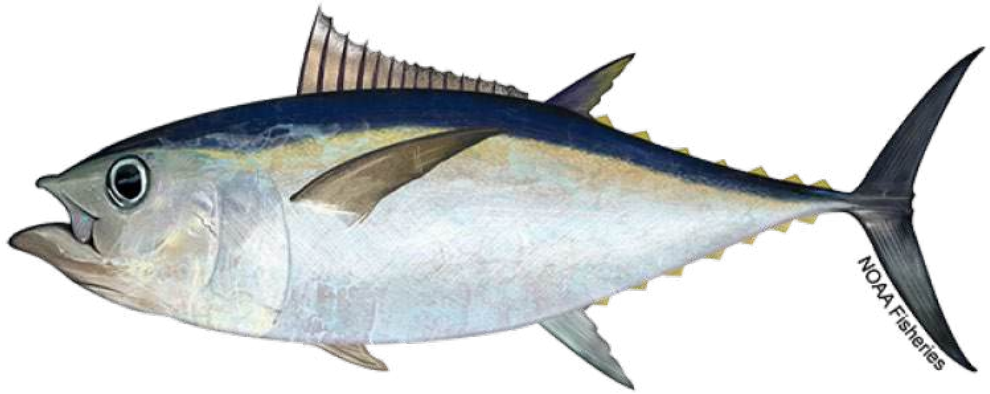
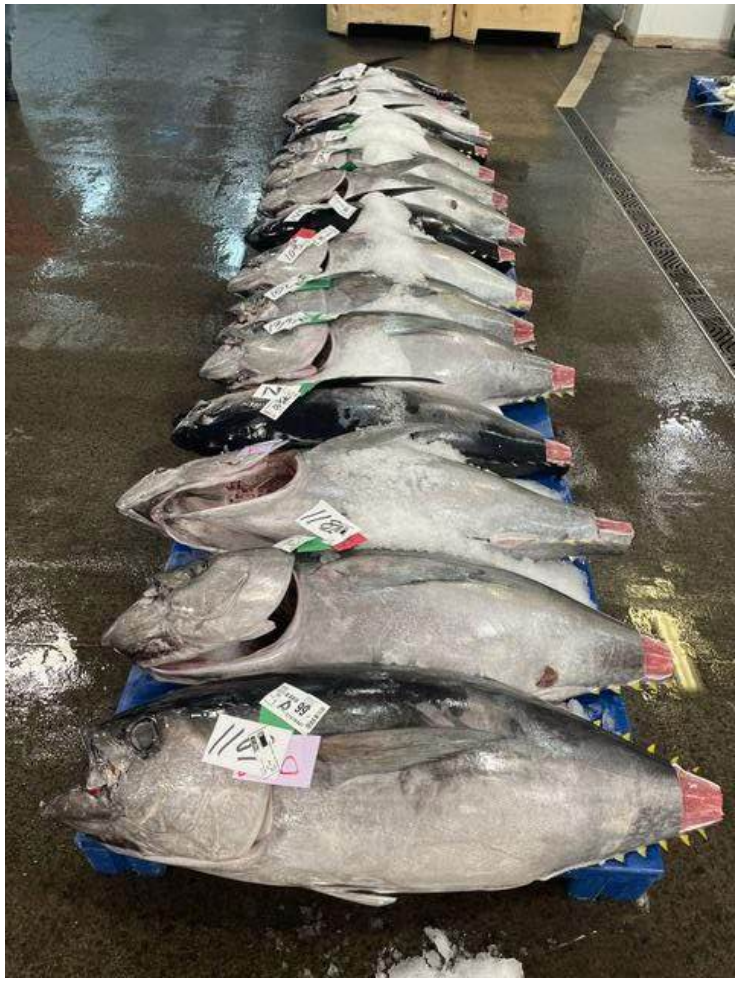
Bigeye tuna in the Central North Pacific

Justin Suca[1]
Nicholas Ducharme-Barth[2]



1 University of Hawai'i – Mānoa, Department of Oceanography
2 NOAA Fisheries, Pacific Islands Fisheries Science Center

Conceptual model basis



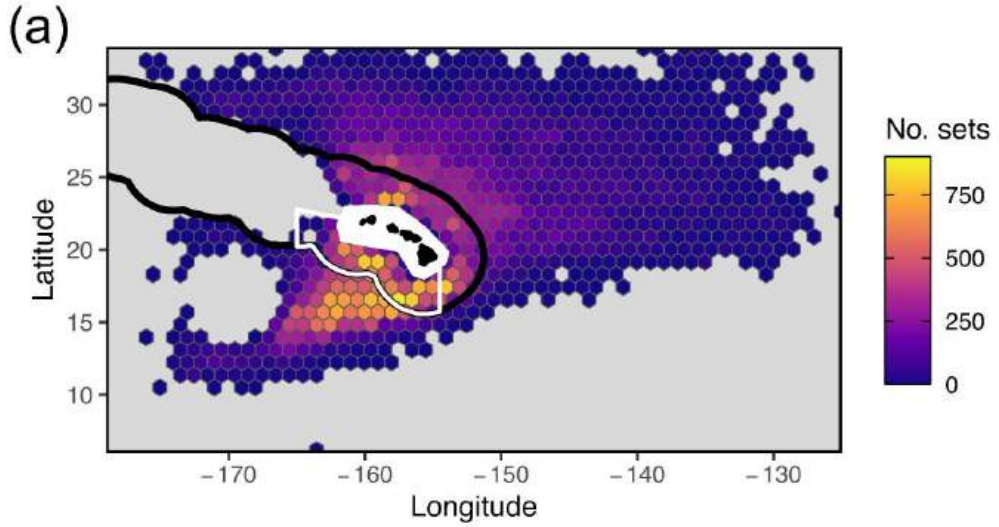
Bigeye tuna movement and distributional dynamics were inferred through analysis of US Hawai‘i longline fisheries dependent data

- Spatial analysis of longline observer CPUE by length
- Temporal analysis of auction weight data (modal progressions–not covered today)

US Hawai‘i longline

The US Hawai‘i longline fishery operates in the central north Pacific, comprising two sectors that deploy gear with a 10–15 hour soak time.

- **Deep-set sector**
  - Targets tropical tunas (mainly bigeye) southwest and north-northeast of the main Hawai‘i Islands (outside the U.S. EEZ)
    - 80+ lb (36+ kg) bigeye preferred by industry and local markets



Jacey C Van Wert, Zachary A Siders, T Todd Jones, Robert N M Ahrens, Hawai‘i's pelagic longline fishery demonstrates the need to consider multispecies impacts in bluewater time-area closures, *ICES Journal of Marine Science*, Volume 82, Issue 7, July 2025, fsaf111, https://doi.org/10.1093/icesjms/fsaf111

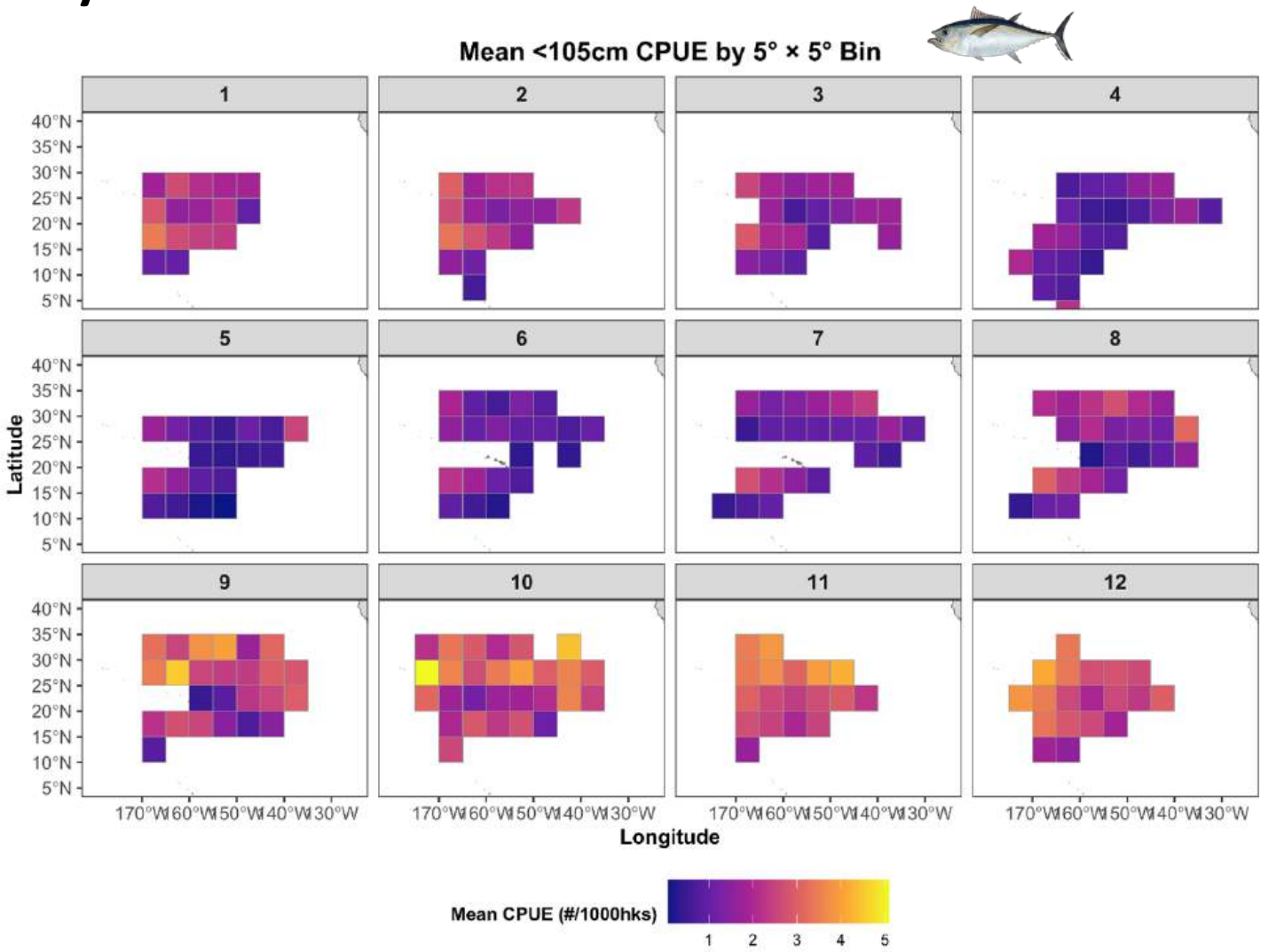
Observer data – spatial analysis

Longline observers covers ~20% of deep-set fishing activity.

Measure fork length of every 3rd fish (across all species) brought on deck

Catch-rate patterns by size class (small & large) were analyzed using Generalized Additive Models (GAMs)

- Small: < 105cm FL (~immature)
- Large: > 105cm FL (~mature)



Preliminary: Suca et al., in prep.
Do not cite/distribute

Observer data – spatial analysis

Longline observers covers ~20% of deep-set fishing activity.

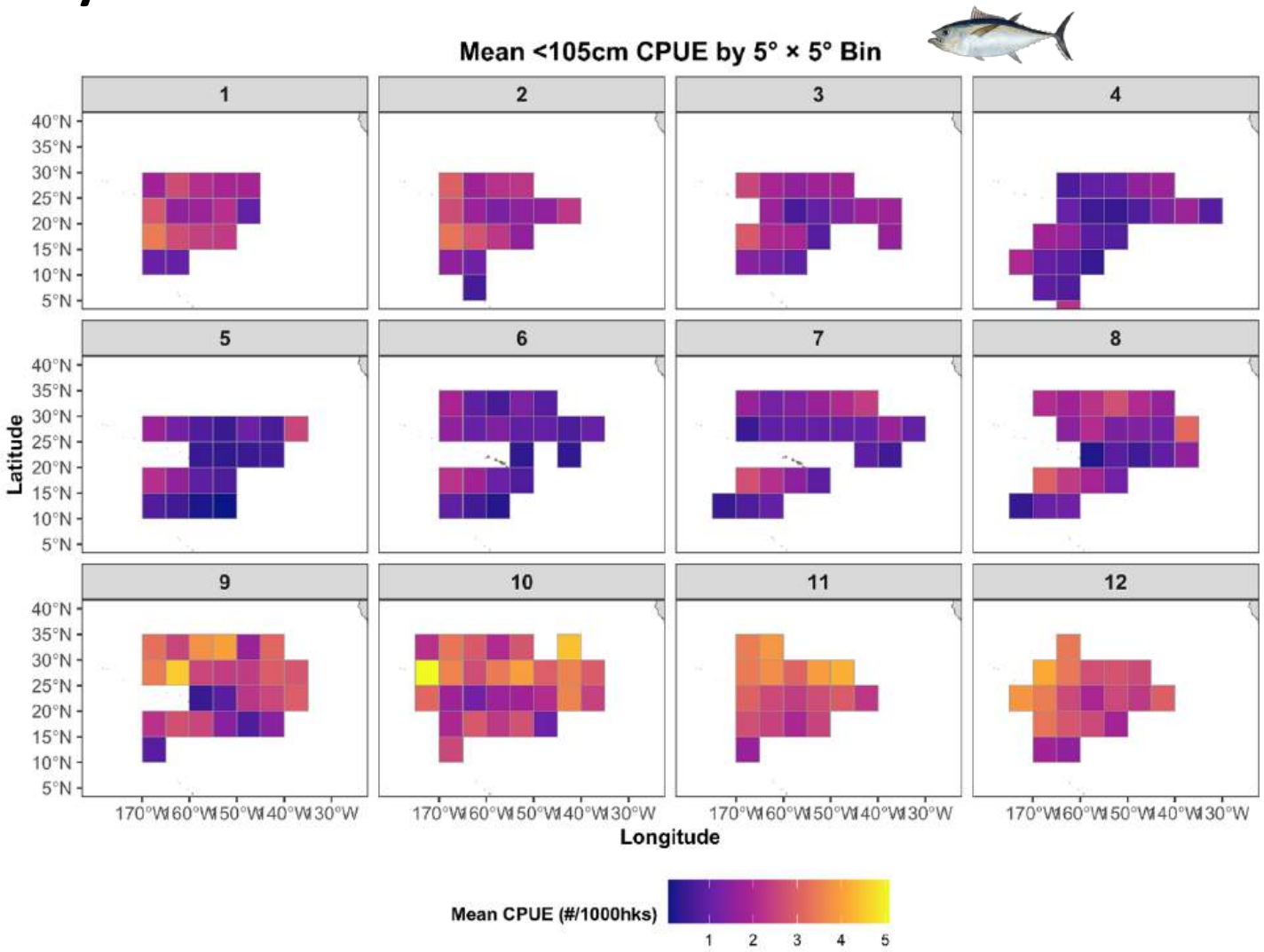
Measure fork length of every 3rd fish (across all species) brought on deck

Catch-rate patterns by size class (small & large) were analyzed using Generalized Additive Models (GAMs)

- Small: < 105cm FL (~immature)
- Large: > 105cm FL (~mature)

Qualitative highlights

- Small BET begin filling out the fishing grounds at the end of Q3 and move out at the end of Q1



Preliminary: Suca et al., in prep.
Do not cite/distribute

Observer data – spatial analysis

Longline observers covers ~20% of deep-set fishing activity.

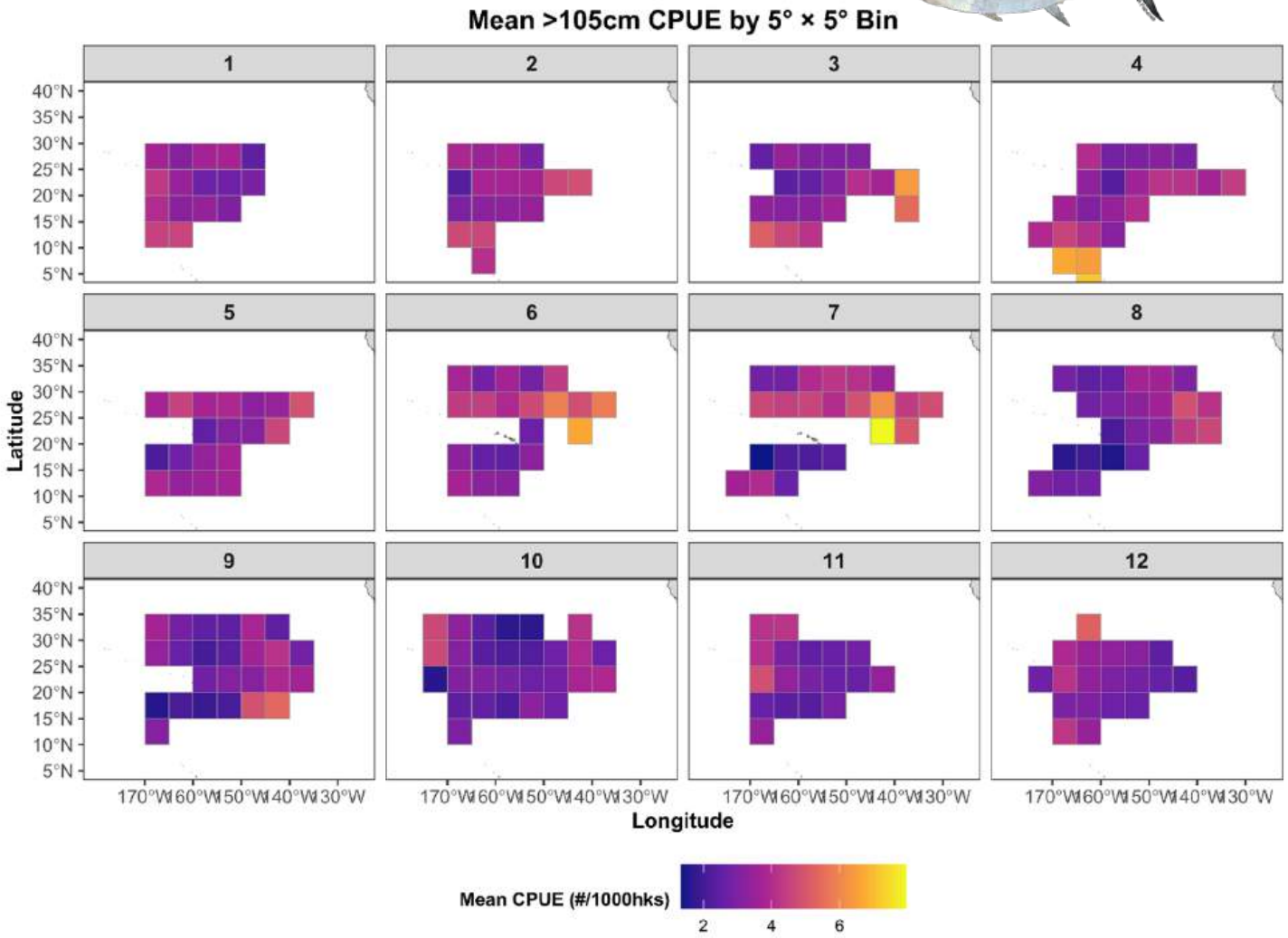
Measure fork length of every 3rd fish (across all species) brought on deck

Catch-rate patterns by size class (small & large) were analyzed using Generalized Additive Models (GAMs)

- Small: < 105cm FL (~immature)
- Large: > 105cm FL (~mature)

Qualitative highlights

- Small BET begin filling out the fishing grounds at the end of Q3 and move out at the end of Q1
- Large BET catch rates peak at periphery of fishing grounds



Preliminary: Suca et al., in prep.
Do not cite/distribute

Observer data – spatial analysis

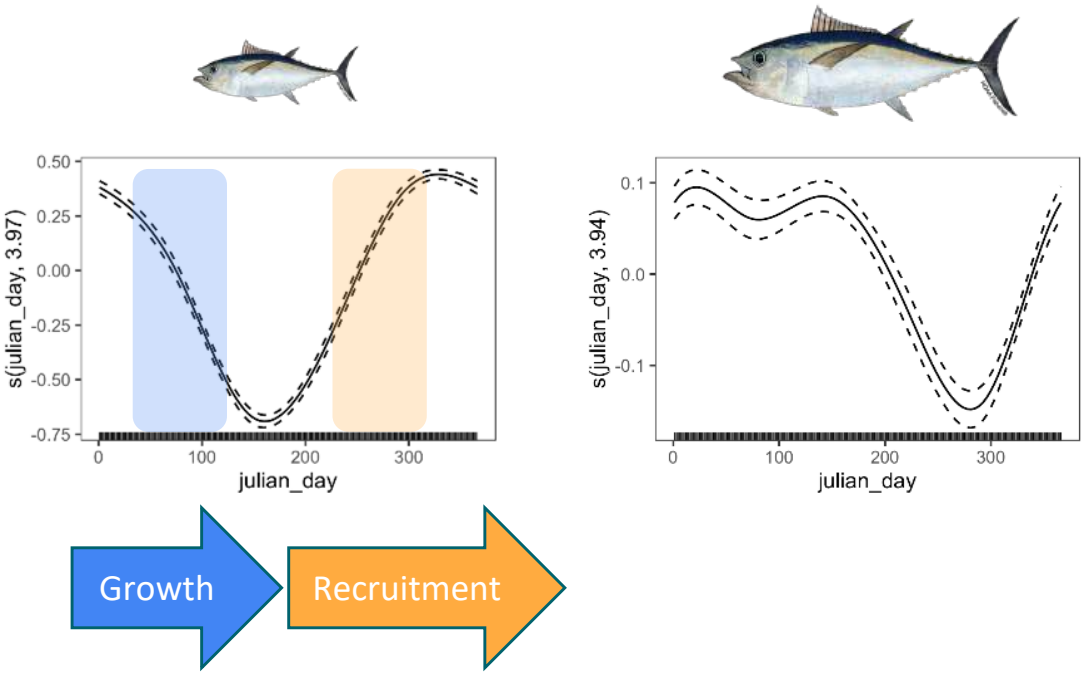
Longline observers covers ~20% of deep-set fishing activity.
Measure fork length of every 3rd fish (across all species) brought on deck

Catch-rate patterns by size class (small & large) were analyzed using Generalized Additive Models (GAMs)

- Small: < 105cm FL (~immature)
- Large: > 105cm FL (~mature)

Qualitative highlights

- Small BET begin filling out the fishing grounds at the end of Q3 and move out at the end of Q1



Preliminary: Suca et al., in prep.
Do not cite/distribute

Observer data – spatial analysis

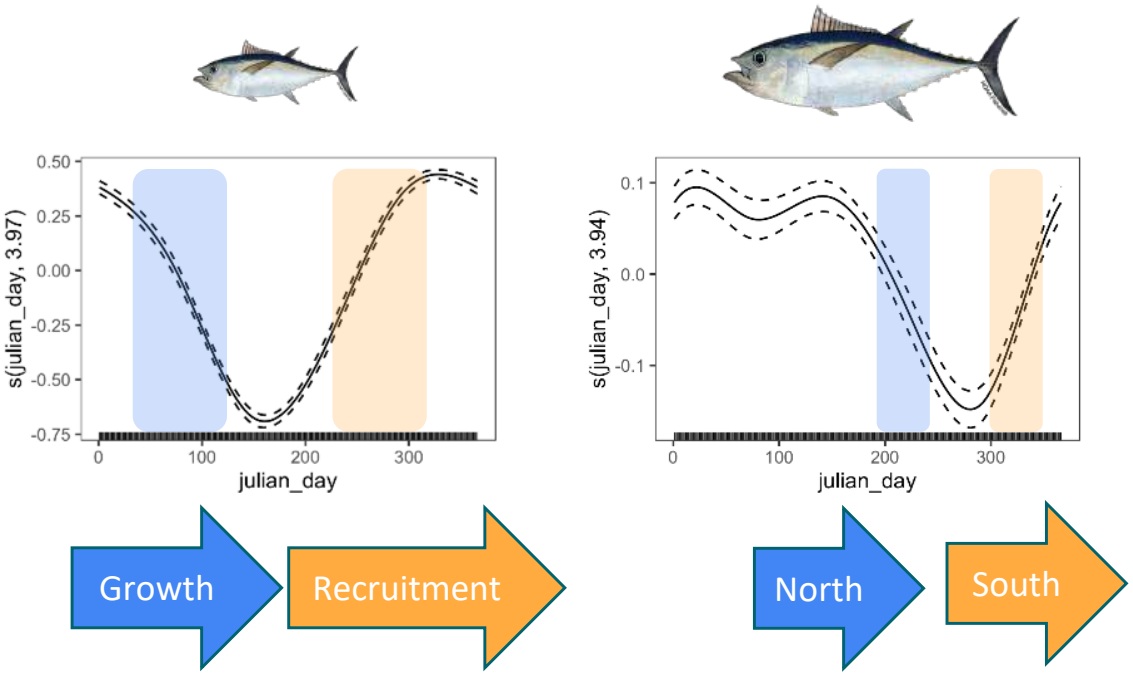
Longline observers covers ~20% of deep-set fishing activity.
Measure fork length of every 3rd fish (across all species) brought on deck

Catch-rate patterns by size class (small & large) were analyzed using Generalized Additive Models (GAMs)

- Small: < 105cm FL (~immature)
- Large: > 105cm FL (~mature)

Qualitative highlights

- Small BET begin filling out the fishing grounds at the end of Q3 and move out at the end of Q1
- Large BET leave fishing grounds at the end of Q2 and return at the end of Q4



Preliminary: Suca et al., in prep.
Do not cite/distribute

Observer data – spatial analysis

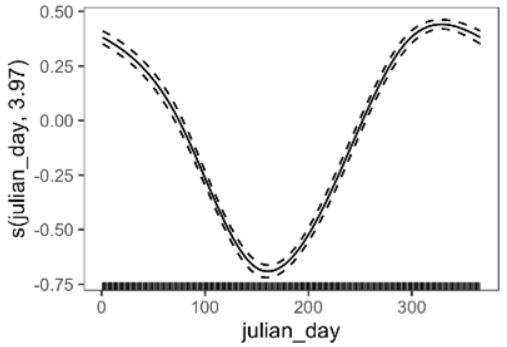
Longline observers covers ~20% of deep-set fishing activity.
Measure fork length of every 3rd fish (across all species) brought on deck

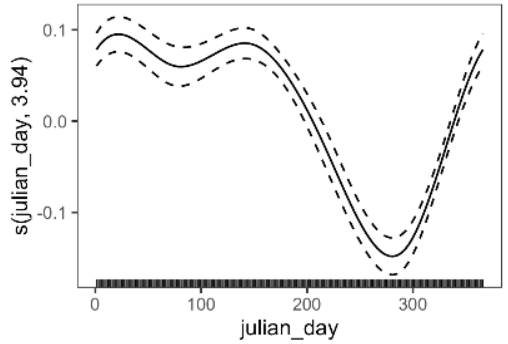
Catch-rate patterns by size class (small & large) were analyzed using Generalized Additive Models (GAMs)

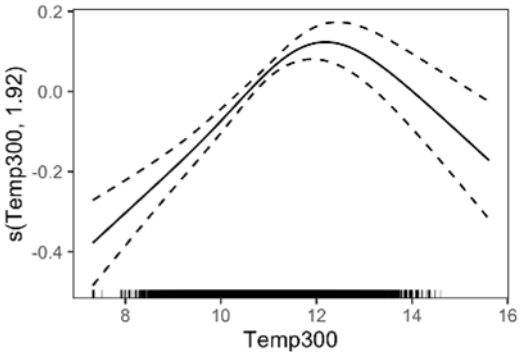
- Small: < 105cm FL (~immature)
- Large: > 105cm FL (~mature)

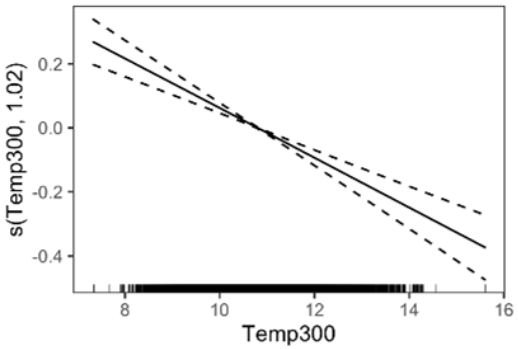
Qualitative highlights

- Small BET begin filling out the fishing grounds at the end of Q3 and move out at the end of Q1
- Large BET leave fishing grounds at the end of Q2 and return at the end of Q4
- Catch rates of large BET occur at cooler sub-surface temperatures than small BET









Preliminary: Suca et al., in prep.
Do not cite/distribute

Observer data – spatial analysis

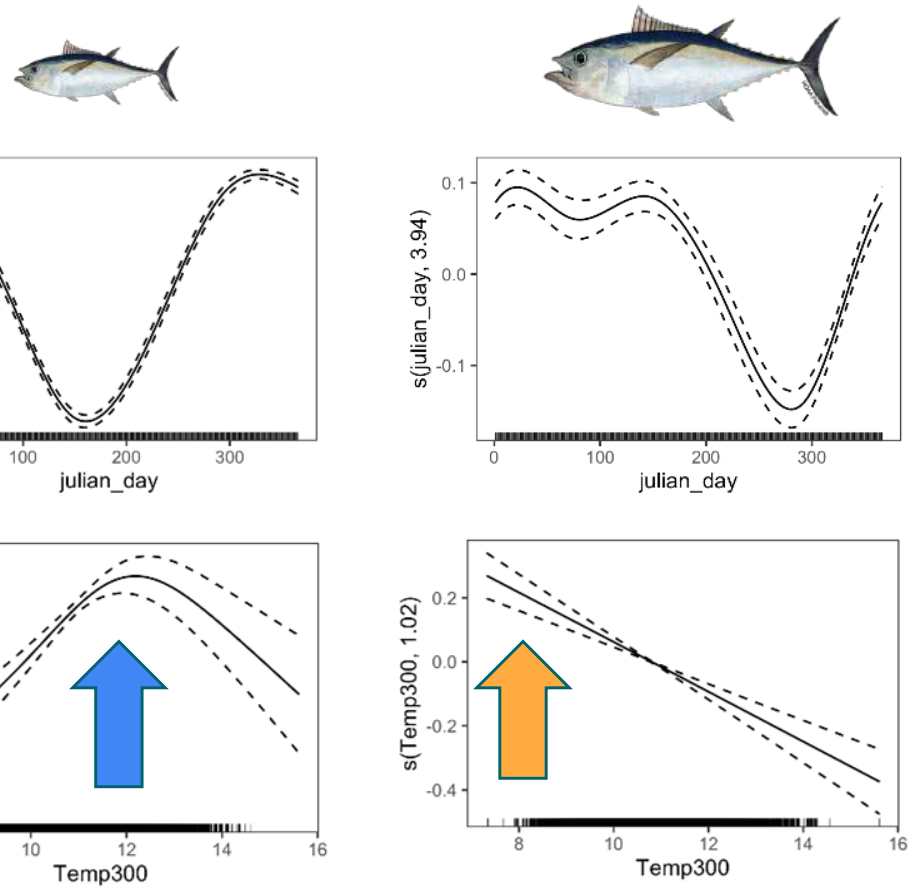
Longline observers covers ~20% of deep-set fishing activity.
Measure fork length of every 3rd fish (across all species) brought on deck

Catch-rate patterns by size class (small & large) were analyzed using Generalized Additive Models (GAMs)

- Small: < 105cm FL (~immature)
- Large: > 105cm FL (~mature)

Qualitative highlights

- Small BET begin filling out the fishing grounds at the end of Q3 and move out at the end of Q1
- Large BET leave fishing grounds at the end of Q2 and return at the end of Q4
- Catch rates of large BET occur at cooler sub-surface temperatures than small BET



~12 C **~8 C**

Preliminary: Suca et al., in prep.
Do not cite/distribute

Observer data – spatial analysis

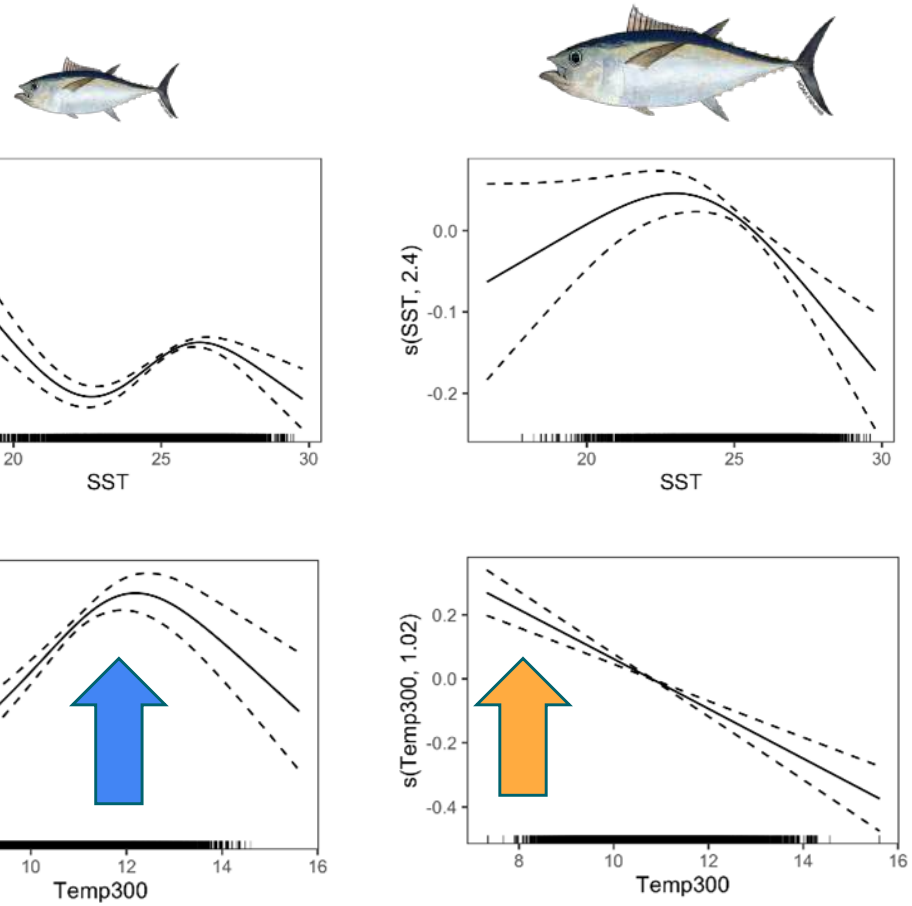
Longline observers covers ~20% of deep-set fishing activity.
Measure fork length of every 3rd fish (across all species) brought on deck

Catch-rate patterns by size class (small & large) were analyzed using Generalized Additive Models (GAMs)

- Small: < 105cm FL (~immature)
- Large: > 105cm FL (~mature)

Qualitative highlights

- Small BET begin filling out the fishing grounds at the end of Q3 and move out at the end of Q1
- Large BET leave fishing grounds at the end of Q2 and return at the end of Q4
- Catch rates of large BET occur at cooler sub-surface temperatures than small BET



~12 C

~8 C

Preliminary: Suca et al., in prep.
Do not cite/distribute

Observer data – spatial analysis

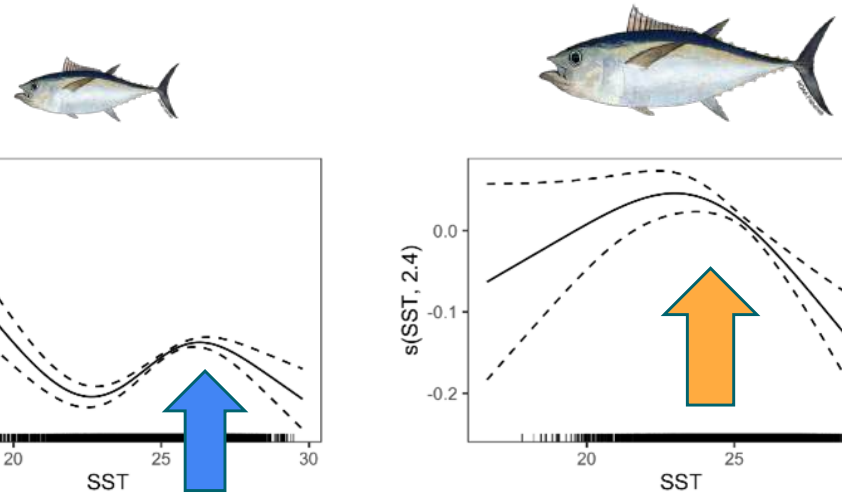
Longline observers covers ~20% of deep-set fishing activity.
Measure fork length of every 3rd fish (across all species) brought on deck

Catch-rate patterns by size class (small & large) were analyzed using Generalized Additive Models (GAMs)

- Small: < 105cm FL (~immature)
- Large: > 105cm FL (~mature)

Qualitative highlights

- Small BET begin filling out the fishing grounds at the end of Q3 and move out at the end of Q1
- Large BET leave fishing grounds at the end of Q2 and return at the end of Q4
- Catch rates of large BET occur at cooler sub-surface temperatures than small BET



Preliminary: Suca et al., in prep.
Do not cite/distribute

Observer data – spatial analysis

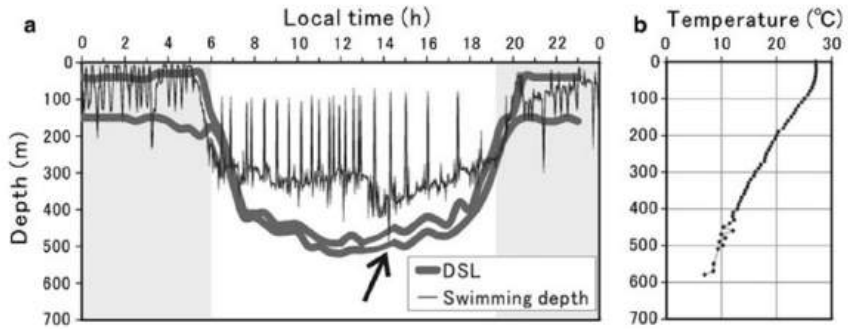


Fig. 3 Representative bigeye tuna swimming trajectory and DSL depth monitored in the same area (around Yonaguni Island) and season. **a** Trajectories of DSL observed on 5/31/2006 [15] and swimming depth of the fish No. 119 (estimated FL 60 cm) was observed on 6/2/2003. *Shaded zones* show nighttime and *arrow* shows excursions of the fish into the DSL layer. **b** Water temperature profile obtained by tag No. 119 between 5/31 and 6/8/2003

Matsumoto et al., 2013

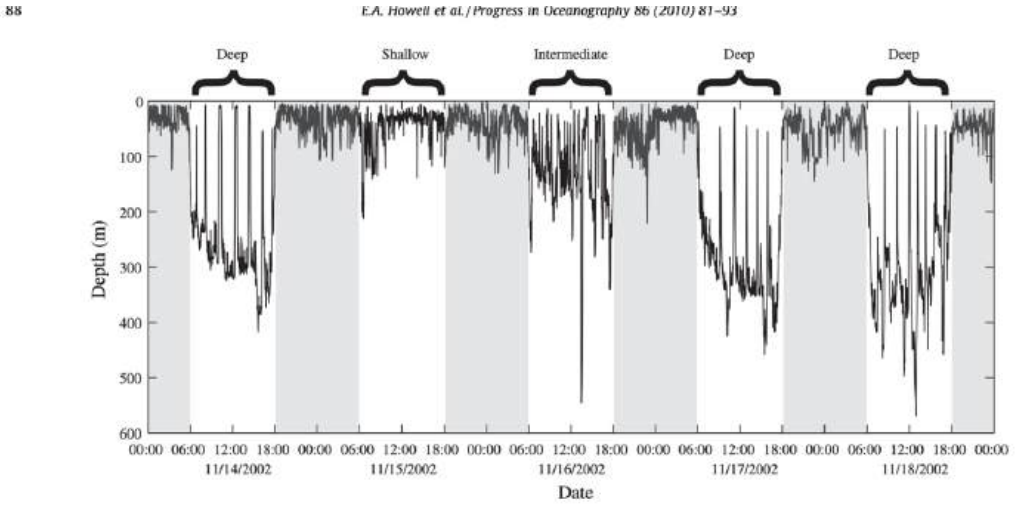
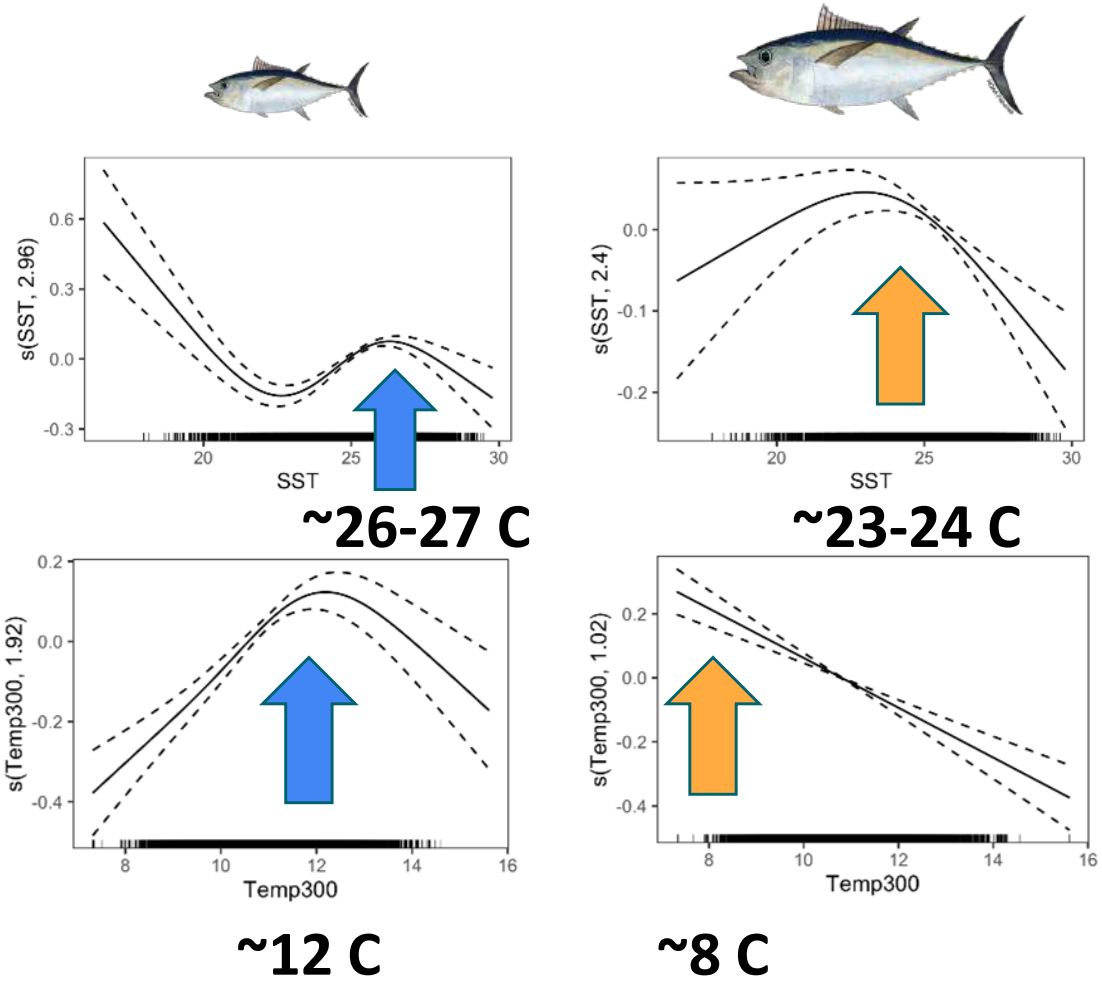


Fig. 4. Five days of high-resolution archival data from the successfully recovered PAT-2 tag #30253. These five days are used to illustrate the shallow (epipelagic), deep (mesopelagic) and intermediate dive behaviors defined in the study. The grey shading indicates the period between dusk and dawn in local time.

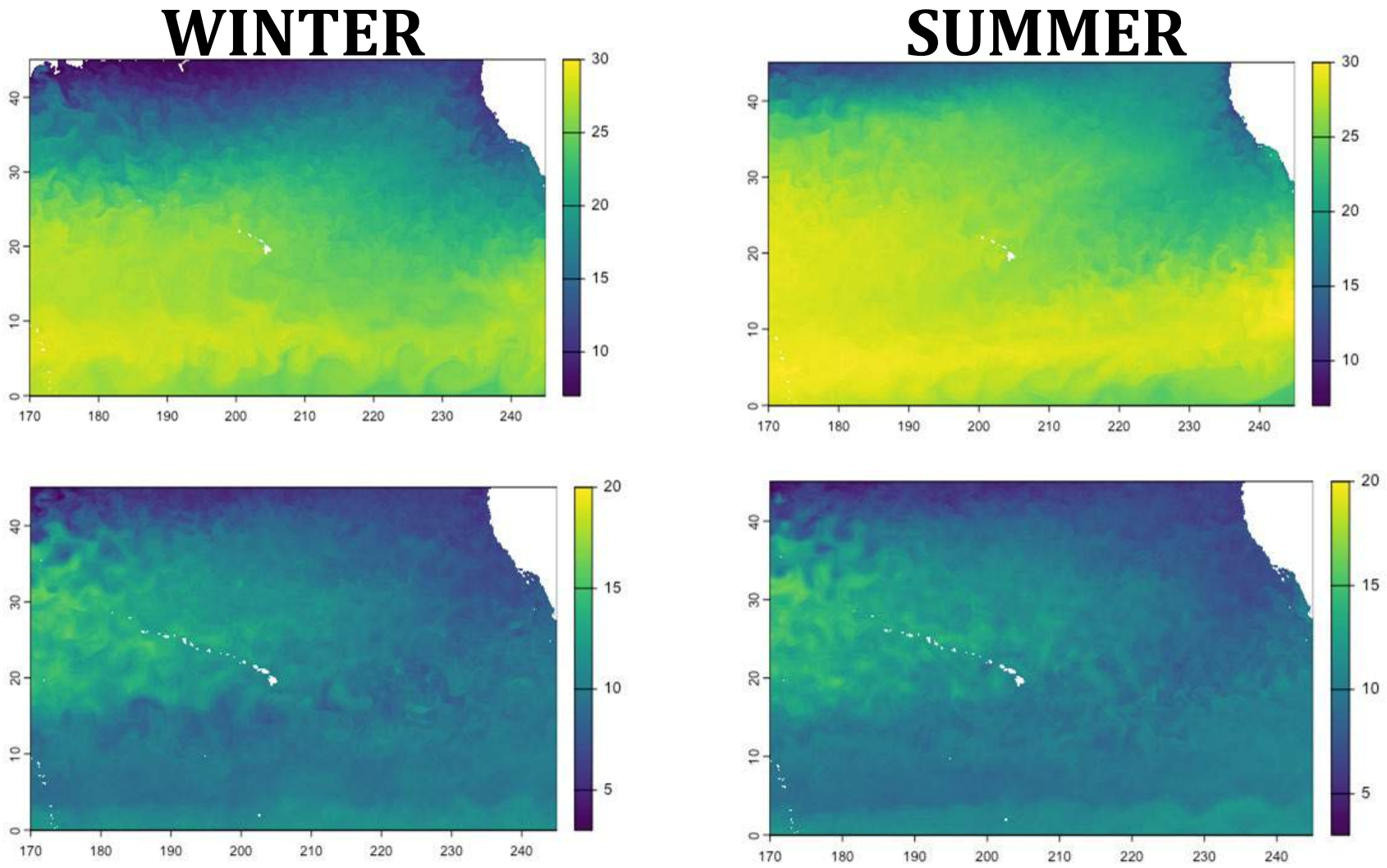


Preliminary: Suca et al., in prep.
Do not cite/distribute

Observer data – spatial analysis

SST (top) exhibits pronounced seasonal variability

Temperature at 300m (bottom) primarily defines the North Pacific Subtropical Gyre vs the Subpolar Gyre and upwelling regions (e.g., California Current & Equator)

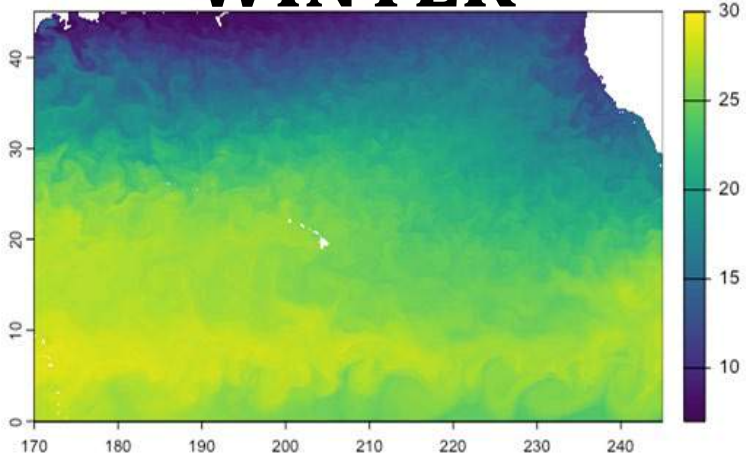


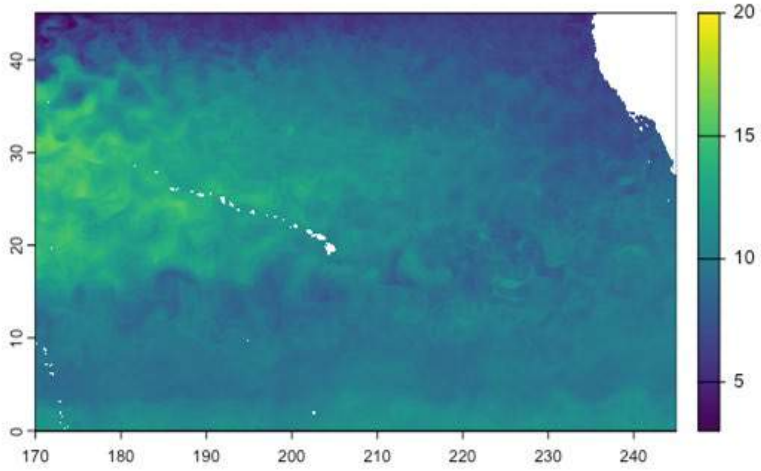
Observer data – spatial analysis

Winter: Too cold at surface for juveniles and adults to deal with cold dives in the northeast extent of fishing grounds

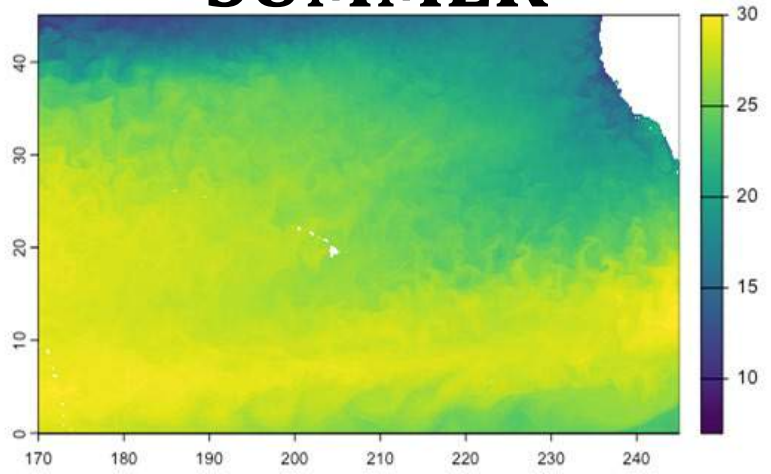
Summer: Surface warm enough for adults to digest and warm-up but subsurface too cold for juveniles in northeast extent of grounds

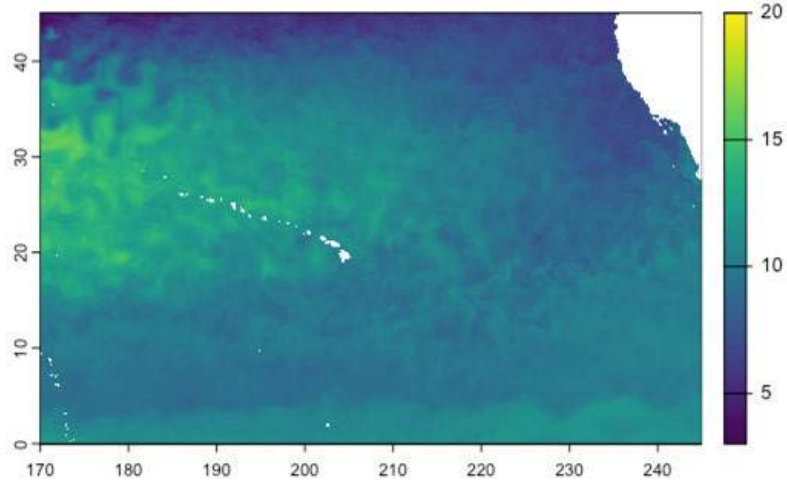
WINTER





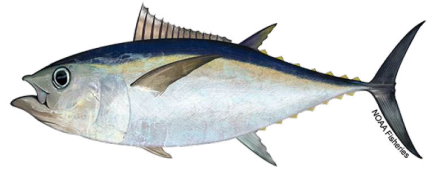
SUMMER





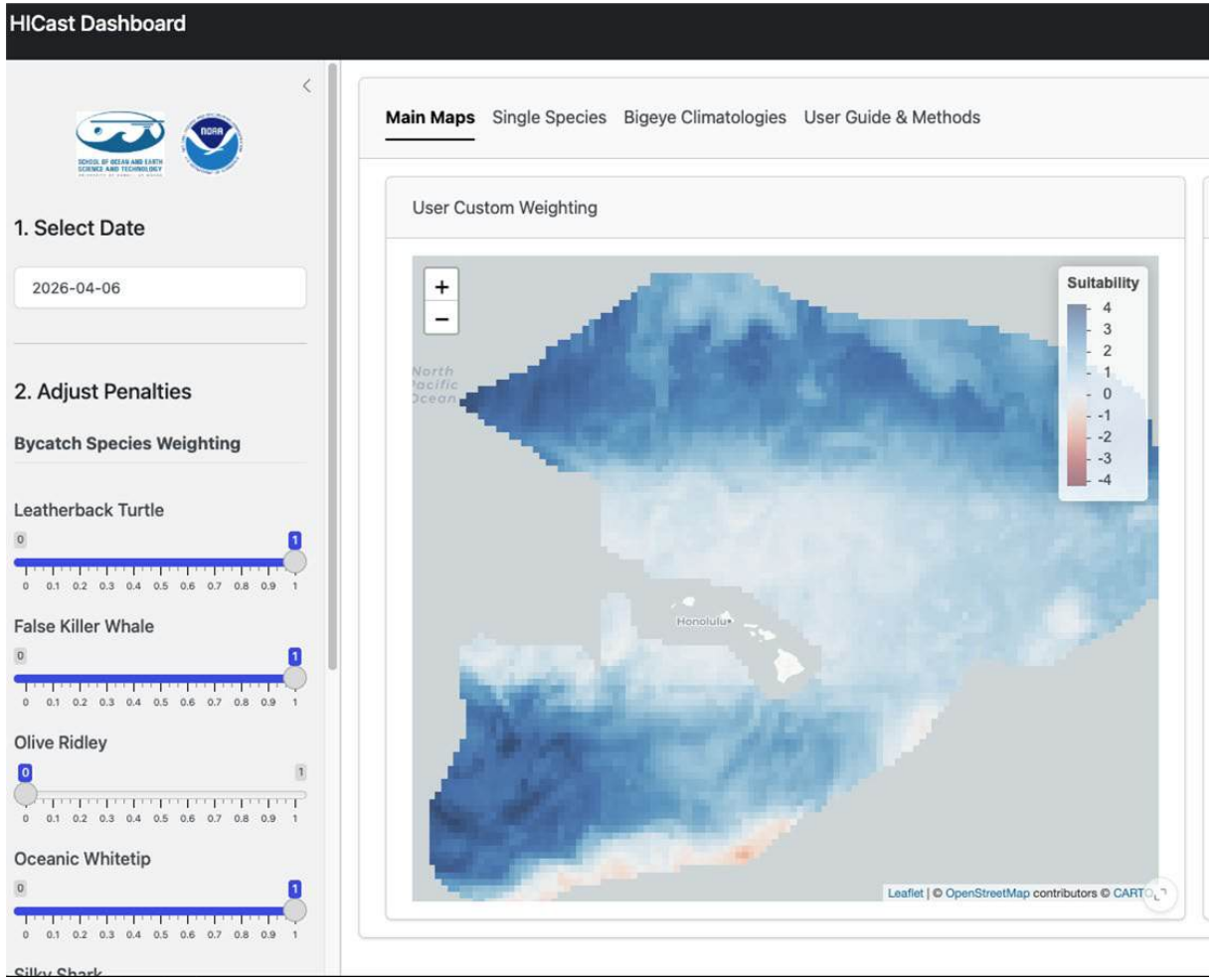
Early hypotheses

- Small bigeye tuna enter (or age into) the Hawai‘i longline grounds in late Q3/Q4
- Small bigeye are constrained by thermal limits in their foraging dives
- Large bigeye (with lower surface area to volume ratio) can deal with foraging trips to cooler sub-surface water
- Large bigeye likely venture to warm waters to spawn
- Effects of changing ocean temperatures likely to have differential effects on bigeye distribution and catchability by size/age class



Early hypotheses

- Effects of changing ocean temperatures likely to have differential effects on bigeye distribution and catchability by size/age class
- Useful to split age classes in forecasting distributions, which we are attempting to do for near-real-time bycatch avoidance & fishing optimization tools



Mukai et al., *in prep.*