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Acoustic tagging: abundance indices and habitat use

Juvenile southern bluefin tuna in Western Australia

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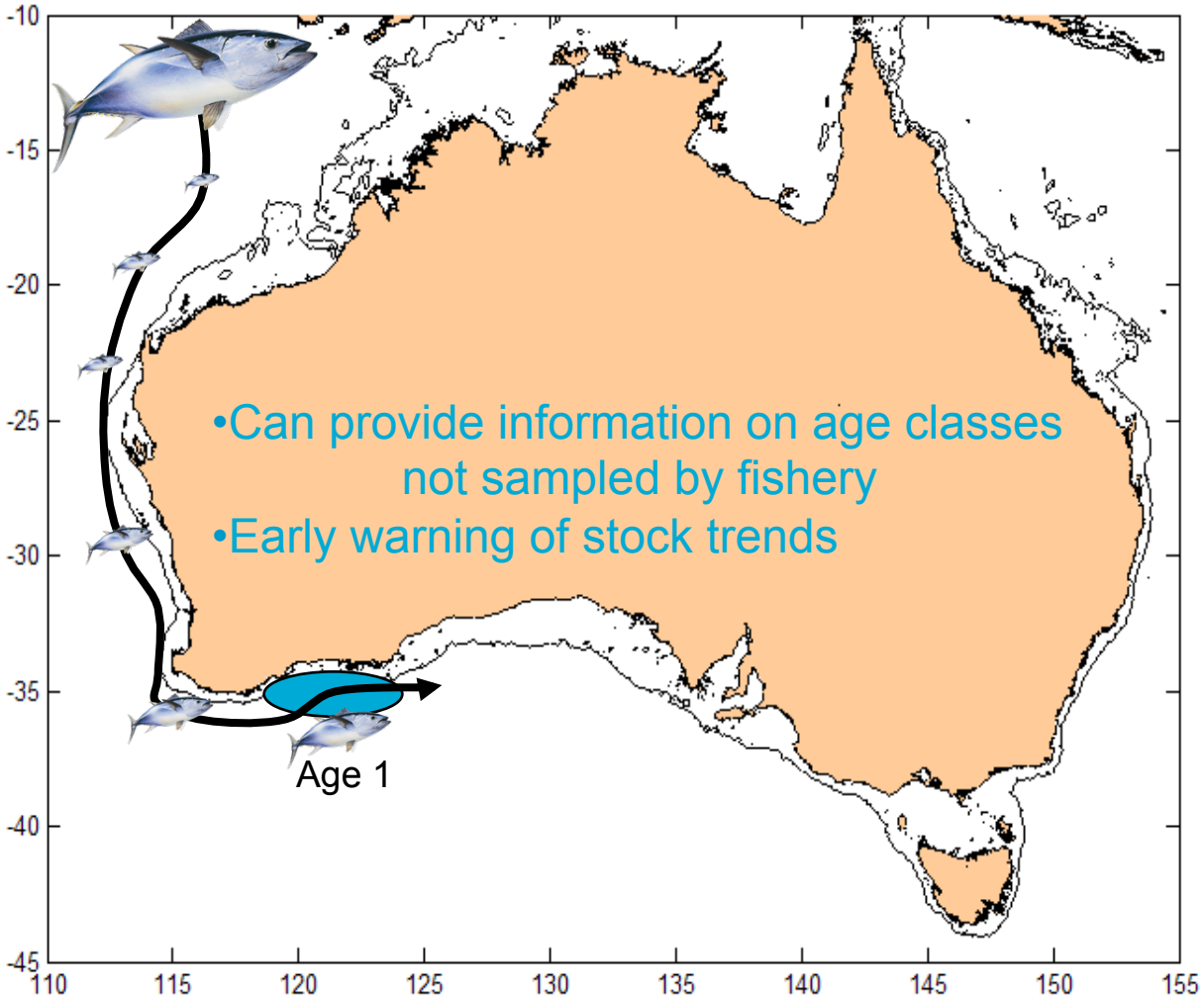
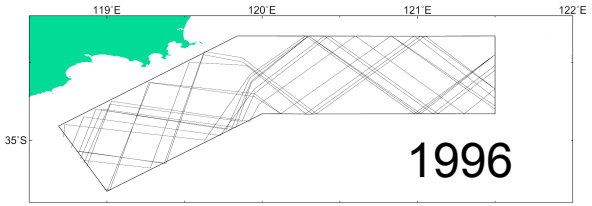
Southern Bluefin Tuna Recruitment Monitoring Program

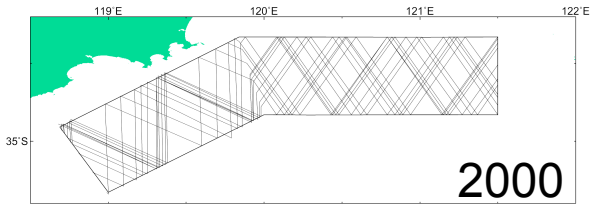
National Research Institute of Far Seas Fisheries · NRIFE · HOKKAIDO UNIVERSITY FOUNDED 1918 · JAMARC · CSIRO

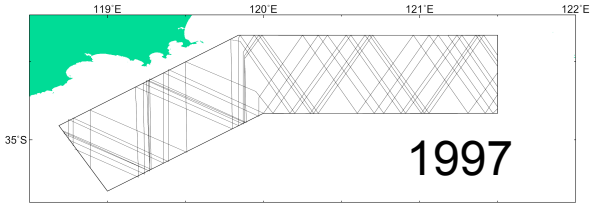
Recruitment index: useful for stock management

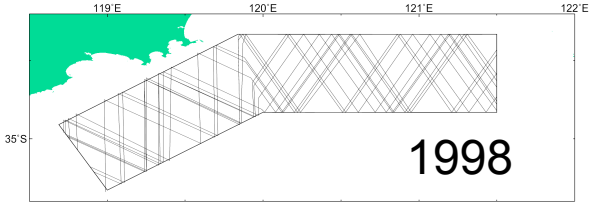


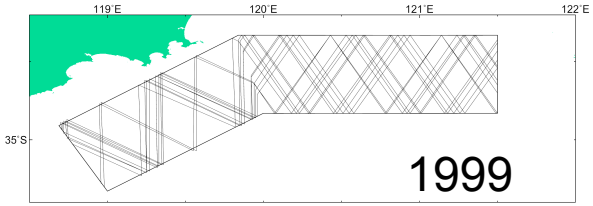
Transect lines – survey area

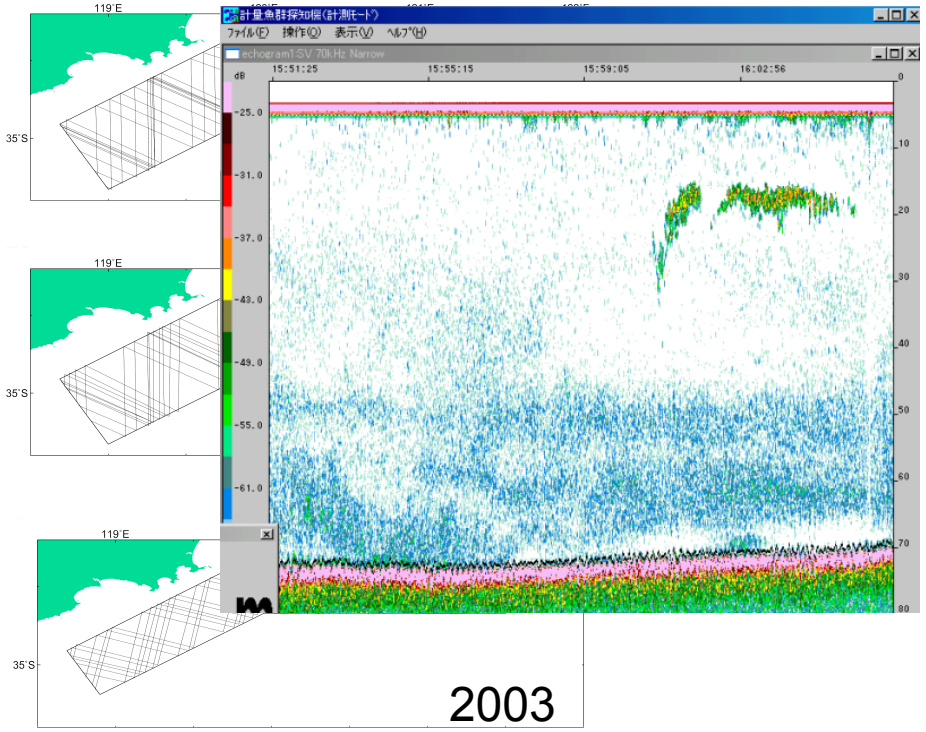












T_{survey} ~ 2 days; 8 – 12 repeats / year

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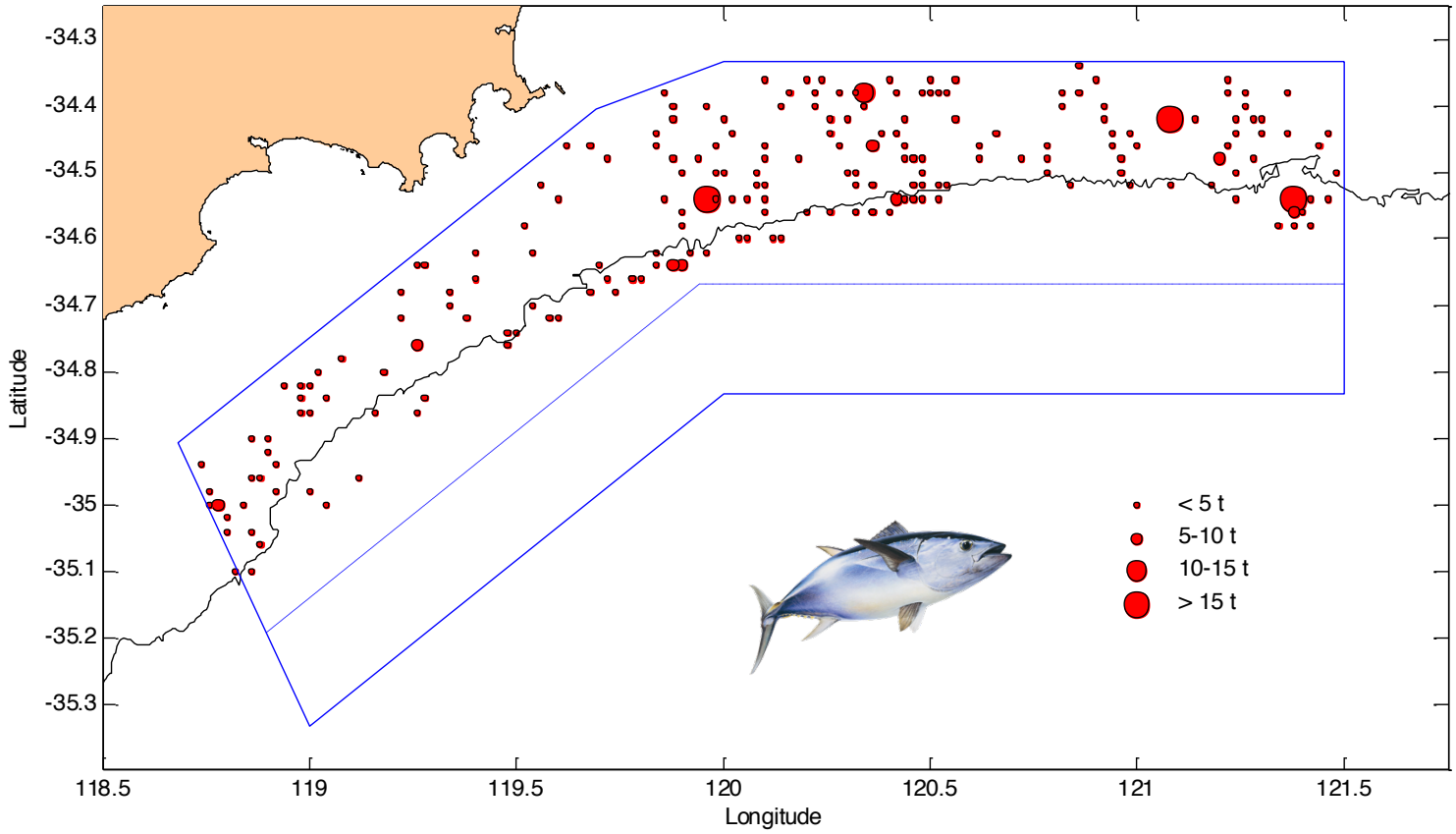
Distribution of fish schools – on shelf



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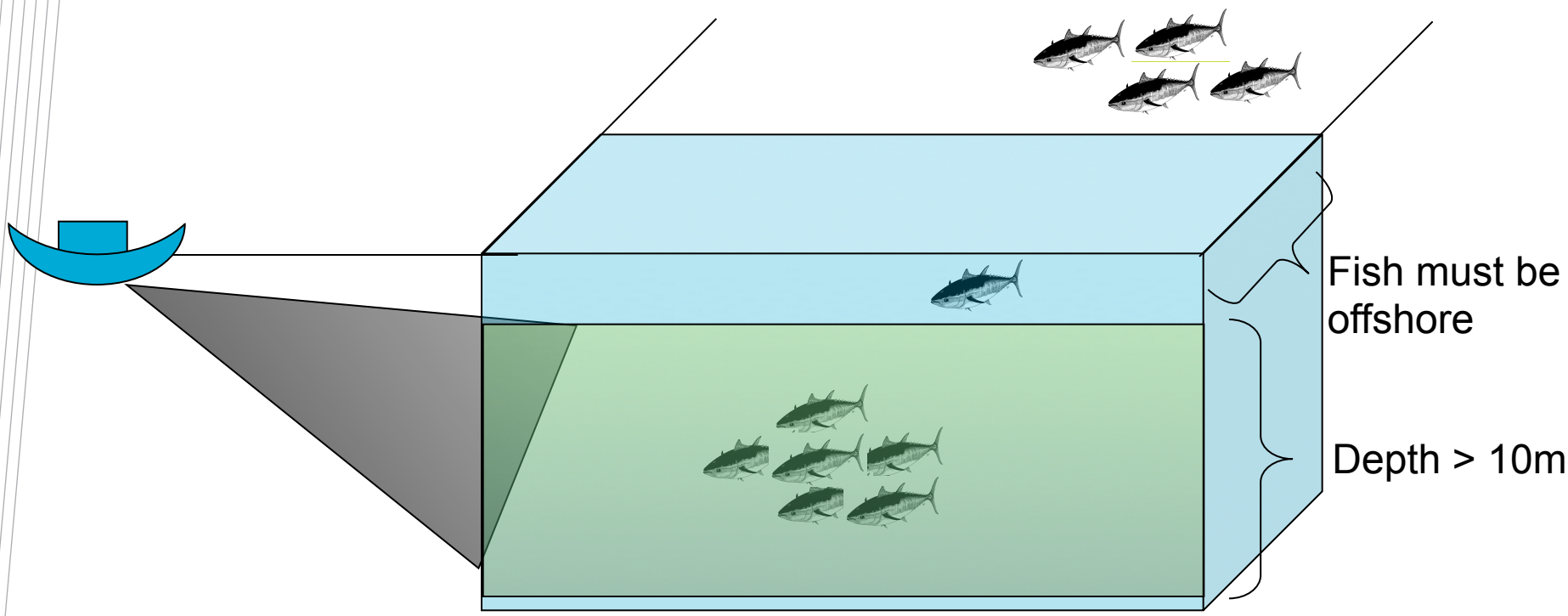
Sampling the fish with sonar survey - biases



Plus, residence time (T_R)

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Abundance index

N_{fish} ~ index ~ E_{fish} (observed in survey)

Generating a realistic abundance index requires that the fraction of the population that is surveyed is known – electronic tags can help.

$$N_{fish} \sim E_{fish} \cdot D_{detection} \cdot F_{offshore} \cdot T_{survey}/T_{residence}$$

Hobday et al 2009

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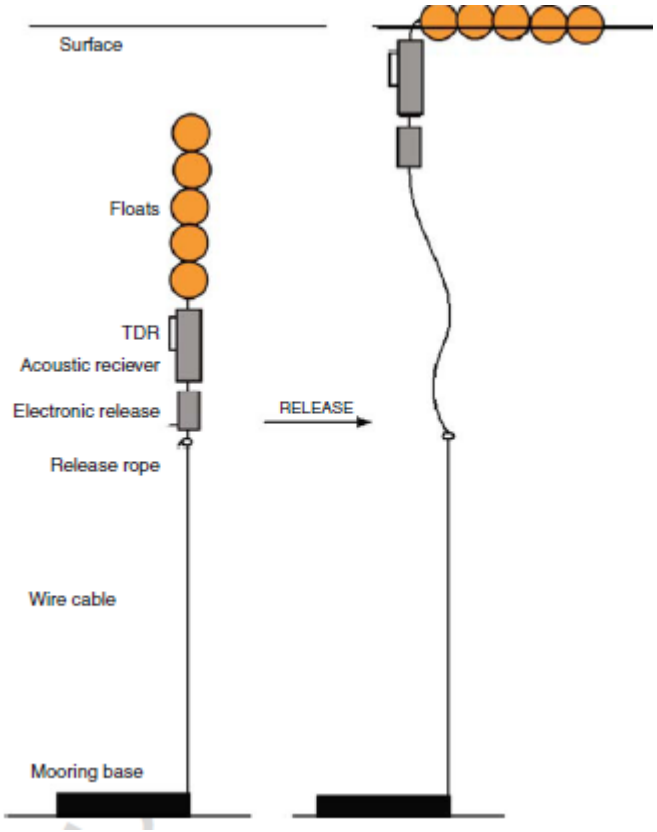
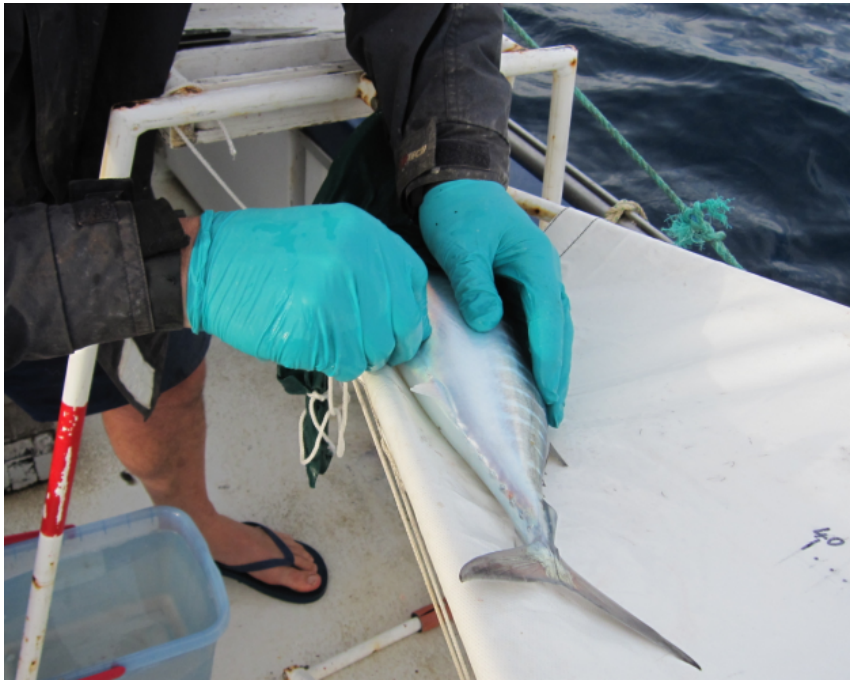
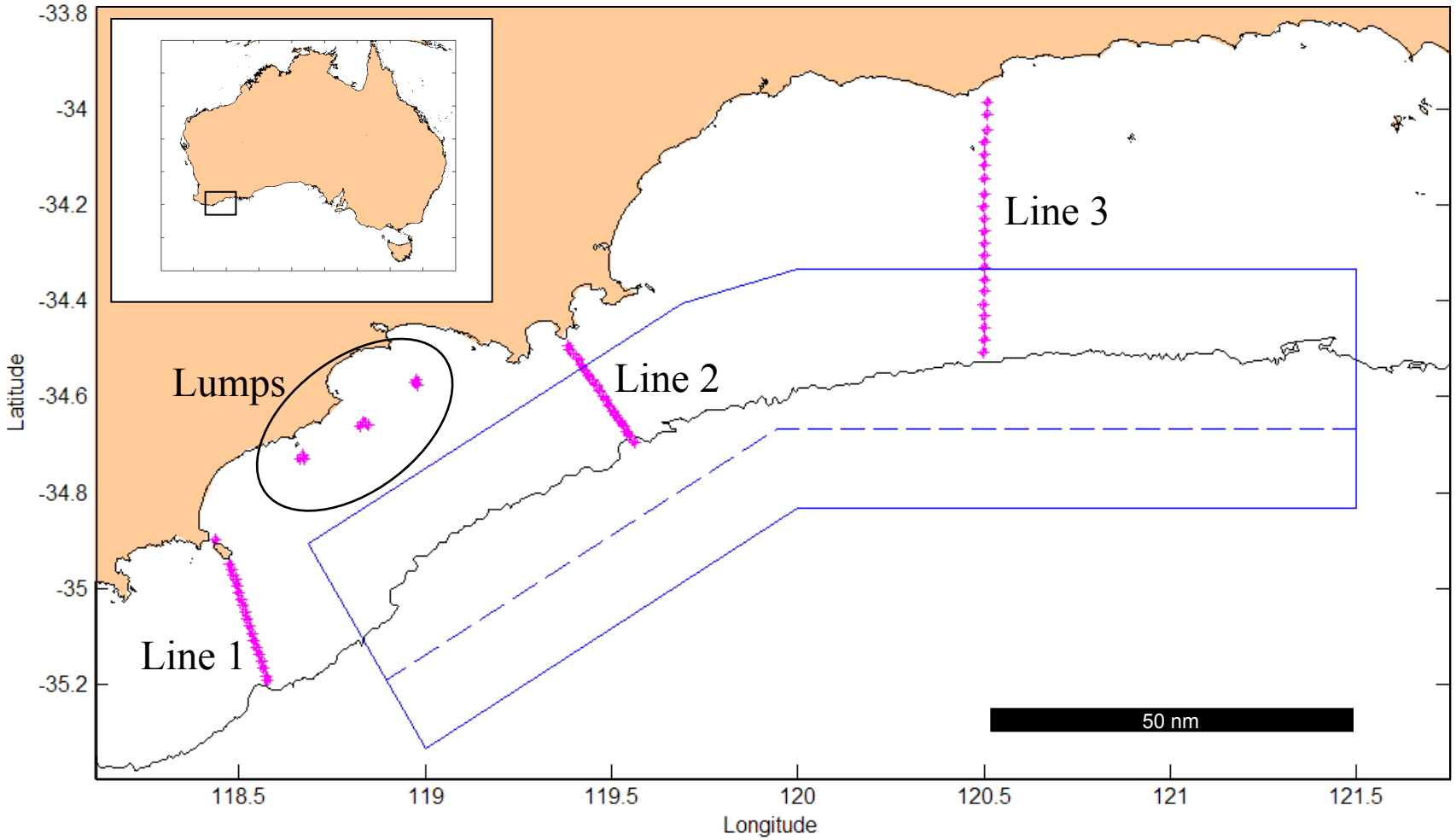
Acoustic tags and receivers





Cross-shelf lines

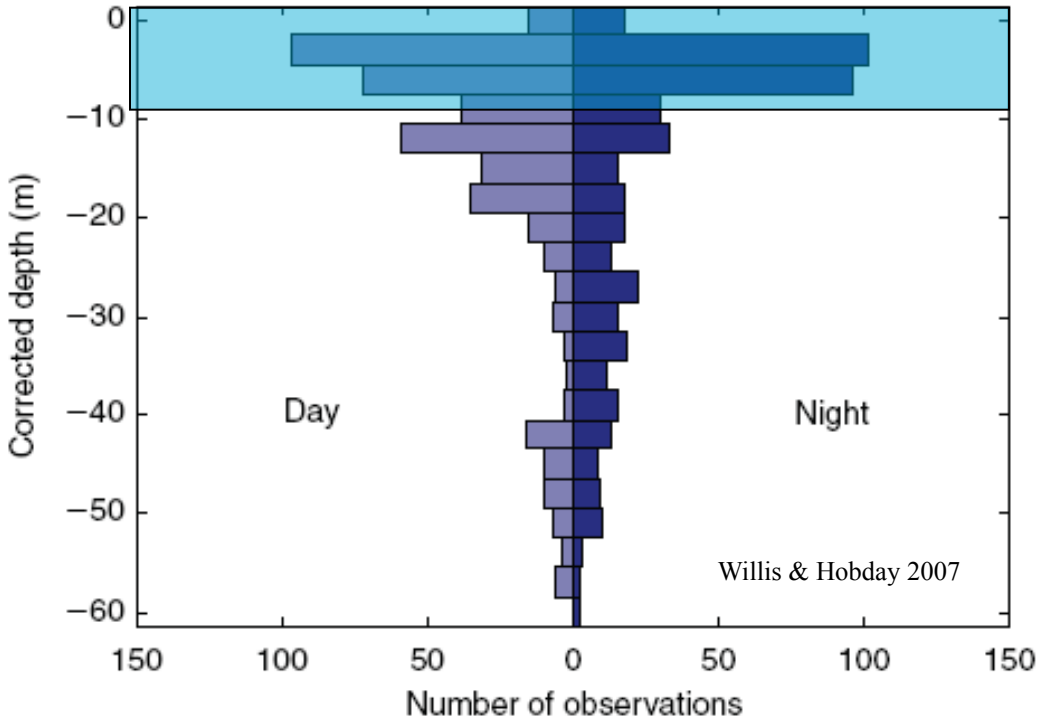
Subsurface moorings (receiver at 25 m, bottom depth to 150m)



1. Depth distribution ($D_{detection}$)

$N_{fish} \sim E_{fish} \cdot D_{detection} \cdot F_{offshore} \cdot T_{survey}/T_{residence}$

Hidden from sonar: 70% detections



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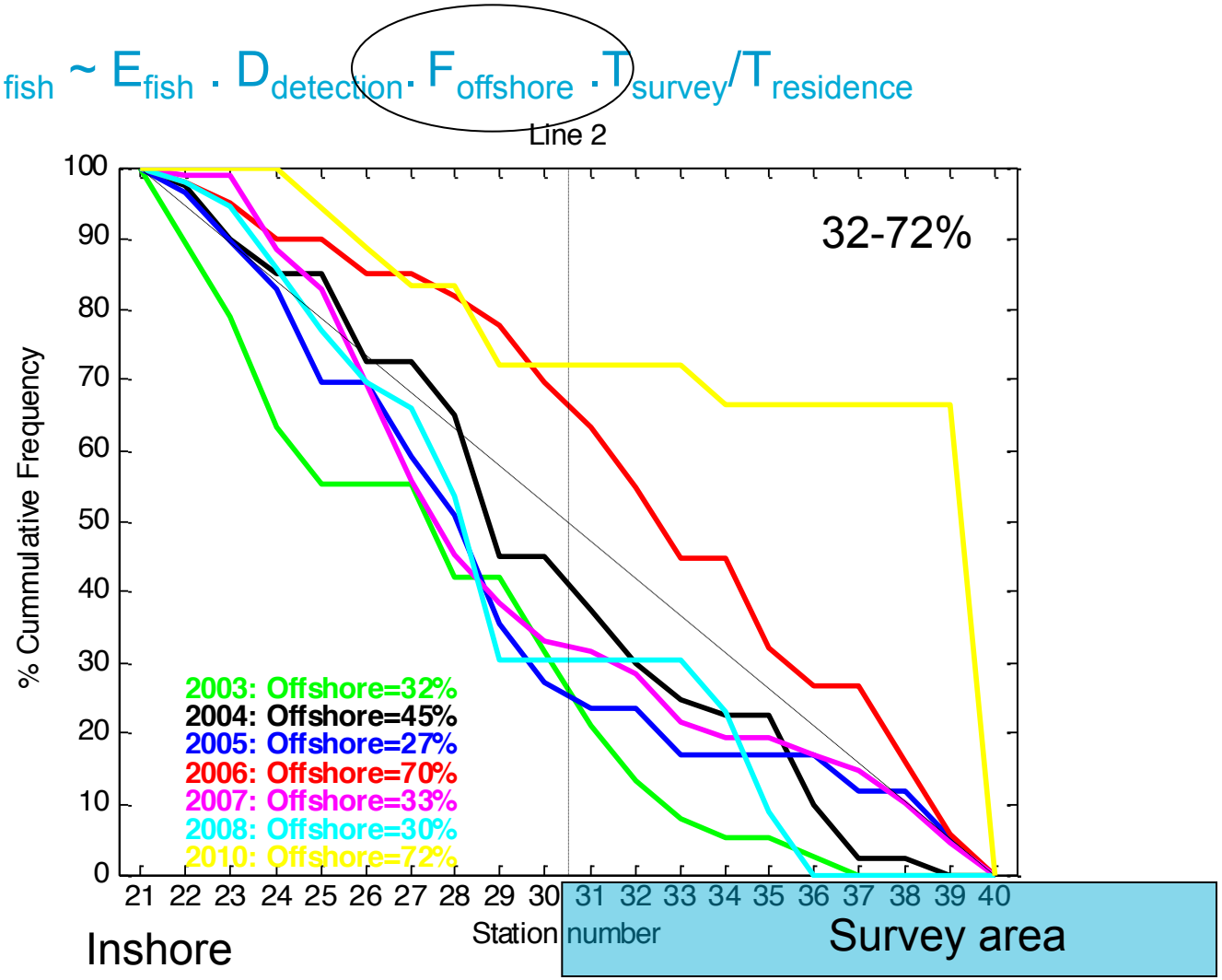
2. Fraction in survey area ($F_{offshore}$)

$$N_{fish} \sim E_{fish} \cdot D_{detection} \cdot F_{offshore} \cdot T_{survey}/T_{residence}$$



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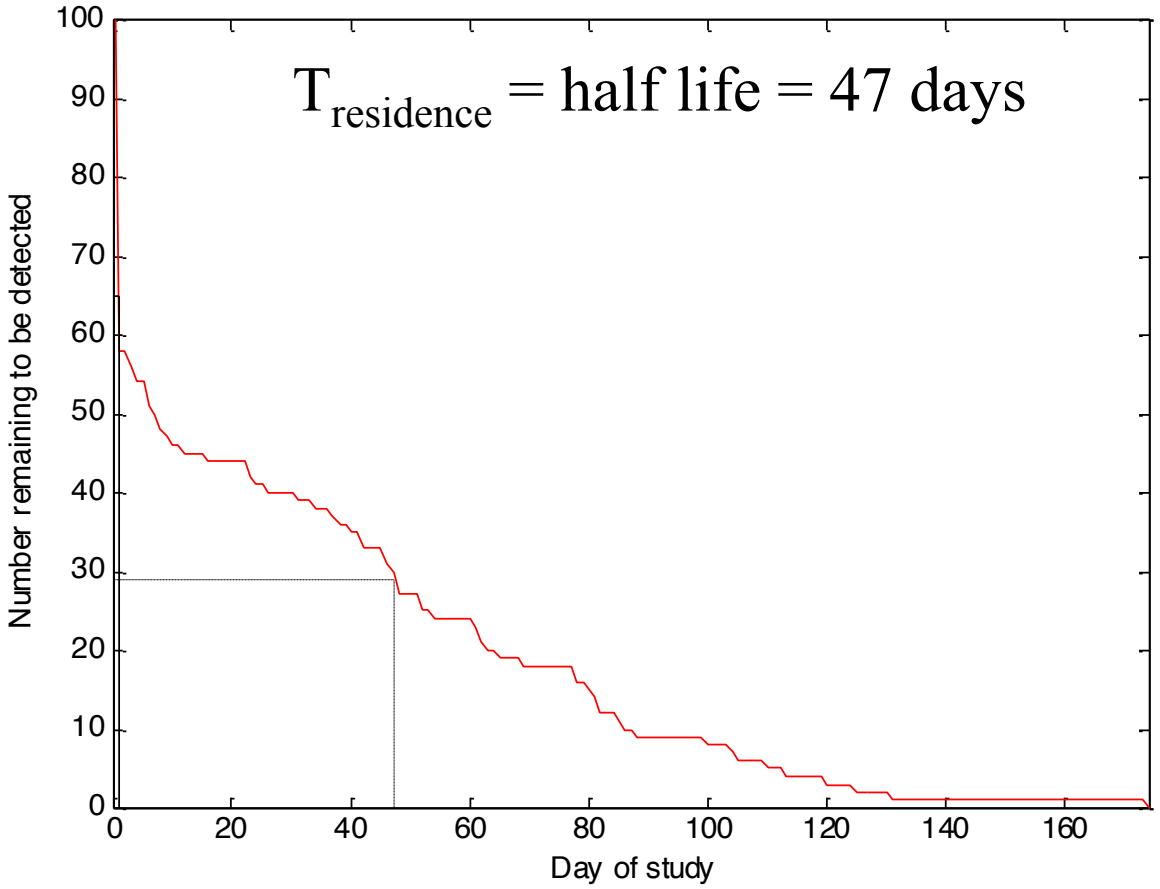
3. Residence time ($T_{residence}$)

$N_{fish} \sim E_{fish} \cdot D_{detection} \cdot F_{offshore} \cdot T_{survey}/T_{residence}$

Range: 23-65 days



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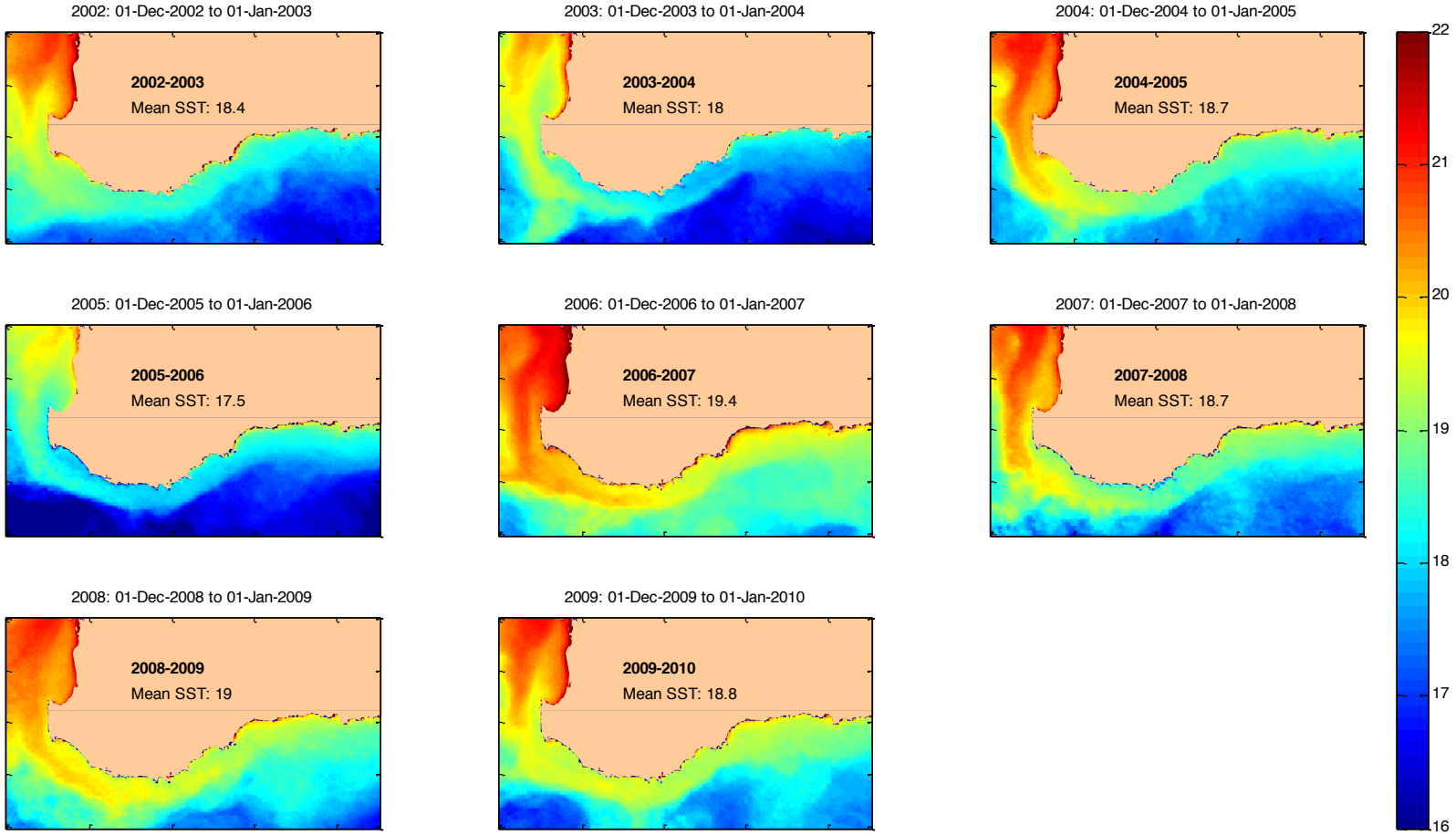
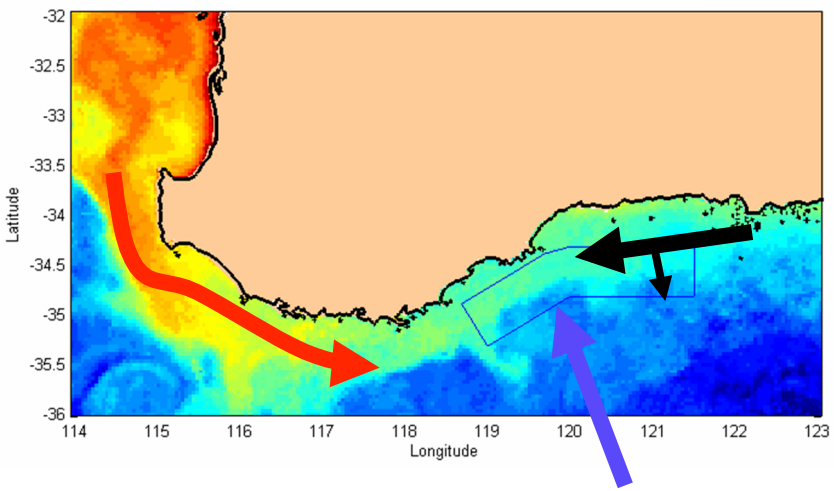
Interannual variation (e.g. summer current)



Variation in habitat use in the survey area – mechanism



Oceanographic Driver	Leeuwin Current **(warm)**	Sub-Antarctic Water Subsurface intrusion crosses shelf (and upwelling) (cold)
Habitat use response by SBT	Inshore distribution Remain in region	Offshore distribution Depart quickly

But thermal tolerance of fish is not “challenged”

Fujioka et al. 2010, *Fish. Oceanog*

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Abundance index

Now can estimate all these parameters:

N_{fish} =

E_{fish} - counts (survey data)

$D_{detection}$ - depth distribution (tags)

$F_{offshore}$. – cross shelf detections (tags)

$T_{survey}/T_{residence}$ - residence times (tags)

$M_{pathway}$ - what fraction move into survey area?

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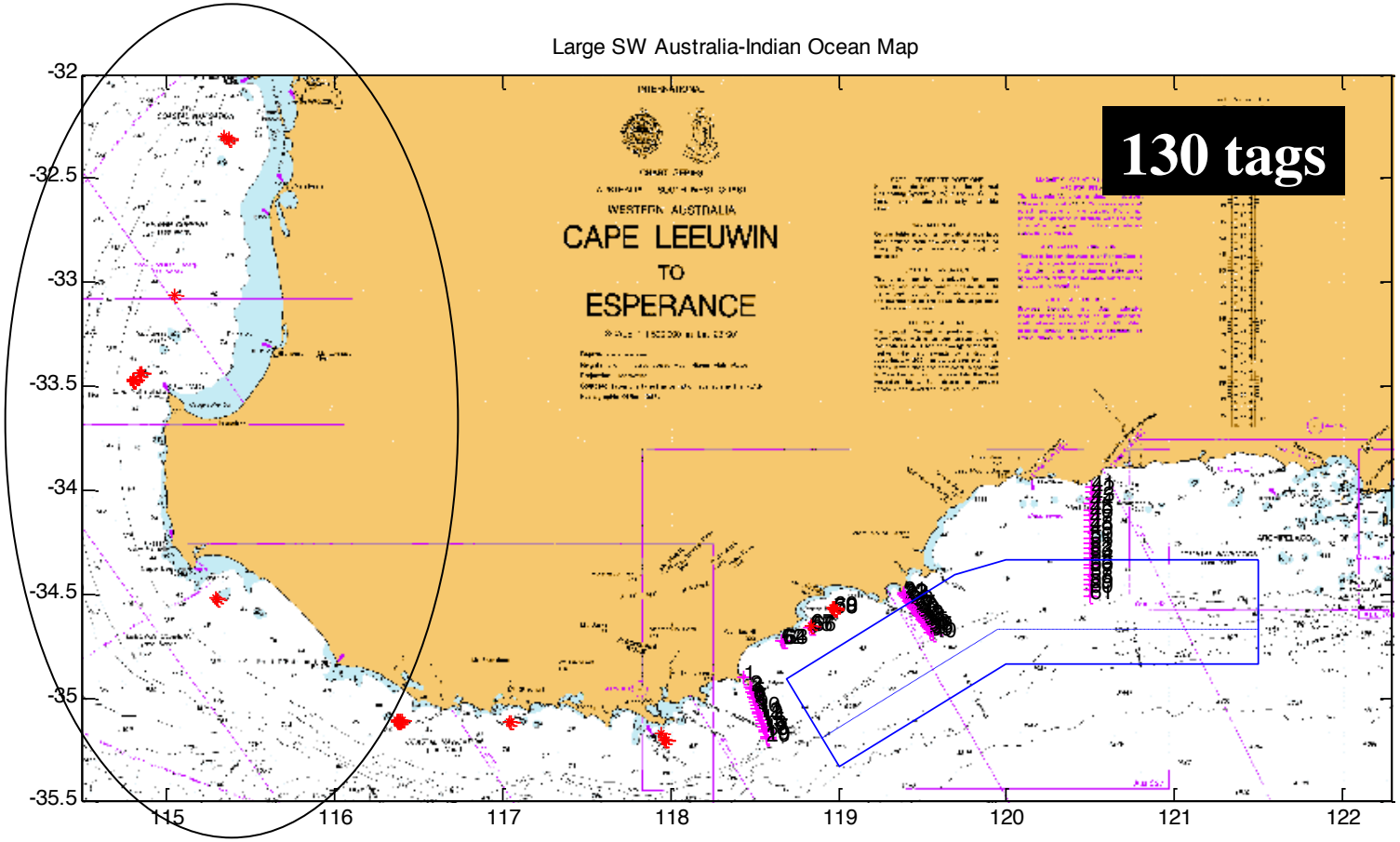
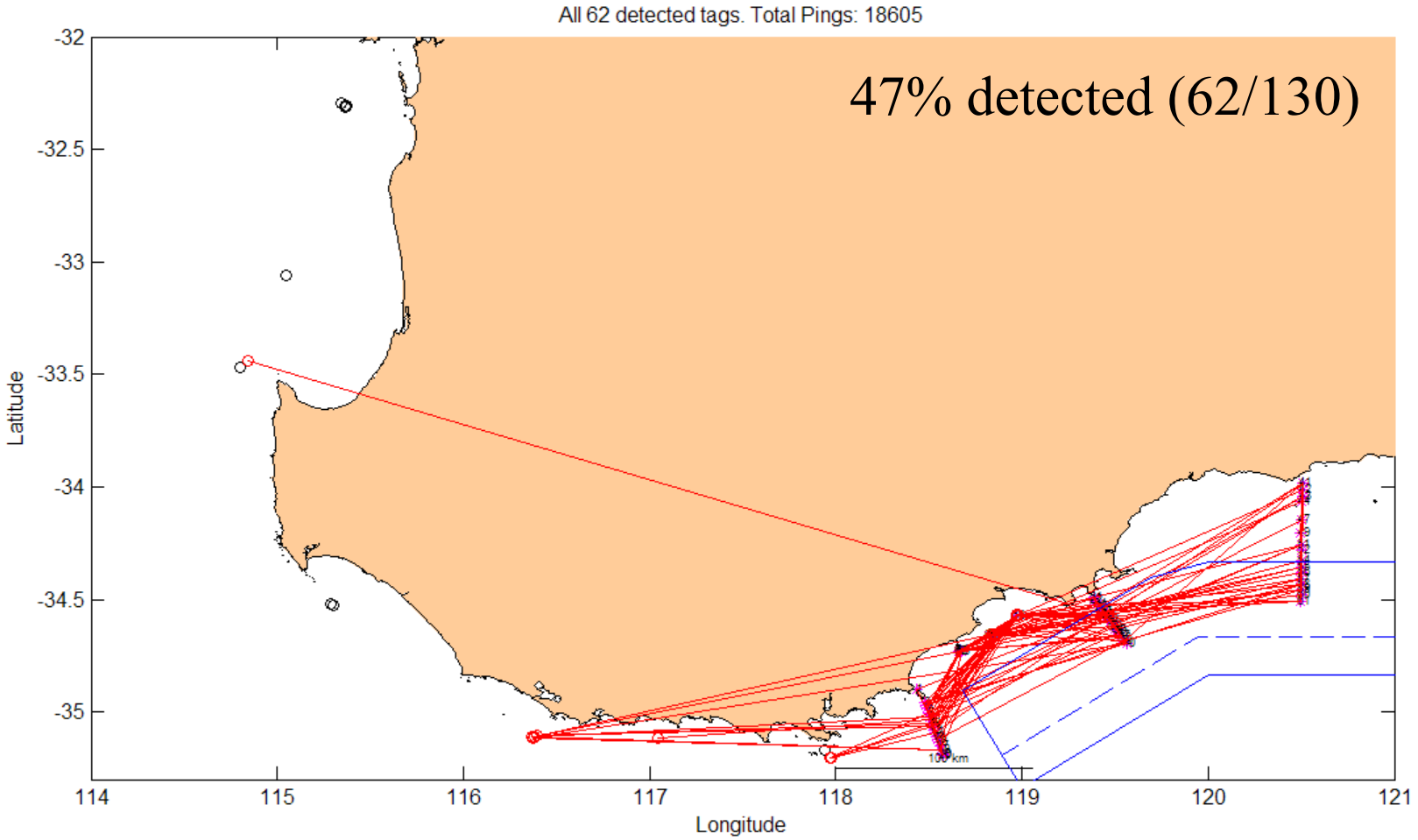
2006-07 Experiment

3 lines, 3 hotspots (70 receivers)



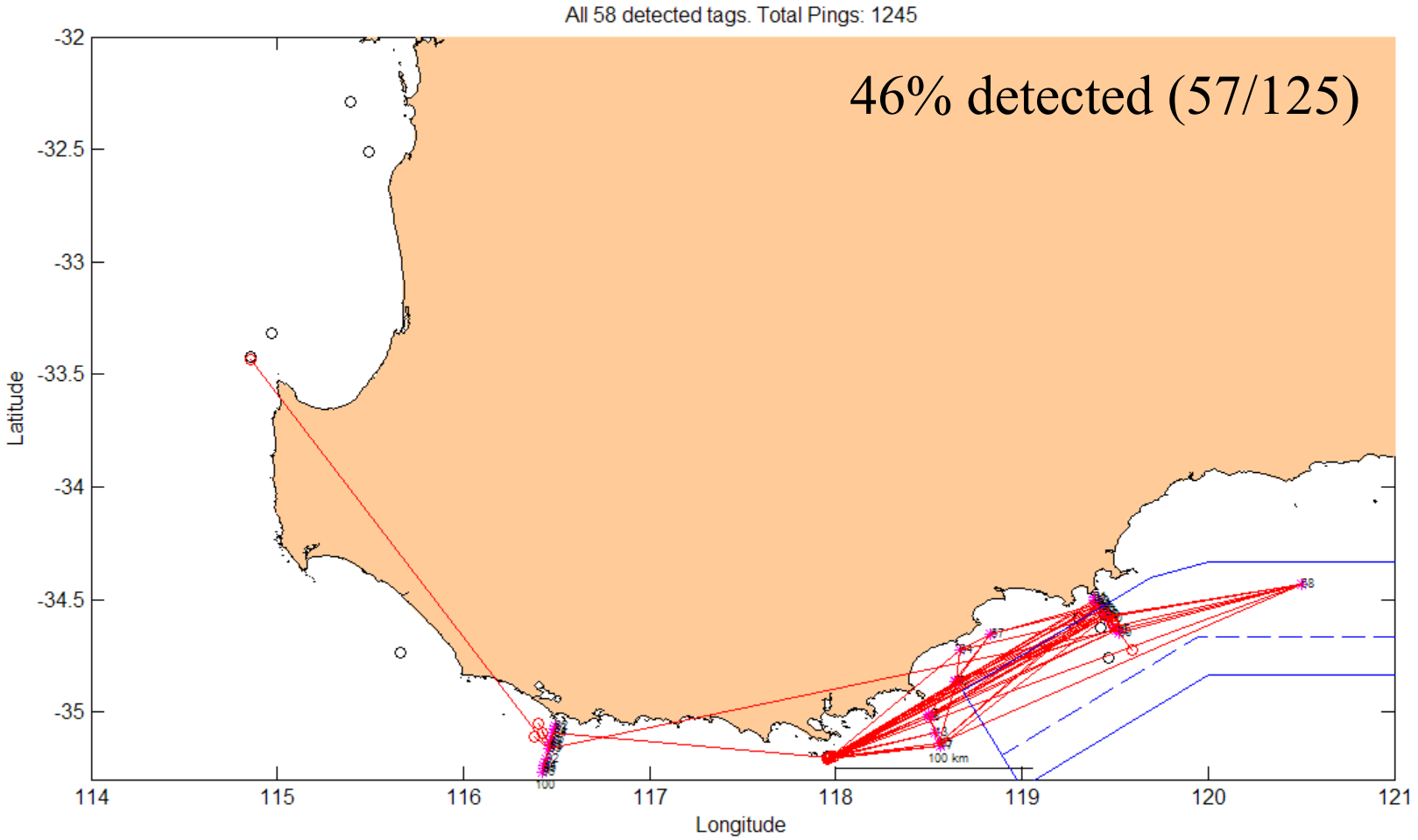
2006-07 Experiment – Dec & Jan tagging

1/46 west coast releases = 2% move to the south



2007-08 Experiment - Dec & Jan tagging

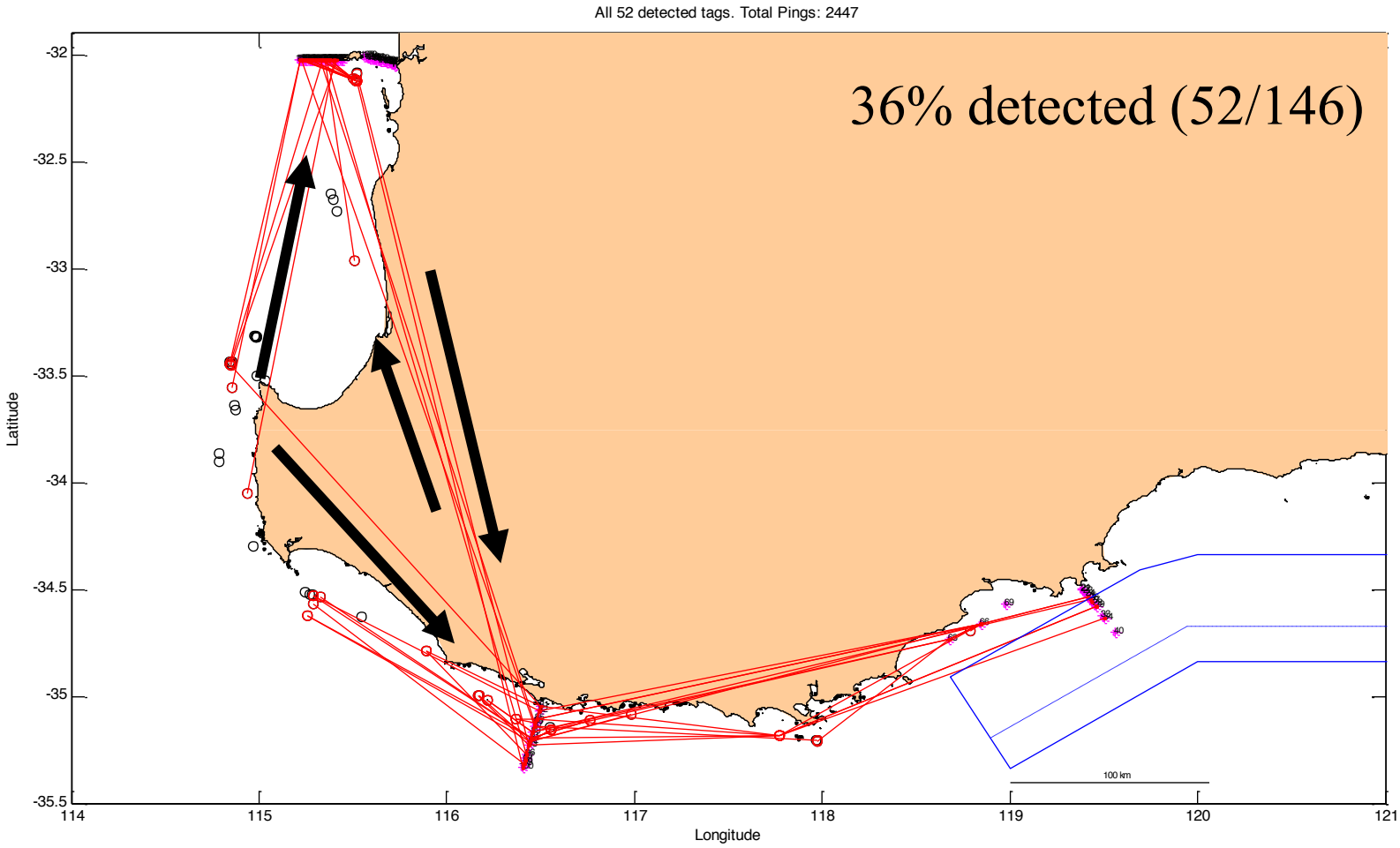
1/27 west coast releases = 4%



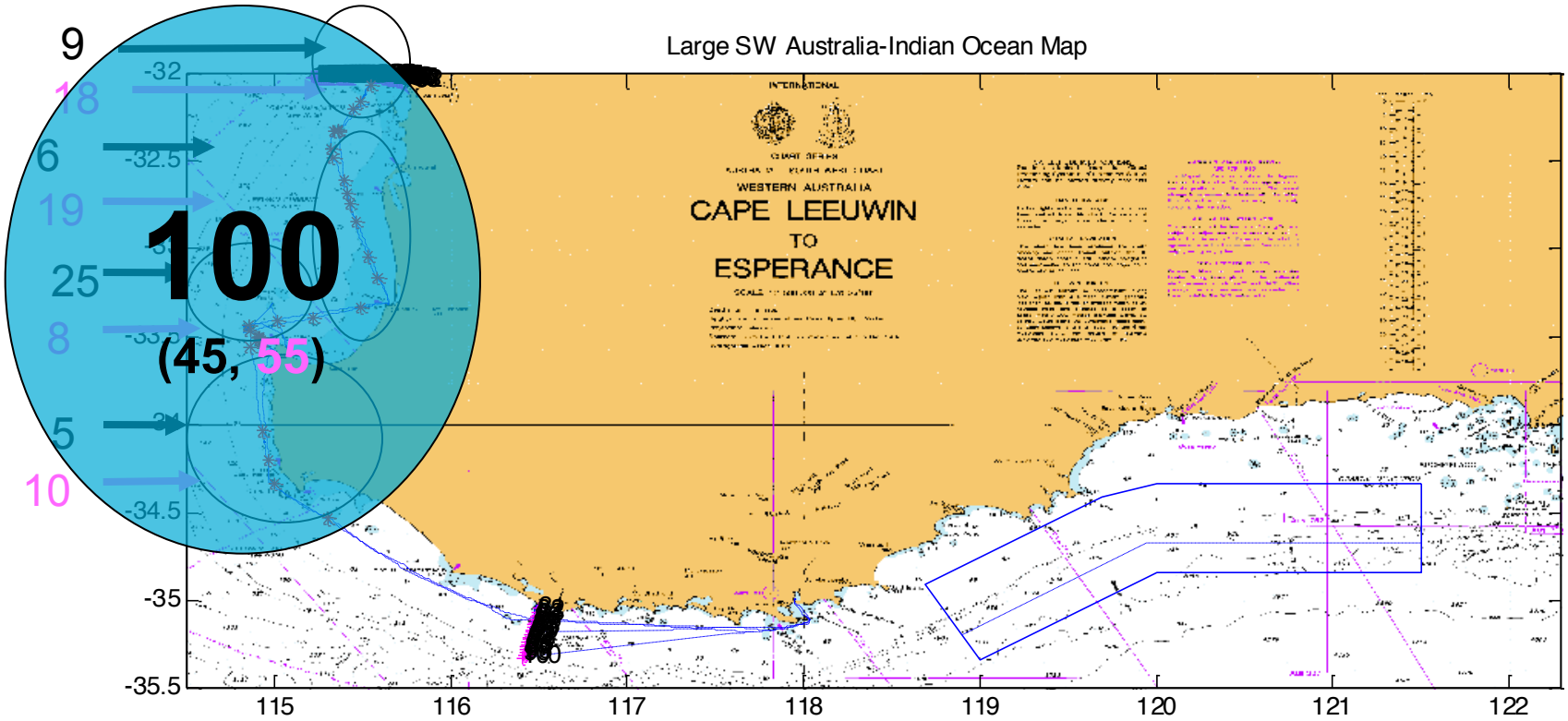
2009-10 Experiment - Dec & Jan tagging

3/82 west coast releases = 4%

(south coast move to west coast: n=3)



2010-11 Experiment: Nov & Jan tagging



(Nov 2010, n=45; Jan 2011, n=55)

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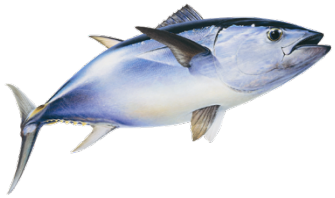
Conclusion 1: Inferences for habitat use

- Local oceanographic conditions influence habitat use on the south coast
  - Leeuwin current and sub-Antarctic water mass intrusion
- Fish tagged on the west coast in December and January only rarely detected on the south coast (5/155, ~3%).
  - During the austral summer, juvenile SBT remain local, presumably in areas where forage is available.
- Movements to the south coast must occur earlier in the season in order for fish to appear on the south coast – a hypothesis we are testing in the present year.
  - Interannual variation in the drivers of migration ($M_{fraction}$) unknown

Conclusion 2: Inferences for recruitment survey



When fish are more inshore than offshore

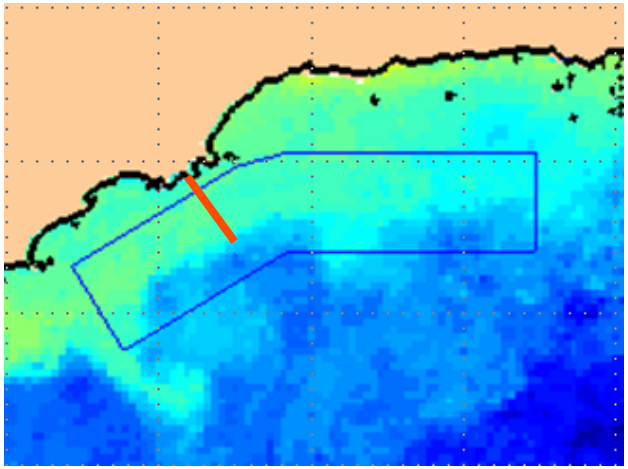
Missed in current survey area

Fish moving in general east direction

Count against the flow of fish (ship)

Resident for ~30-90 days

Some prospect for double counting



Impact on acoustic survey design

- Change in survey design (reduce far offshore)
- Addition of in-out piston line

Ultimately, tagging data may improve the recruitment estimates for tuna

$$N_{fish} \sim E_{fish} \cdot D_{detection} \cdot F_{offshore} \cdot T_{survey}/T_{residence} \cdot M_{fraction}$$

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