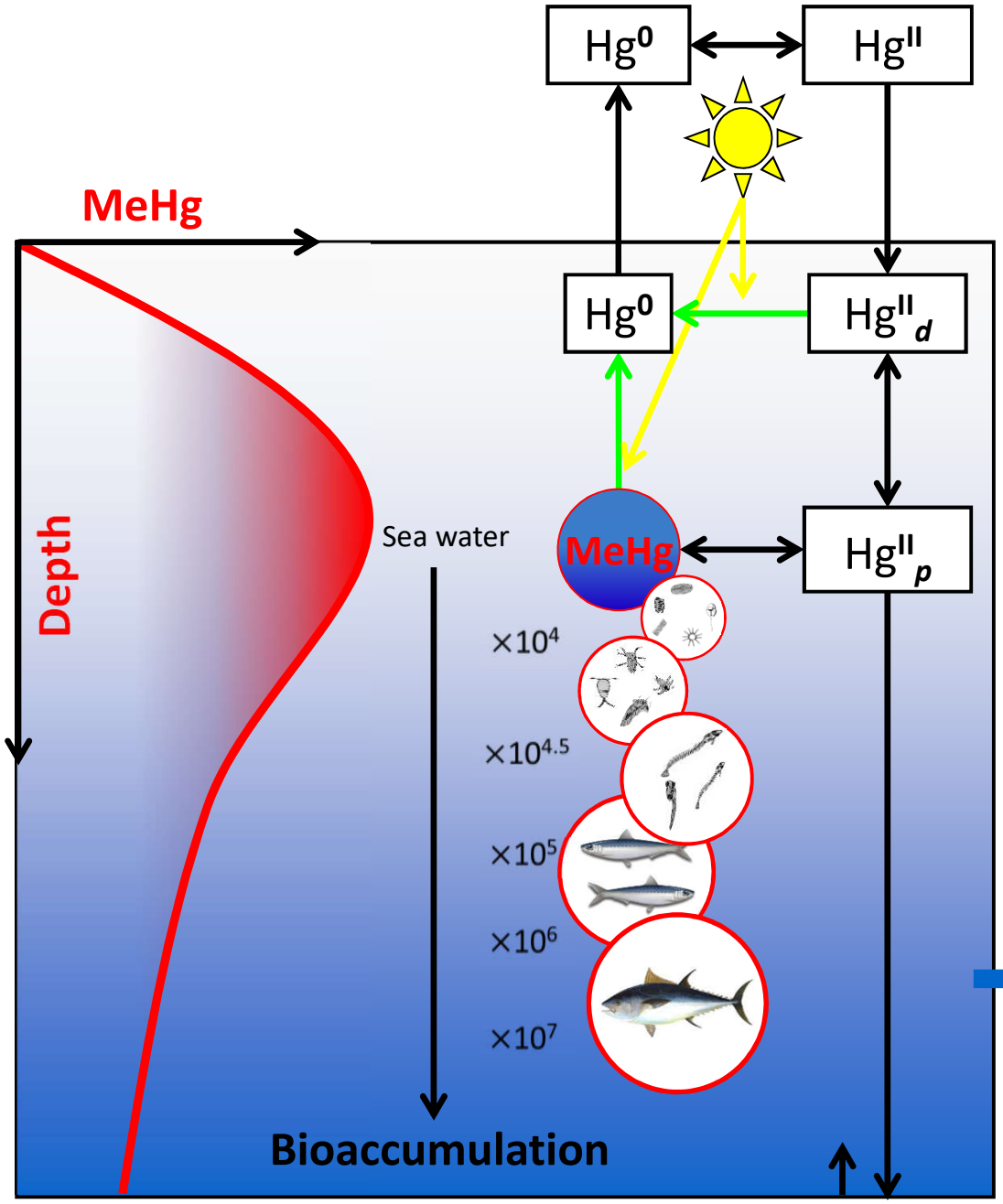


N = 1500

International observatory program



Simplified marine biogeochemical mercury cycle



- Atmospheric deposition
- *In situ* methylation of Hg^{II} to MeHg by bacteria in water-column
- Bioaccumulation of MeHg

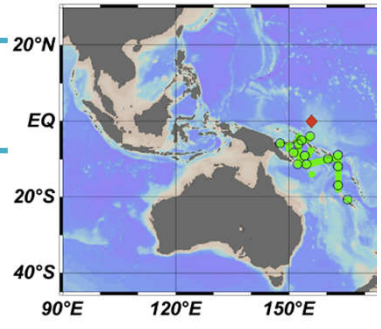
Size/Age

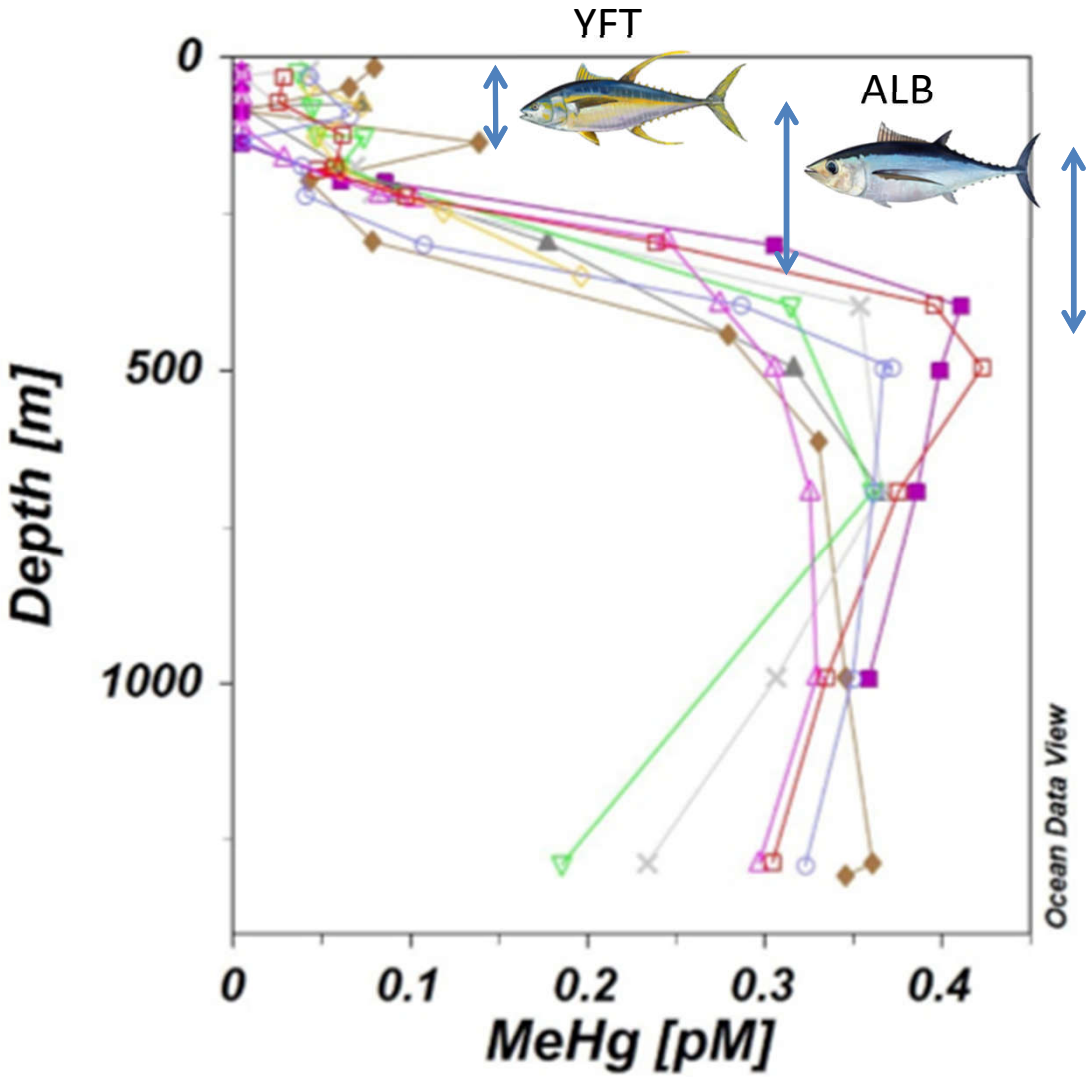
Trophic position

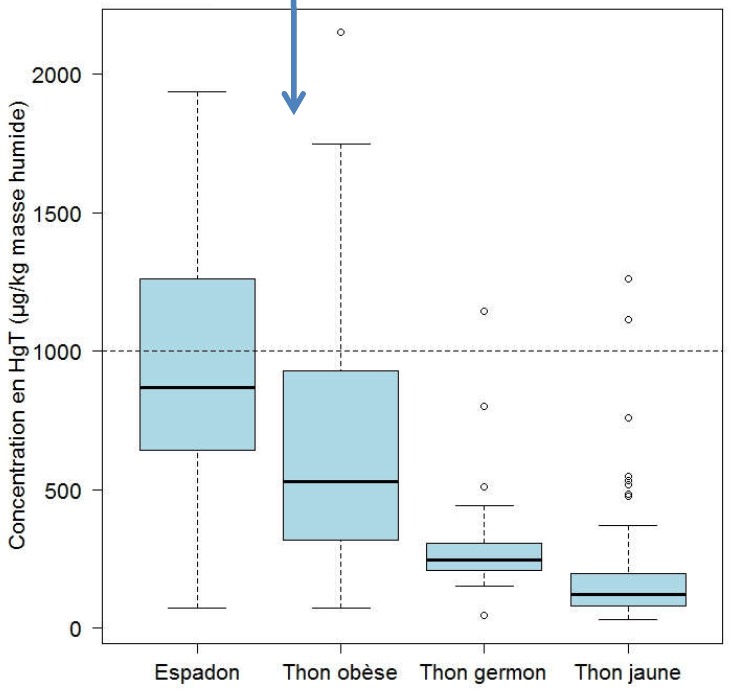
Foraging depth

Methylmercury cycle

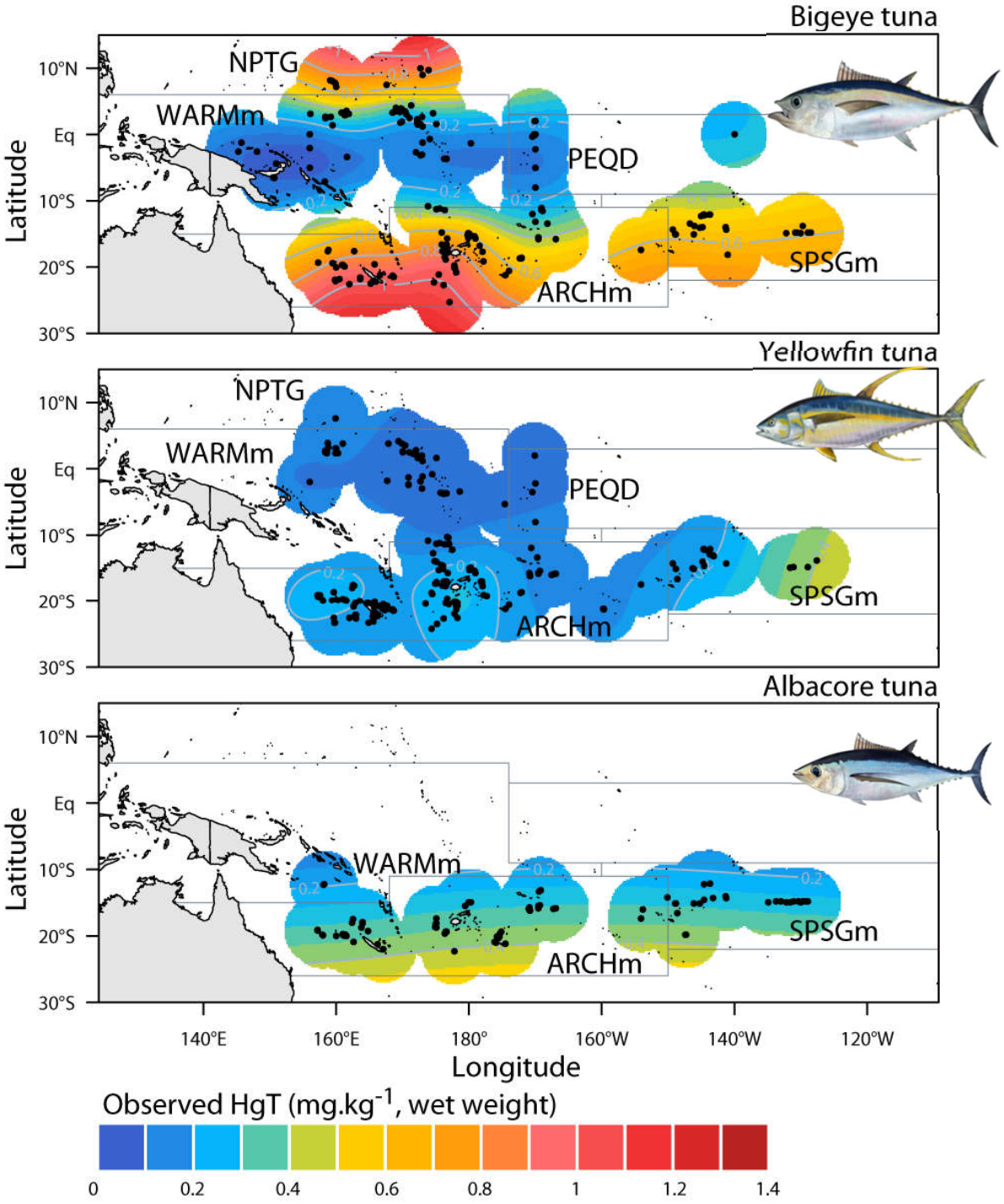
Foraging depth vs in situ oceanic MeHg formation







Lars-Eric Heimbürger et al. PANDORA cruise 2012



HgT

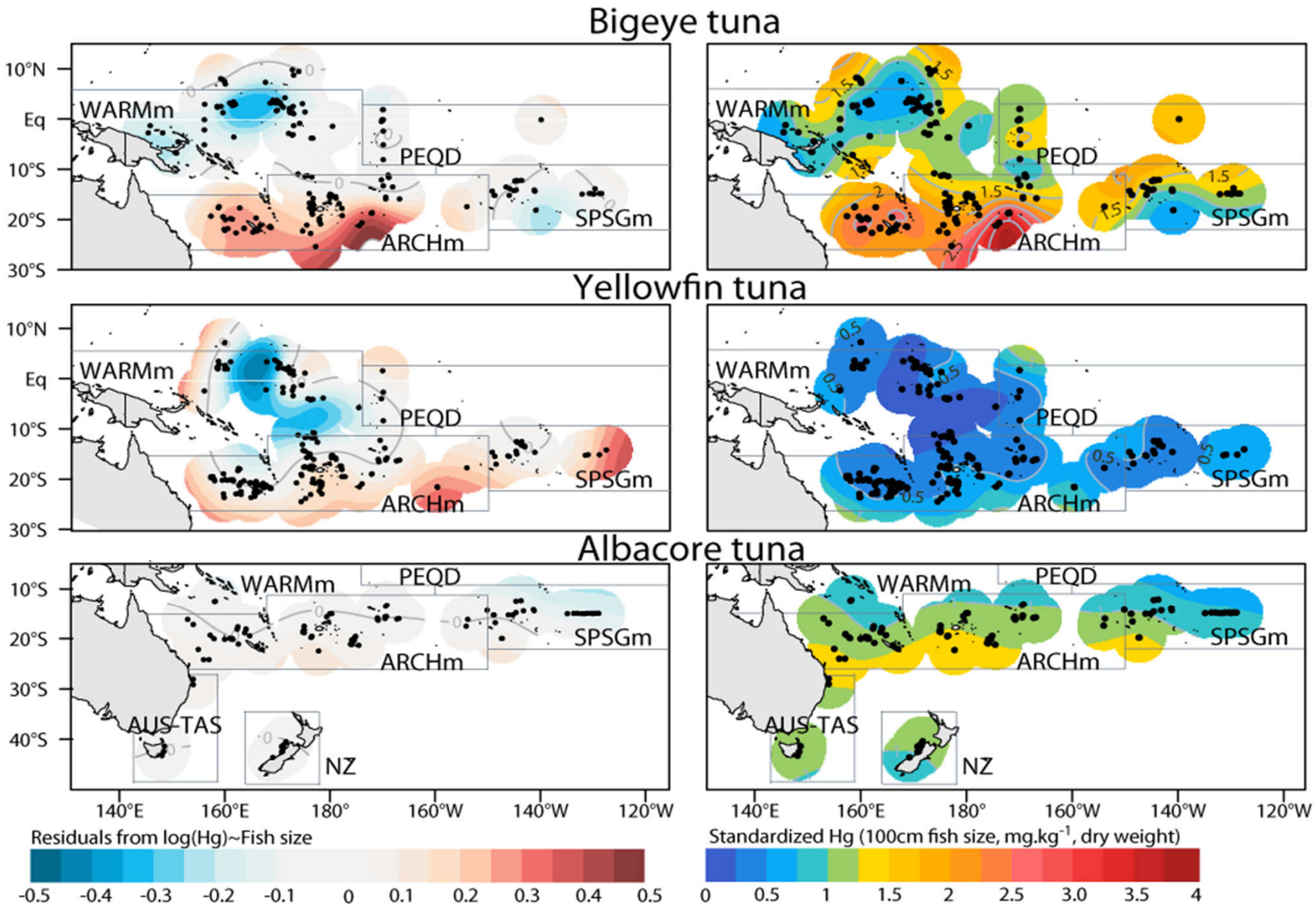
Size/Age

Trophic position

Foraging depth

Methylmercury cycle

Houssard et al. in revision


Bigeye tuna
Yellowfin tuna
Albacore tuna
WARMm
PEQD
SPSGm
ARCHm
AUS-TAS
NZ
10°N
Eq
10°S
20°S
30°S
40°S
140°E
160°E
180°
160°W
140°W
120°W
Residuals from log(Hg)~Fish size
-0.5 -0.4 -0.3 -0.2 -0.1 0 0.1 0.2 0.3 0.4 0.5
Standardized Hg (100cm fish size, mg.kg-1, dry weight)
0 0.5 1 1.5 2 2.5 3.0 3.5 4

Future: global scale

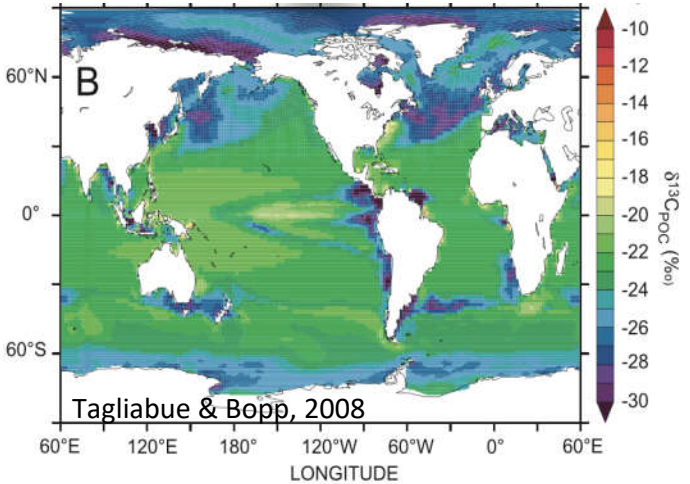
Task-team 2017-2018: Global analyses of top predator biomarkers ISOTOPES C & N

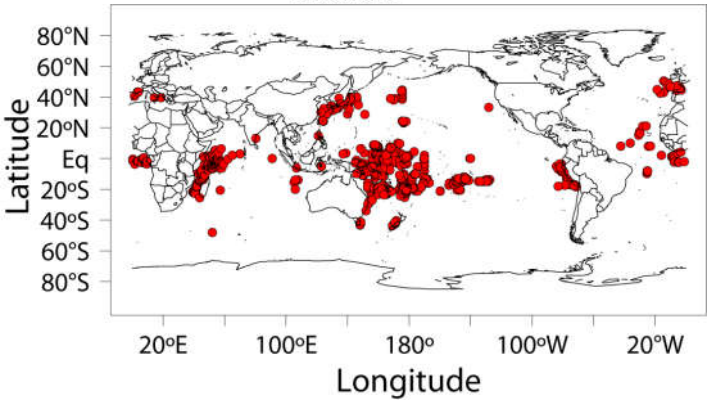
Co-leaders: H. Pethybridge (CSIRO, Tasmanie), A. Lorrain (IRD, Brest)

>18 members; 9 countries

More than 5000 data

ANR MERTOX (2018-2021)





nature ecology & evolution

ARTICLES

Bird et al. 2018

A global perspective on the trophic geography of sharks

WHERE DO SHARKS GO FOR DINNER?

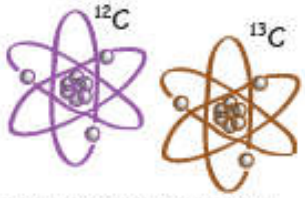
1.

GLOBALLY, SHARK POPULATIONS ARE DECLINING: TO PROTECT THEM, WE NEED TO KNOW HOW THEY MOVE AROUND THE OCEANS FOR FOOD

TRACKING SHARKS ACROSS THE OPEN OCEAN IS VERY DIFFICULT, SO WE TURNED TO FORENSIC TOOLS..

HOW IT WORKS.....

2.



TWO ISOTOPES BEHAVE DIFFERENTLY IN REACTIONS. . .

. . .INCLUDING DURING PHOTOSYNTHESIS. . .

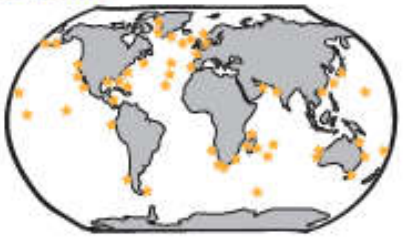
. . .LEADING TO DIFFERENCES IN ISOTOPE RATIOS IN PLANKTON ACROSS THE GLOBAL OCEAN

ISOTOPES IN PHYTOPLANKTON ARE PASSED THROUGH THE FOOD CHAIN TO SHARKS, LEAVING A CHEMICAL RECORD IN THE SHARK'S TISSUES OF WHERE THEY ATE

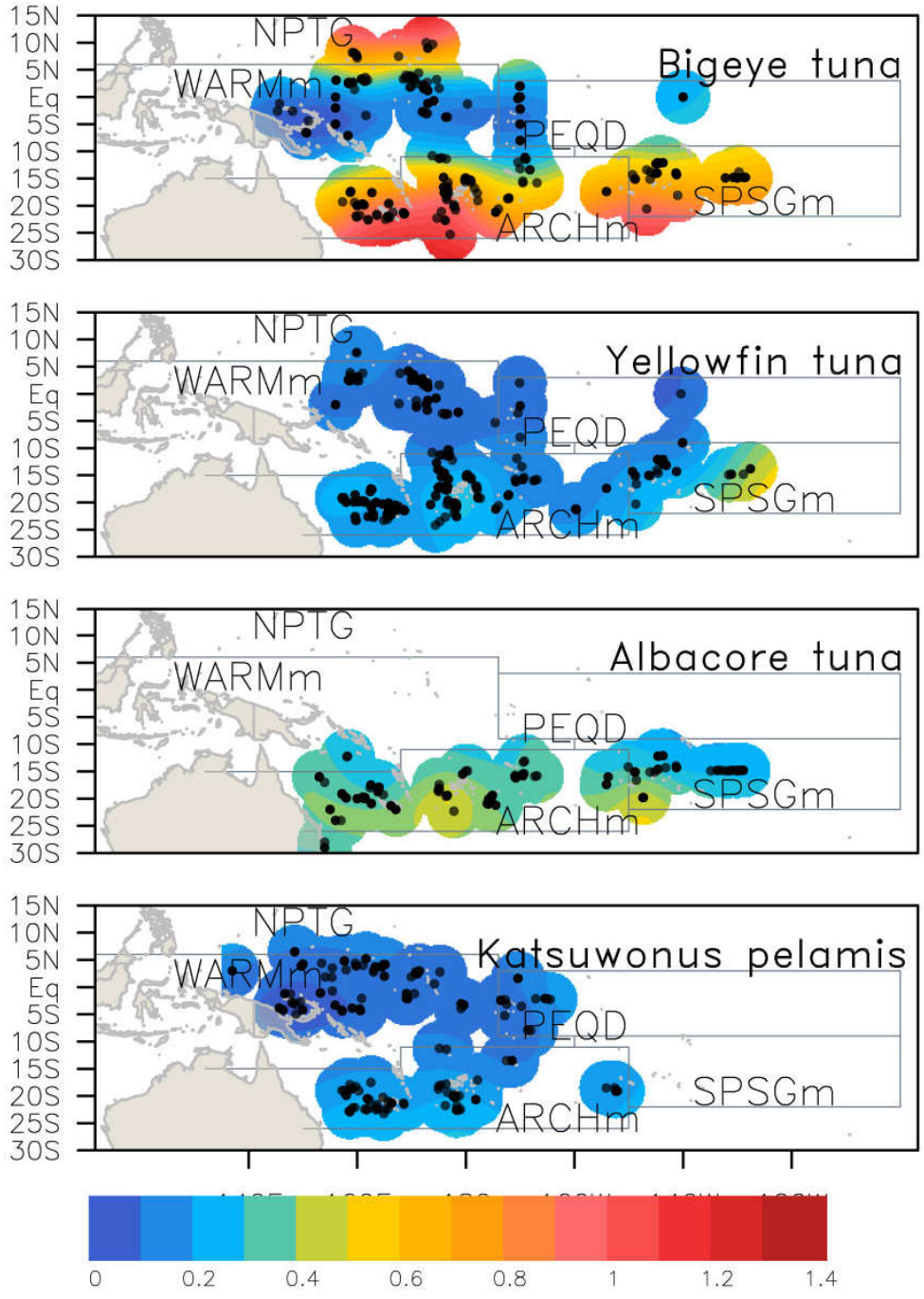
WHAT WE DID.....

3.

SCIENTISTS MEASURED ISOTOPES IN **5394** SHARKS FROM **114** SPECIES AROUND THE WORLD ....



. . . AND COMPARED THEM TO PLANKTON ISOTOPES FROM THE SAME PLACES


15N
10N
5N
Eq
5S
10S
15S
20S
25S
30S
NPTG
WARMm
PEQD
SPSGm
ARCHm
Bigeye tuna
Yellowfin tuna
Albacore tuna
Katsuwonus pelamis
0
0.2
0.4
0.6
0.8
1
1.2
1.4