



What do electronic tags offer in characterizing pelagic fish movement for stock assessment?

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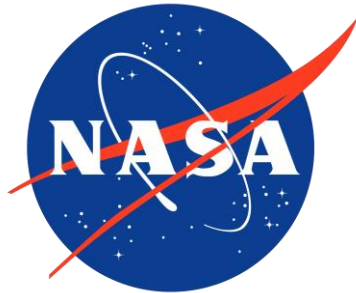
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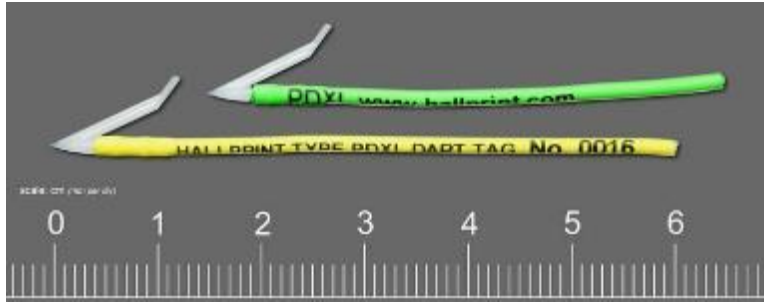


NOAA

FISHERIES SERVICE
Northeast Fisheries Science Center
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



Dart/ conventional



Equipment
unit cost (\$
USD)

< 2

Scientific
program
cost (\$ USD)

multi million

Typical
temporal
coverage

2 time points

Implanted data logger



~ 1000

multi million

years

longest data to date = 4.1 yr

Popup satellite archival



~ 4000

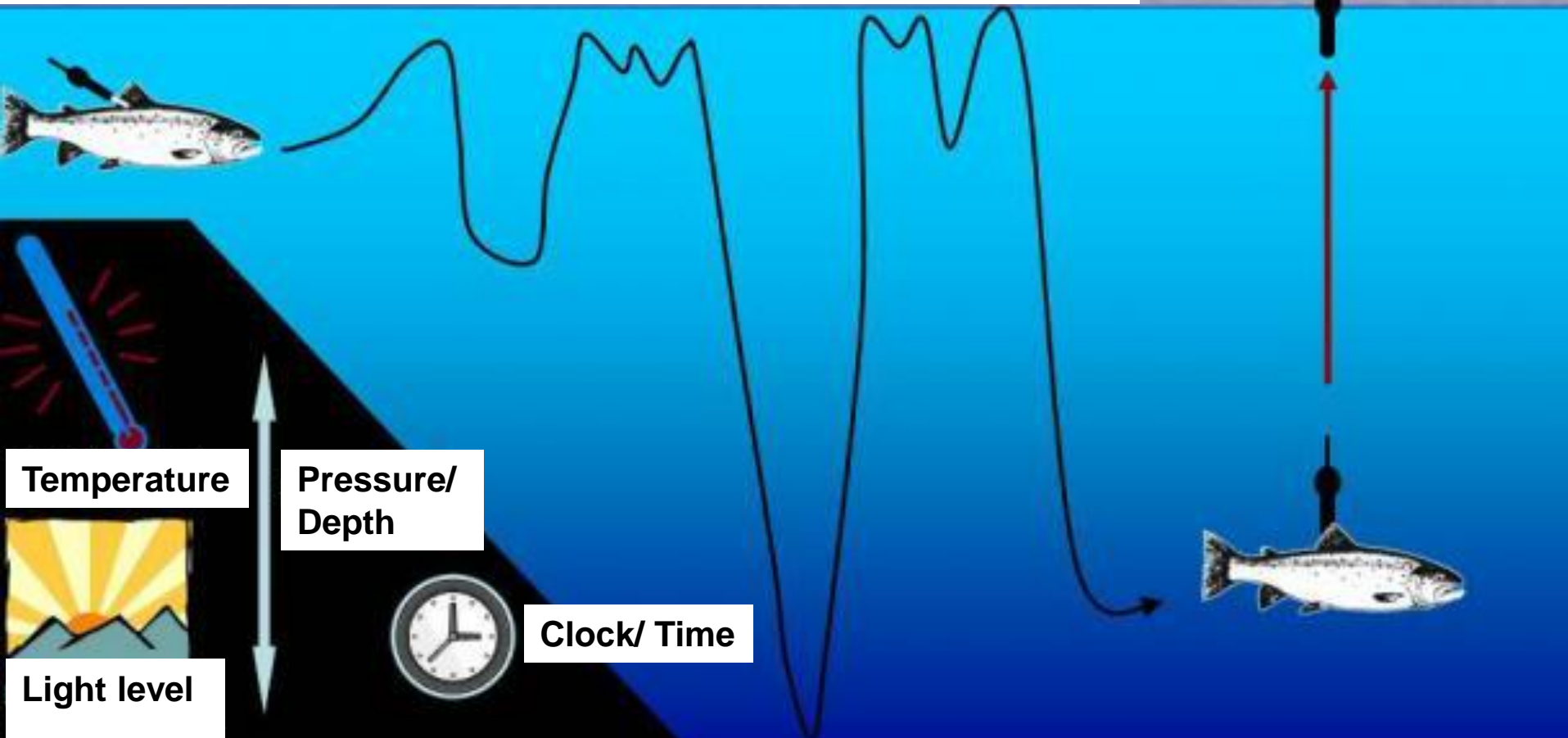
< 1 million

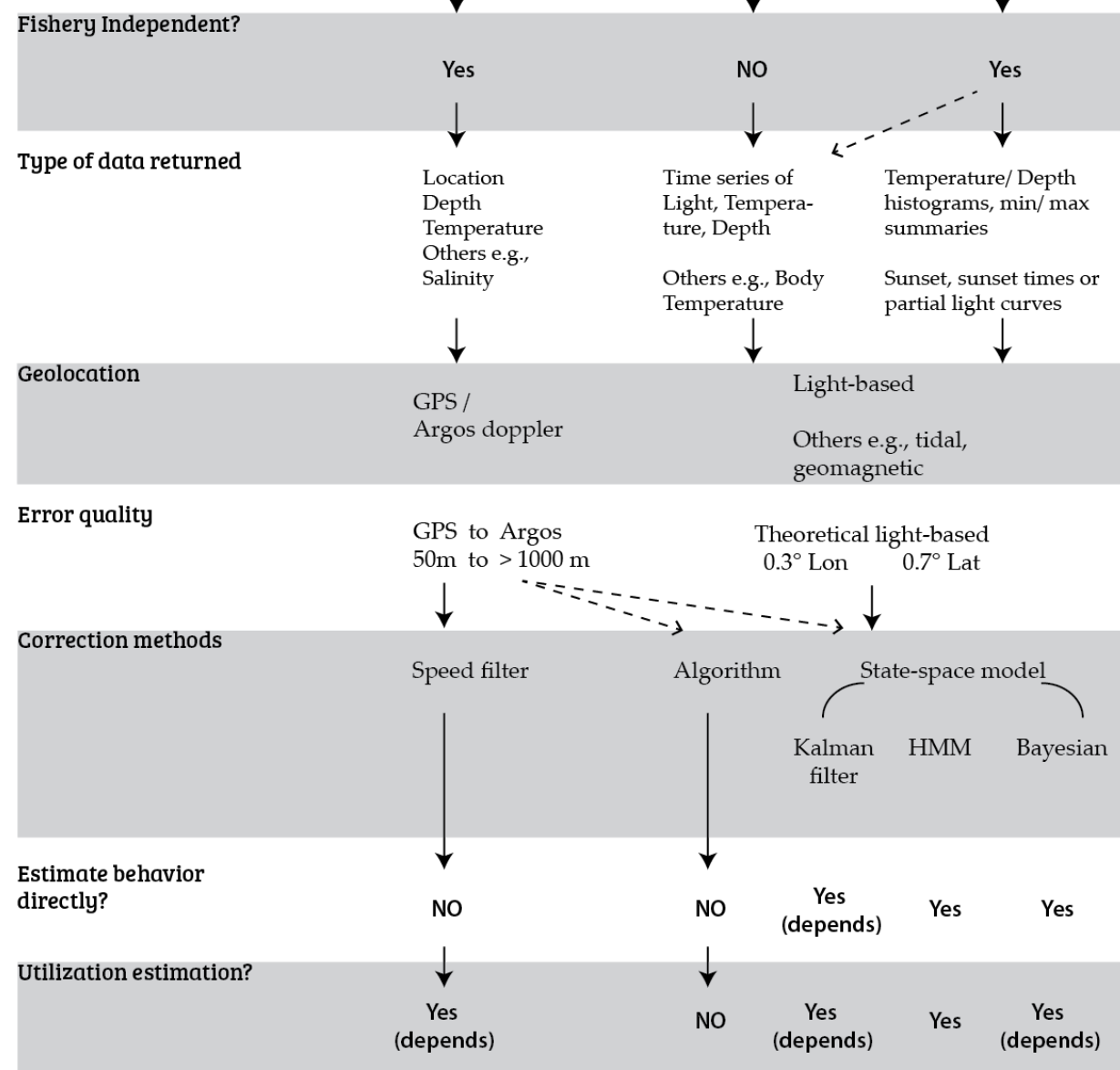
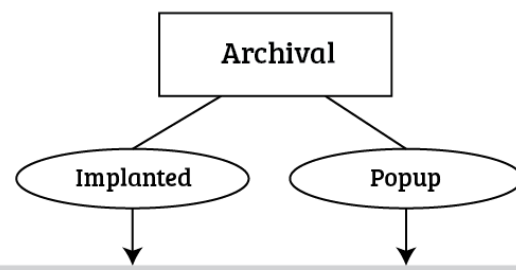
months

longest data to date = 411 d

Perspective # 1

Except for internal temperature obtained via an implanted tag, **all sensor data are physical measurements of the environment that a fish has passed through**



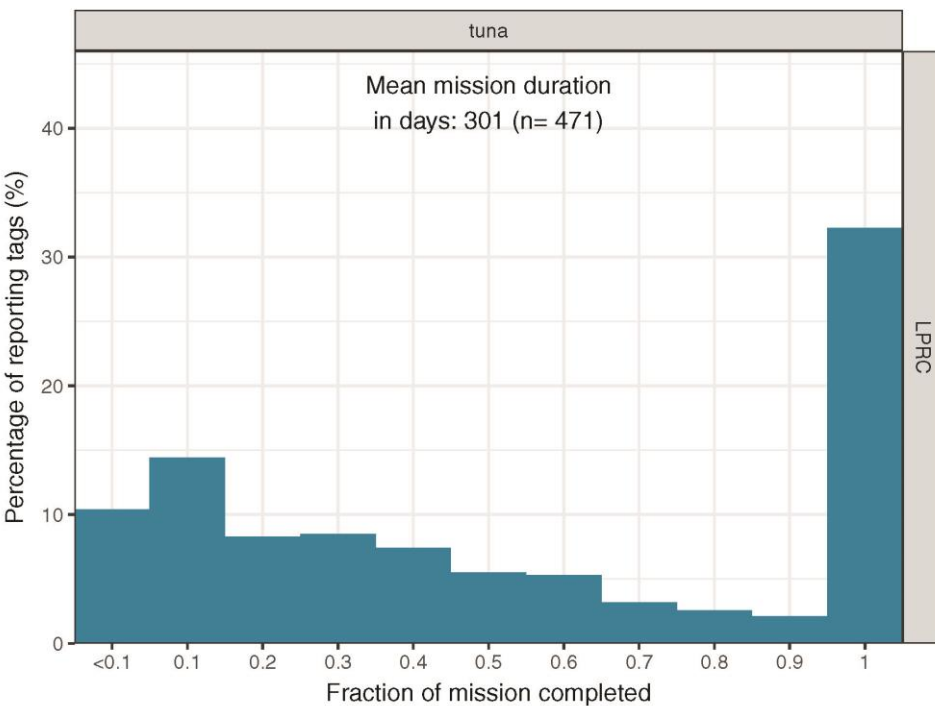
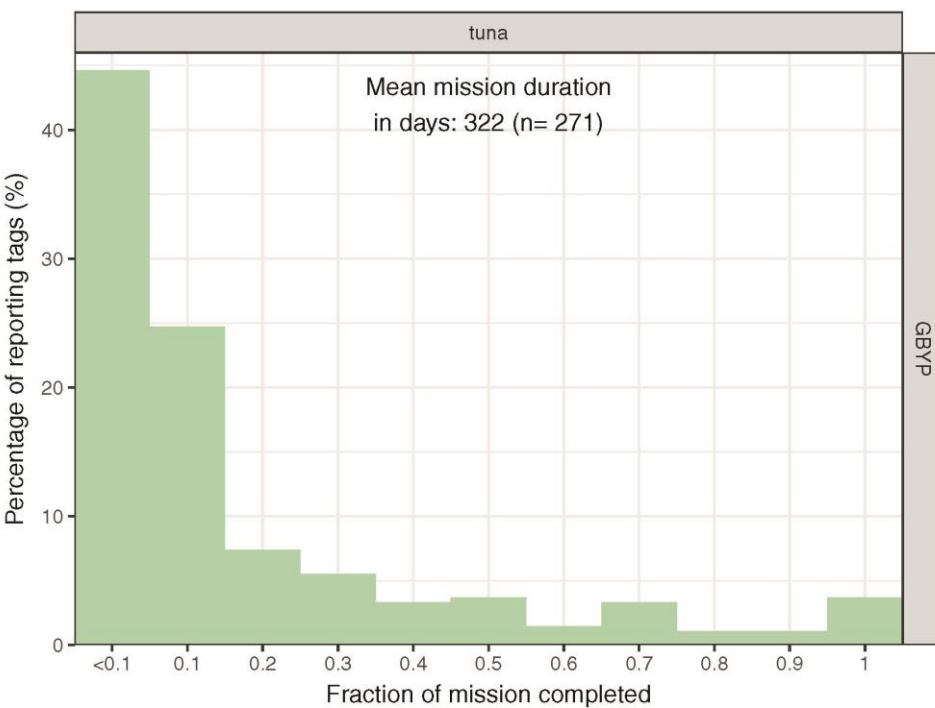


Perspective # 2

All positions are derived and have various degree of estimation errors

that can't be easily quantified without double tagging

Data collection



- Team technical know-hows & field experience
- Personnel consistency
- Animal care
- Experimental design
- Equipment failure
- Manufacturing Quality Control
- LUCK

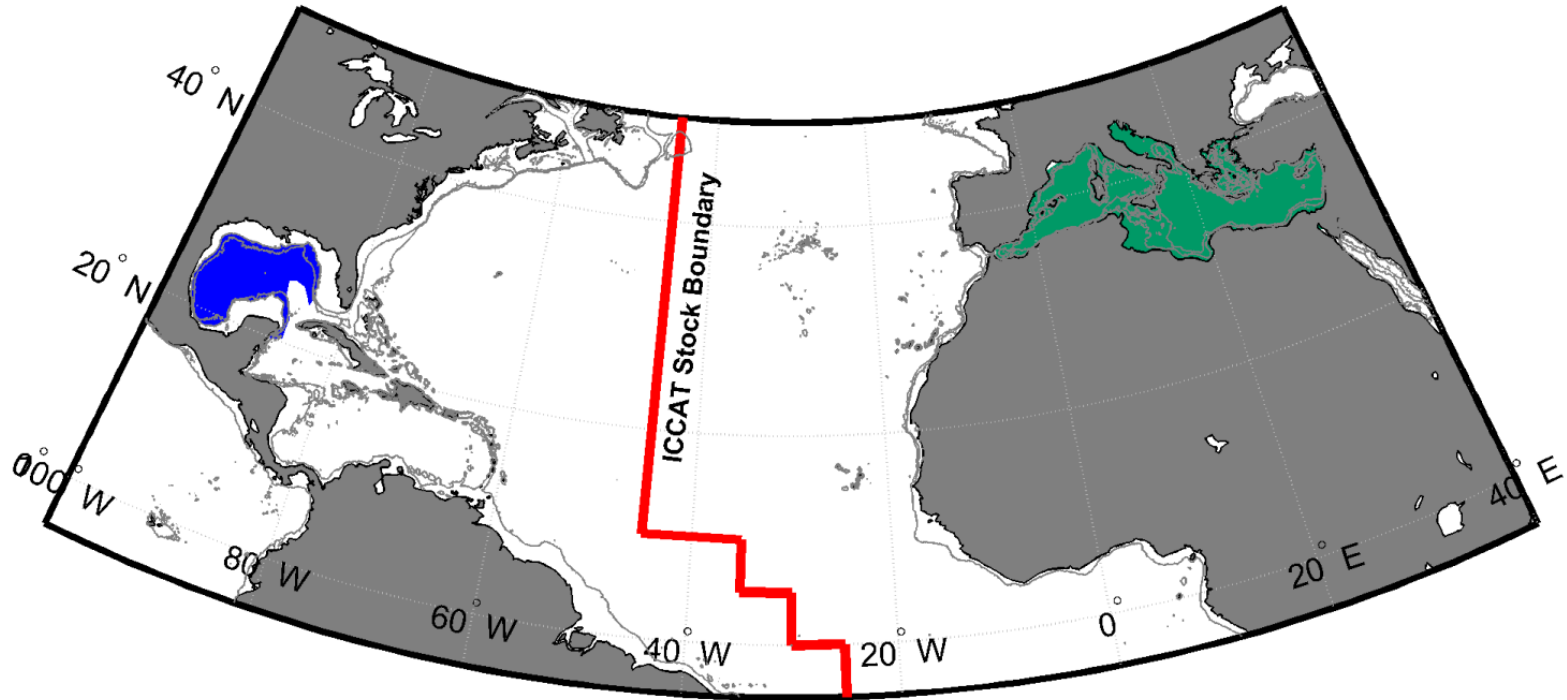
Major issues

1. No idea on the motivations behind an individual fish's movement

- A. Schooling and socio-behavioural factors
- B. No understanding on prey dynamics and their movement
Golet et al. 2013. PLOS One 8(9): e75480
Duffy et al. 2017 Deep Sea Res II 140:55-73
- C. Unquantified influences of FADs
Kurt and Dan's earlier work
Philips et al. 2017 PLOS ONE 12(6): e0179045

2. Limited ability to observe multi-year movements

Case study: Atlantic bluefin tuna



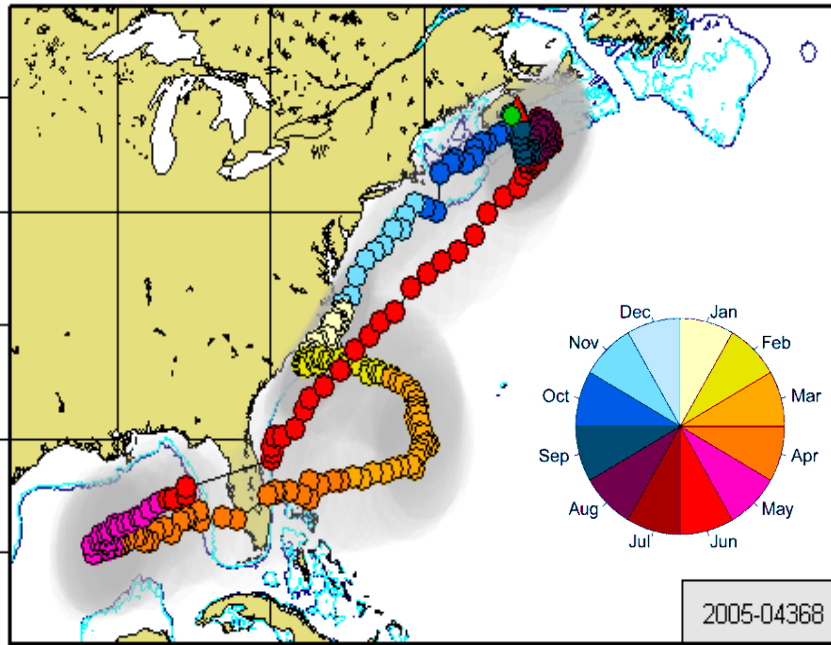
- **Spawning grounds established by histological studies and larvae found inside 2 enclosed seas**
- Limited sampling efforts elsewhere : expensive \$\$\$
- **Assessed as 2 separate stocks – an eastern Atlantic stock that spawns in the Mediterranean Sea and a western Atlantic stock that spawns in the Gulf of Mexico**
- Fish recognized to be cross the management boundary but presumed only for feeding

Interpreting electronic tagging data on giant bluefin

Tags can't observe behaviour

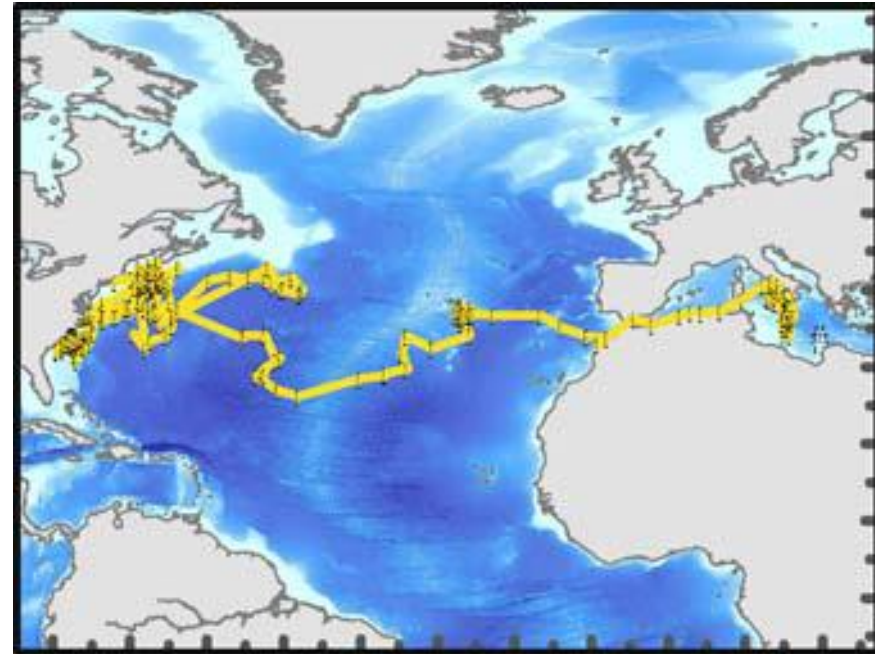
- “Classical” adult: forage in temperate waters, spawn in an enclosed sea

Western origin



Galuardi et al. 2010 Can. J. Fish. Aquat. Sci. 67:966-976.

Eastern origin



Boustany et al. 2008 Mar Biol 156(1):13-24 Fig. 2B

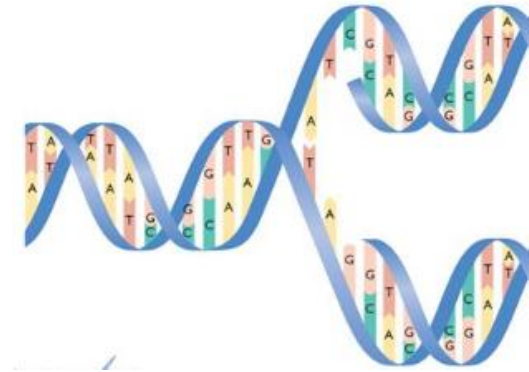
Over 50% of adult did not visit either spawning sites during the presumed spawning months (*e.g., Walli et al. 2009 PLOS ONE 4(7): e6151 Table S1, 55 out of 94 tracks, 392-3073 days at liberty*)

Genetics and chemistry

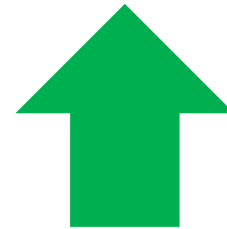
The other “tags”

Bluefin tuna

- Markers only have regional-scale resolution
- Assignment requires the assumption that a fish is born from either 1 of the two spawning grounds, and would return to the same spawning ground when they are mature
- Assumptions largely based on inferences from tracking data



Genetics & chemistry

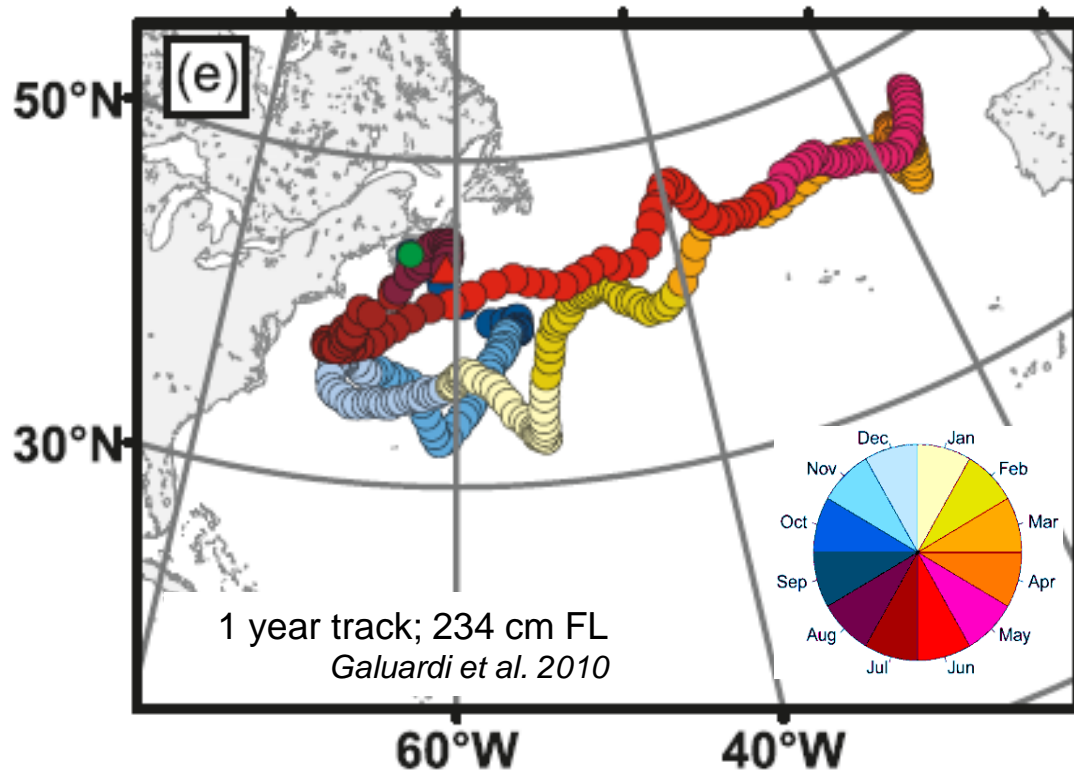


Movement from e-tags

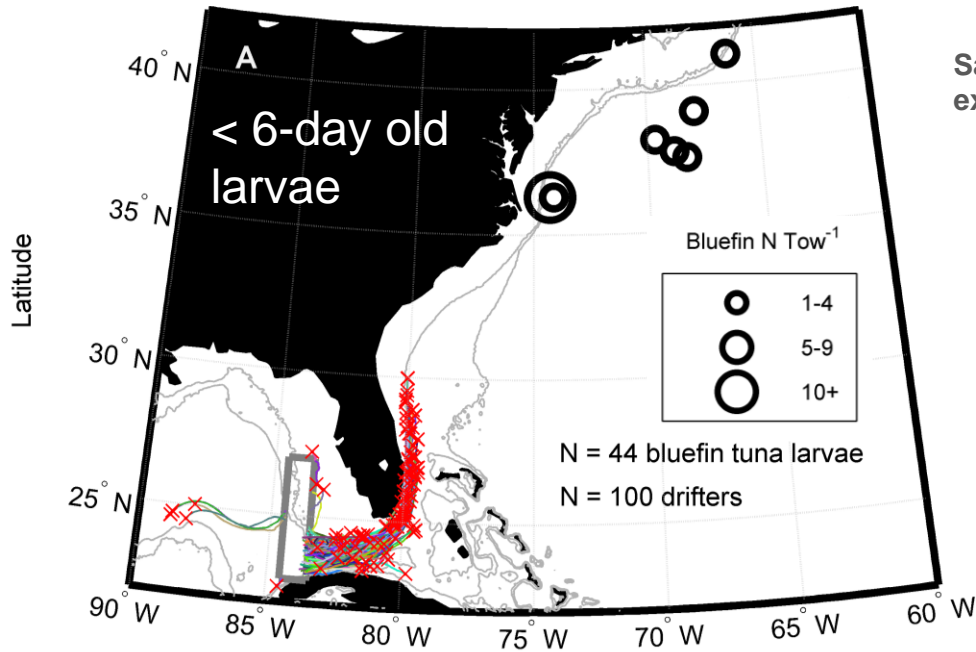
Many fish larger than the assumed size at maturity do not visit either the Mediterranean Sea or Gulf of Mexico

Are these fish not spawning until an older age?

Are these fish spawning elsewhere?



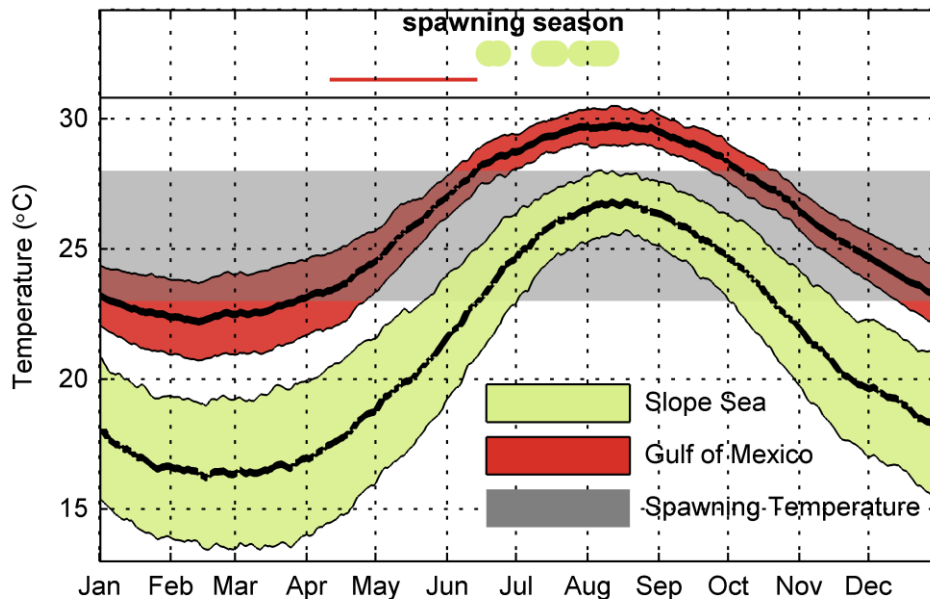
Rediscovering the Slope Sea spawning area



Satellite tracked drifter locations 6 d after Gulf of Mexico exit (red x) and larvae ages 1–6 d.

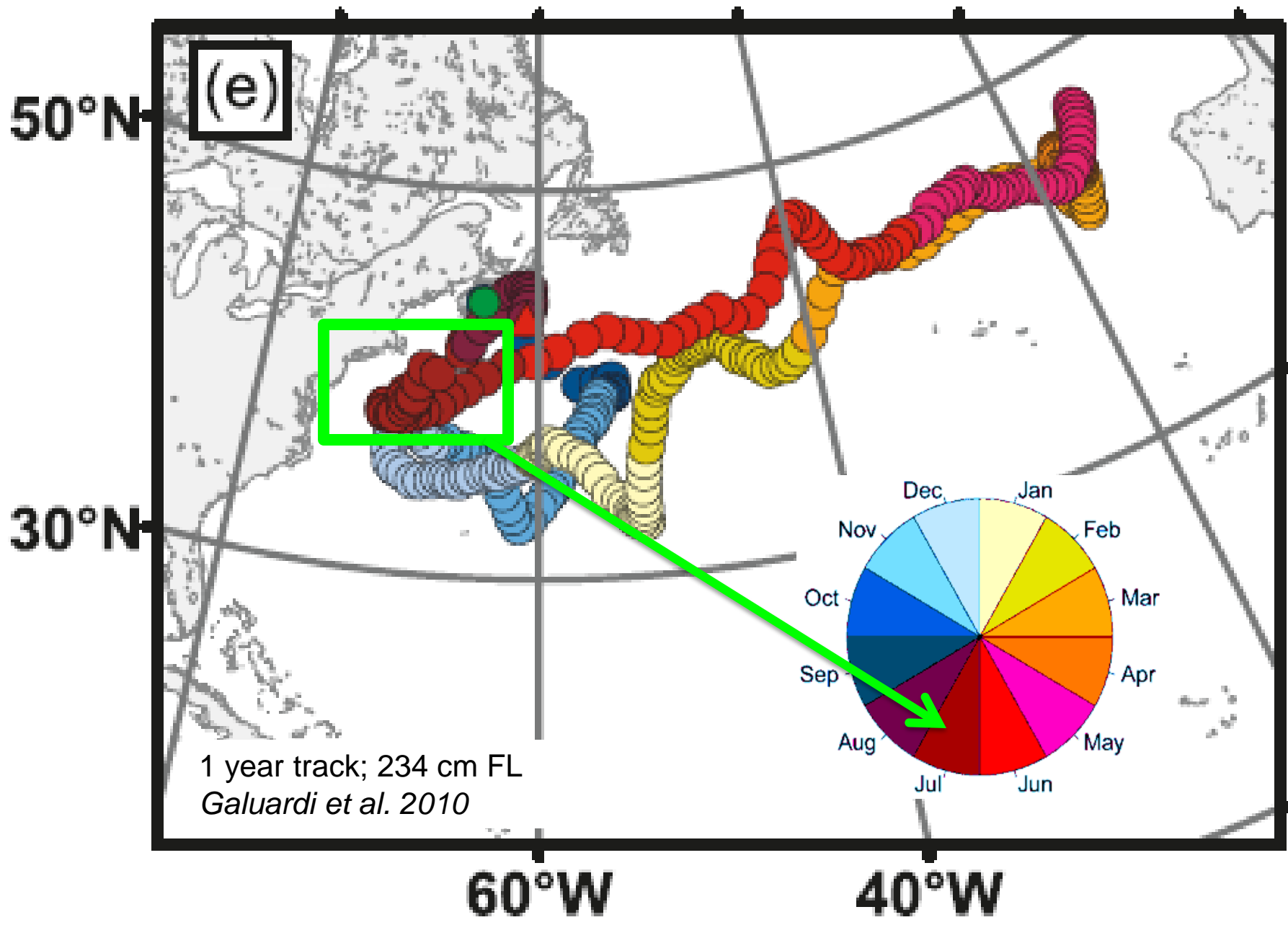


GU1302-Station 141-Fish 3; 2.3-mm SL; GenBank accession no. KT285186.



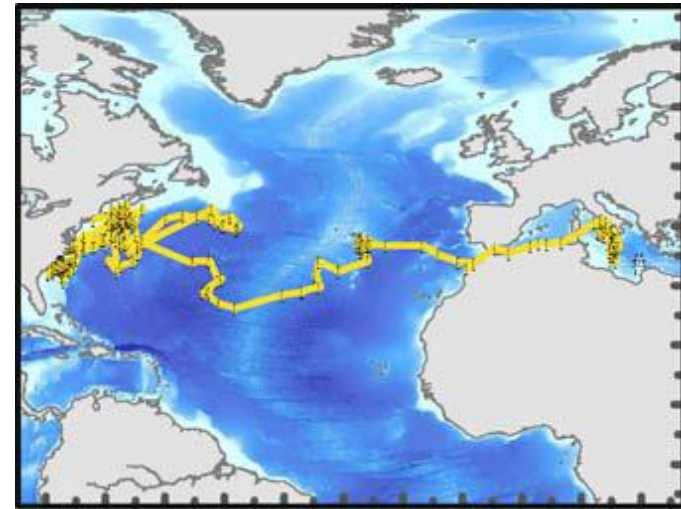
Spawning season occurs in different months

- Gulf of Mexico: Apr-Jun
- Slope Sea: Jul-Sep



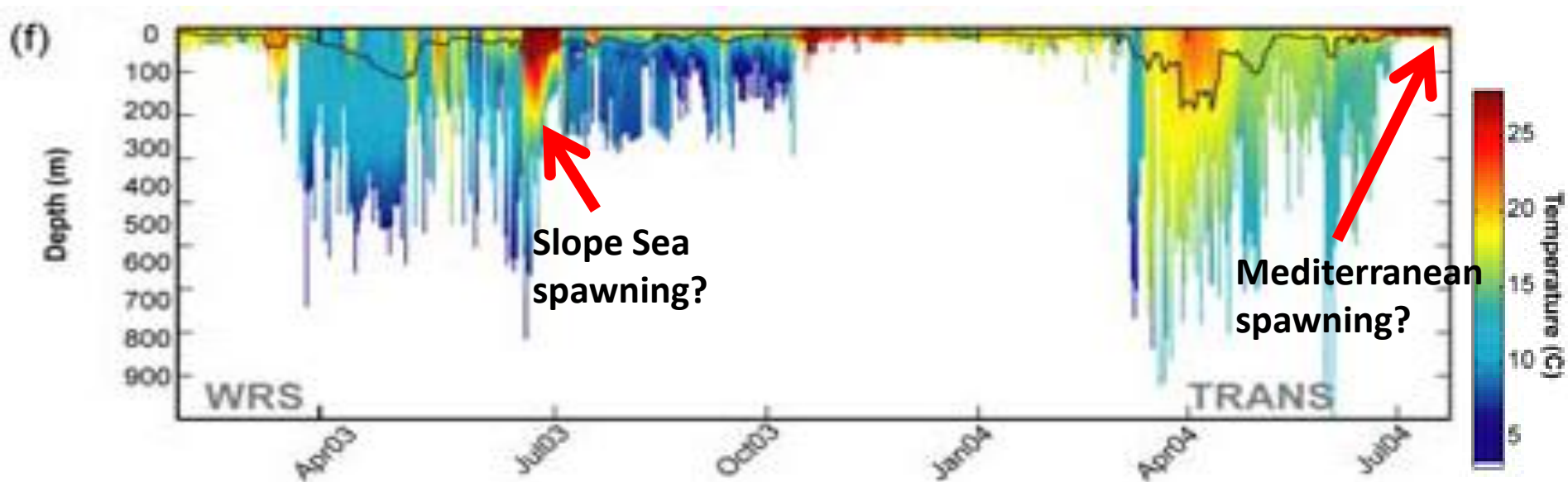
Eastern origin still? Um...

- 209 cm CFL
- Late June-Early July 2003 in waters $>24^{\circ}$ C in western Atlantic; likely in the Slope Sea
- April 2004 undertakes a TRANS-Atlantic migration and enters the Mediterranean Sea in June



Boustany et al. 2008 Fig. 2B


Did this fish spawn in the Slope Sea?





Walli et al. 2009 Fig 10f. Depth/temperature profile of fish 1016

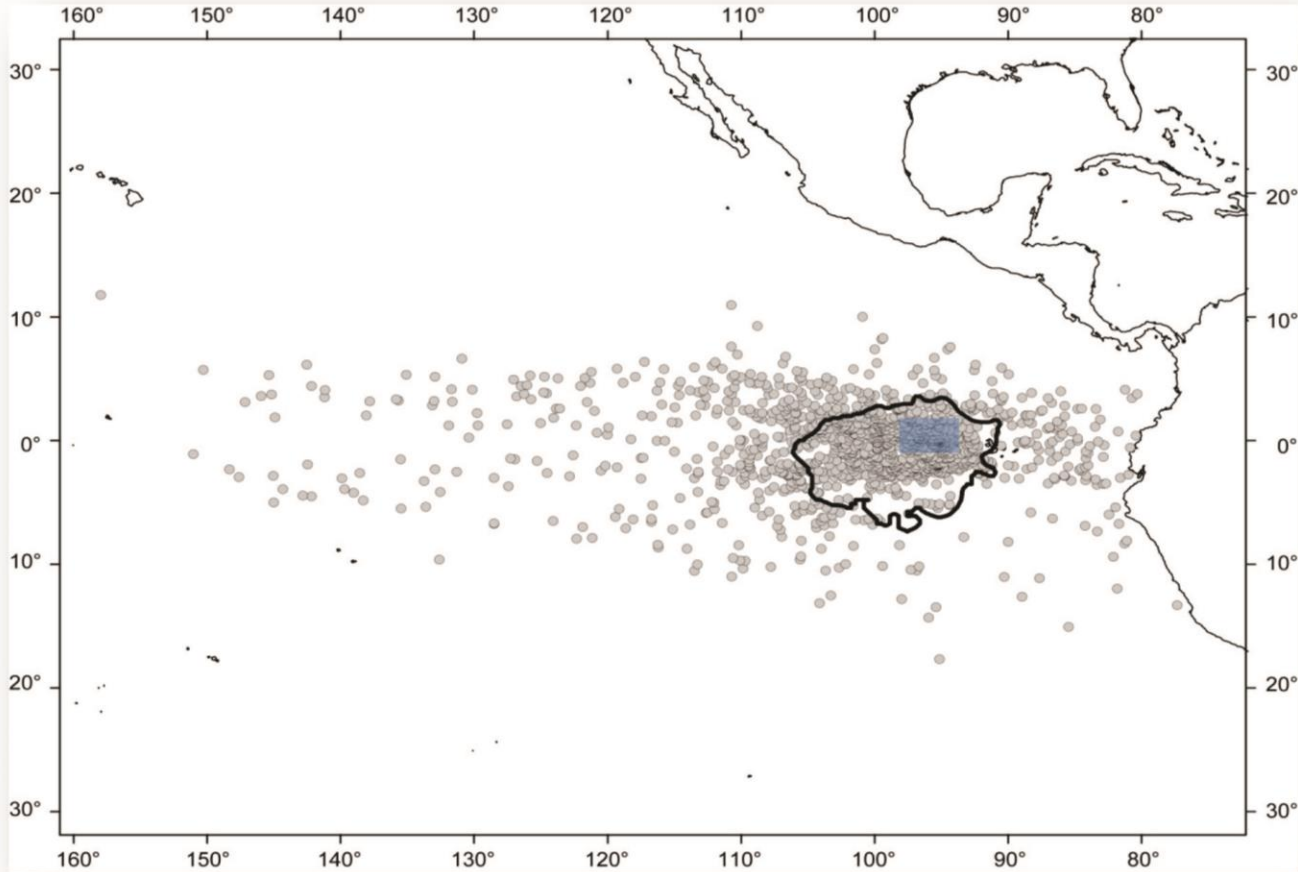
Bigeye tuna in the Eastern Pacific



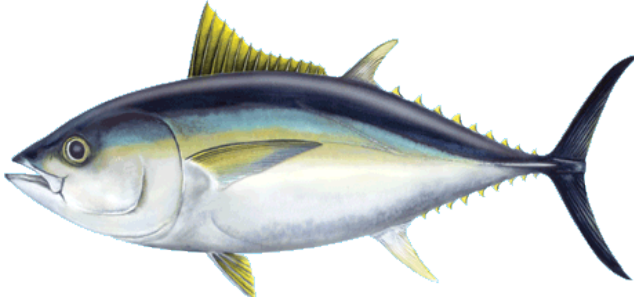
 approximate area of release

 recaptures of fish tagged with conventional and archival tags

 utilization distribution estimated for all fish with archival tags recovered



Schaefer & Fuller. Mar Biol (2010) 157:2625–2642
DOI 10.1007/s00227-010-1524-3



- **Mk10 archival tag**
- **2005 April – 2009 June**
- **Estimated fork length: 67 cm → 159 cm**
- **Recaptured 1245 km from tagging location**