# Preliminary external analysis of WCPO skipjack tagging data

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WCPFC Project 123 – Scoping the next generation of tuna stock assessment software

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# The problem: tags and the mixing assumption

- WCPO skipjack (SKJ) assessments fit tag-recapture data inside the integrated model (MULTIFAN-CL).
- This requires that tagged fish are well mixed within broad assessment regions.
- Hard to meet: only holds after long times at liberty or with uniform effort.
- The handling of mixing strongly affects results — the assumed *mixing period* "had the most influence on management quantities" in the 2019 assessment.

## Idea

Analyse the tagging data externally, modelling the redistribution of tagged fish explicitly — replacing region-level mixing with an *estimated* movement process.

Jordan et al. 2022; Scutt Phillips et al. 2022; Teears et al. 2025

# Method: a modular external framework

**Movement** — advection–taxis–diffusion. **Taxis** follows the gradient of a *habitat preference*: smooth functions of environmental fields (SST, MLD, ...). Needs only release/recapture + covariates.

**Mortality** (+ spatial effort) — relationship between fishing mortality and effort, e.g. $F = \lambda E$; length-specific $F, M$.

**Biomass** (+ spatial catch) — relative (Baranov) and absolute (Petersen) indices.

EPO lesson: recapture probability depends strongly on **fishing effort** — even movement estimation benefits from joint estimation with mortality.

## What this changes

- ✓ Replaces region-level mixing with an *estimated* movement process — no **region-scale** mixing period to pre-specify
- ✓ The only mixing left is **within one grid cell**
- × Still assumes tagged ≡ untagged fish
- × Still needs tagging mortality, shedding & reporting-rate assumptions

**This study applies only the movement module — as a first step.**

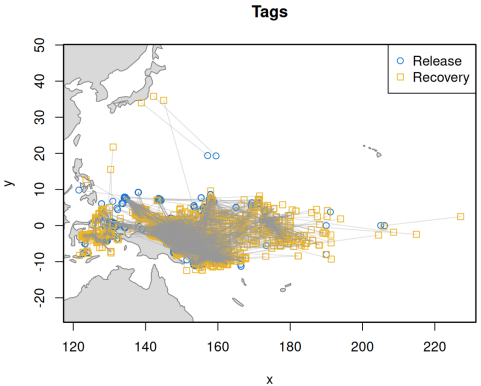
# WCPO data: Pacific Tuna Tagging Programme

- ∼19k tags (PTTP, 2006–2025); **10,495** used after cleaning + 14-day cut
- No archival tags; no length / fleet info
- 5 covariates (SST, MLD, depth-int. $T$, 2 currents), $1° \times 1°$ monthly

**The core limitation**

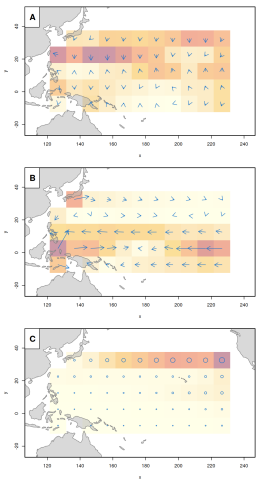
Short times at liberty, small displacements, narrow environmental range:

- liberty median **19 d** (60% <1 month)
- displacement median **66 km** (25% <10 km)
- SST **28–31°C** (99%)




Recaptures concentrated NE of Papua New Guinea.

# Preliminary movement results: taxis, advection, diffusion




- Net **taxis** (A), **advection** (B), **diffusion** (C) on $10^\circ \times 10^\circ$ cells
- Patterns **robust** to using SST instead of depth-integrated $T$
- Fitted with the **KF** engine ($\sim$42 min, single core)

## Take-home

Fine-scale movement estimation for WCPO SKJ is **feasible**, but there are some challenges...

# Challenges revealed by the preliminary analysis

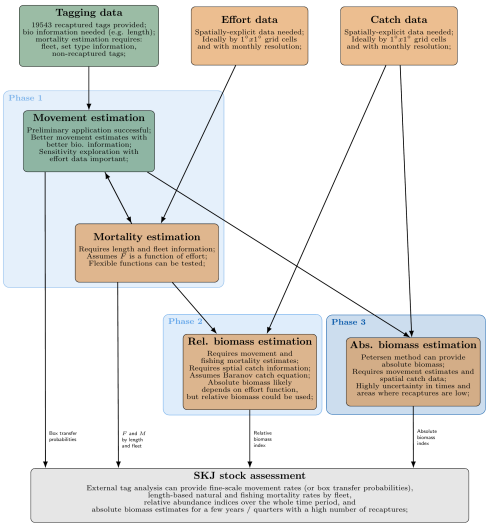
**Data**

- Narrow spatial & environmental range → unstable flexible models
- Need broader tag coverage (e.g. Japanese tagging programme)
- Need effort & catch (fine-scale, spatial)
- Need length + fleet/set-type info

**Confounding & implementation**

- No explicit **land boundaries** yet
- Run in lon/lat, but `admove` is Euclidean → need to run in **projected** coords
- CTMC engine did not fit in 200 GB → used Kalman filter

# Recommendation: a three-phase programme



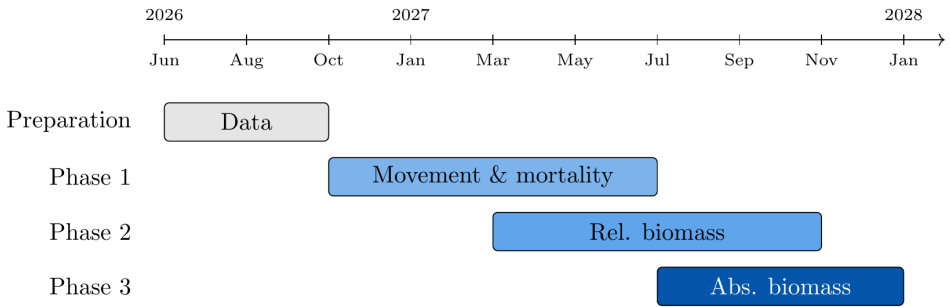

**Phase 1** — movement *jointly with* effort-dependent mortality (the foundation).

**Phase 2** — relative (Baranov) biomass index; continuous series, bounded by effort data.

**Phase 3** — absolute (Petersen) biomass; a few well-sampled points.

Movement source is swappable (e.g. SEAPODYM) — a valuable sensitivity analysis.

# Indicative timeline




Under this timeline, mortality and biomass indices could be available for the **next SKJ assessment in 2028**.

# Conclusions

- Movement, mortality, and biomass **can** be estimated for WCPO SKJ externally — already operational for EPO SKJ.
- Preliminary movement estimation was **feasible**, but revealed real challenges.

**Why external analysis of tags is worthwhile:**

- Replaces region-level mixing with an *estimated* movement process; the mixing assumption drops from assessment-region scale to one grid cell
- Uses each tag's actual displacement & time at liberty
- Re-aggregates to any regions without refitting (within-region weighting made explicit)
- Mechanistic environmental link → prediction under ENSO / climate change
- Extra ecological insight into fine-scale tuna movement

# Thank you

**SC report**: *WCPFC-SC22-2026/SA-WP-03*

`admove`: `https://tokami.github.io/admove/`

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