Leatherback Sea Turtle Interaction Rate

Hawai‘i Deep-Set Longline Fishery, 2005–2024

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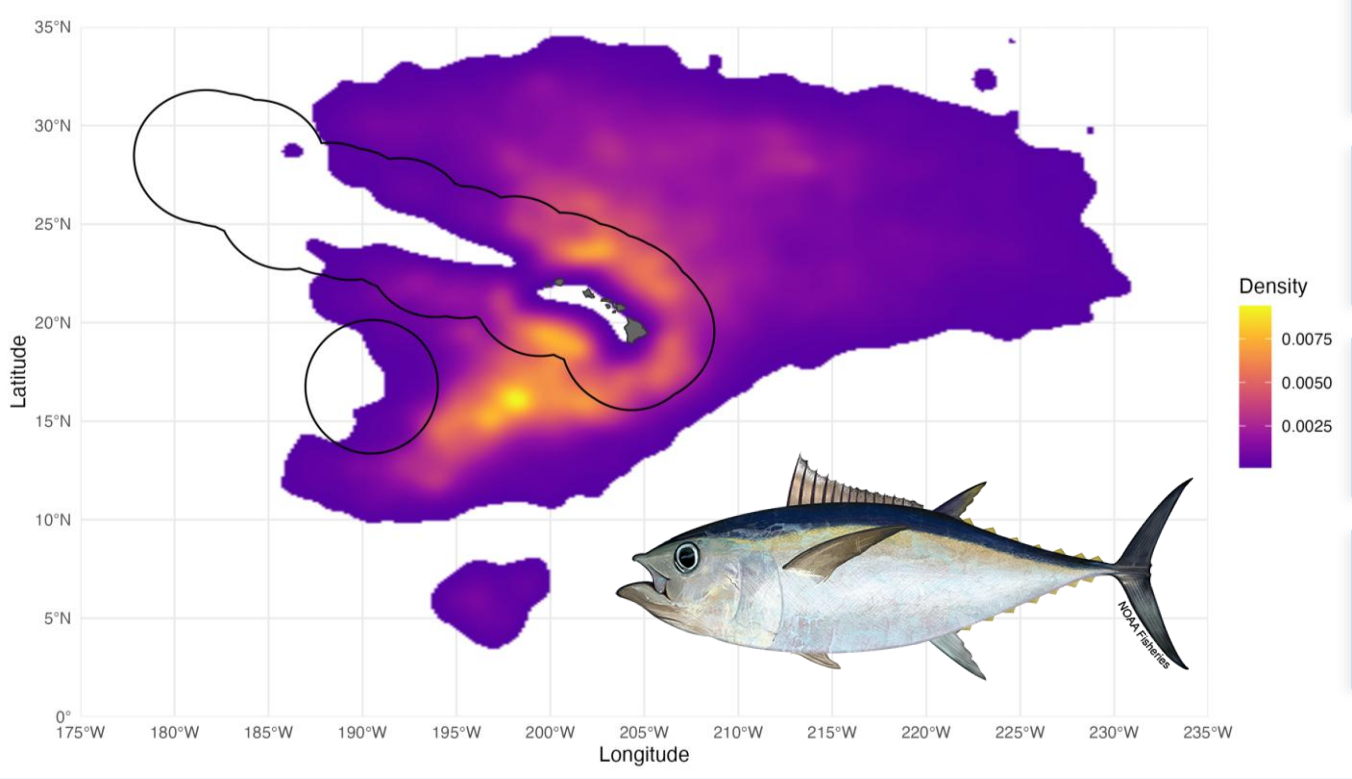
Hawai‘i deep-set characteristics



150 · 1635

Vessels · Trips
2024

65.9 million

Hooks set

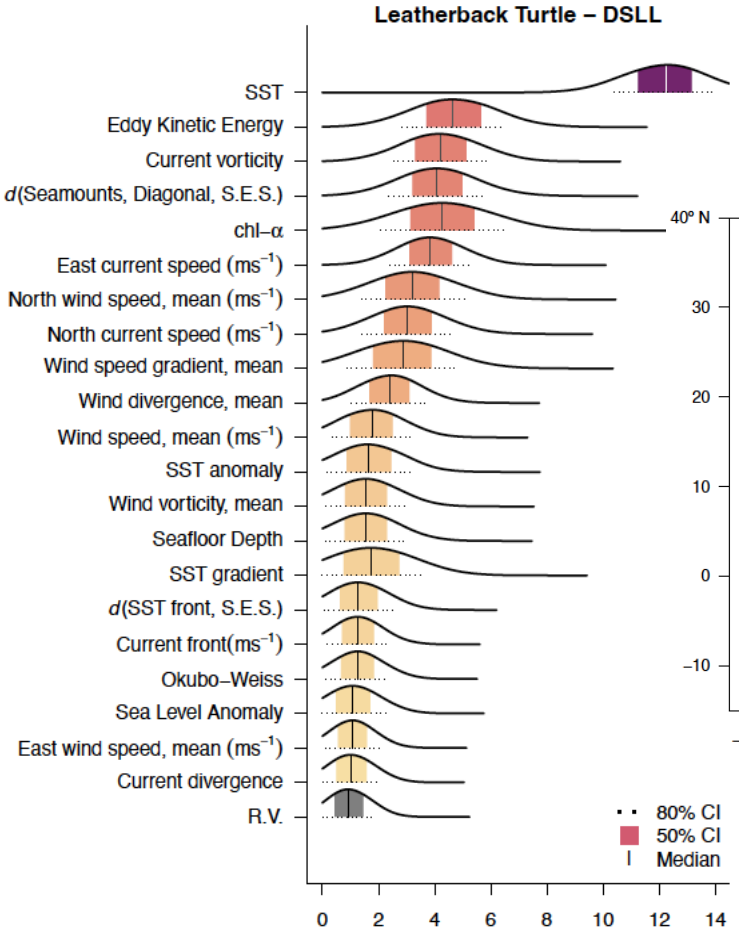
24 (16-35)

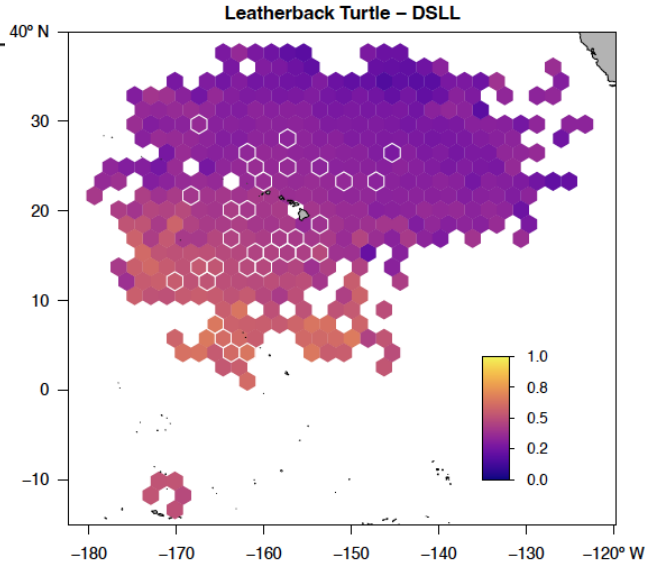
Hooks between floats

Milkfish / Circle hook

Bait · Hook

Estimated deep-set leatherback interaction characteristics





13/55 = 23.6%

At vessel mortalities / Interactions
2005-2024

19.4% (0–60%)

Assigned post release mortality

43%

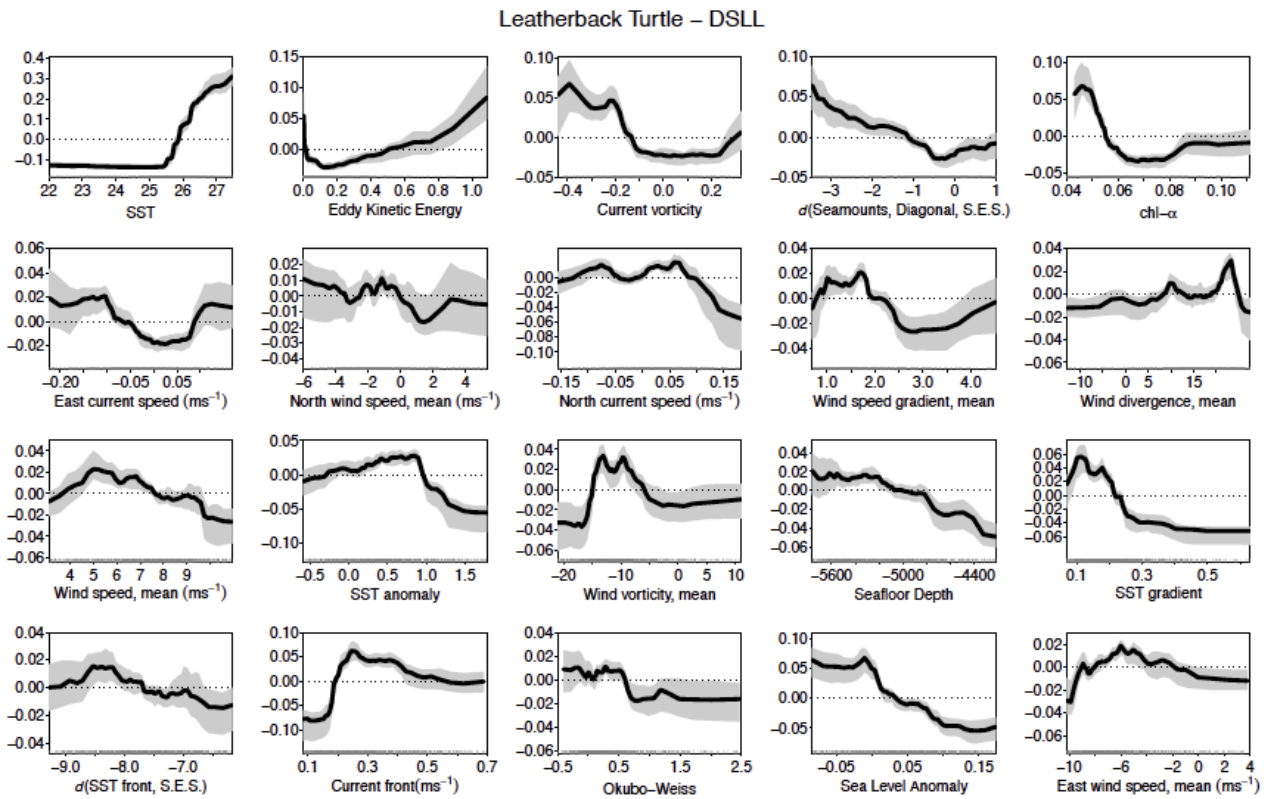
Total mortality

44%

Estimated to be adult

Model developed with Dr. Zach Siders using the ERF R package
https://zsiders.github.io/EnsembleRandomForests/

Interaction characteristics ALE plots



>25.5°C

Sea surface temperature

High EKE

High eddy activity

Near seamounts

Closer than random S.E.S.

Lower chl-α

Not at productivity fronts

Interaction rate estimation

Sampling design

Data is from the Pacific Islands Regional Observer Program coverage of the Hawai‘i deep-set (~20% coverage until recently). Sampling unit = trip; hooks nested within trips. 5,757 trips, 191M hooks, 55 turtle interactions, 2005–2024.

Ratio estimator*

Rate $\hat{\lambda} = \Sigma t_i / \Sigma h_i$ (turtles per hook), scaled to per 10^6 hooks. Appropriate when both numerator and denominator are random variables varying across trips.

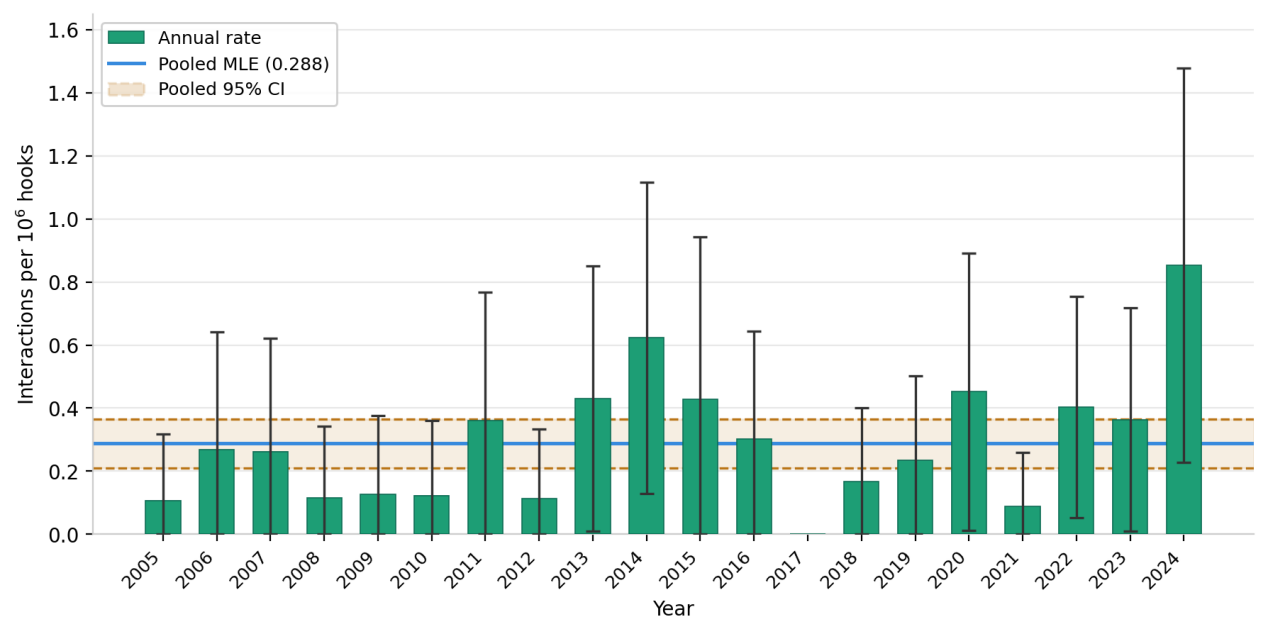
*Simple ratio estimator can be biased at low sample sizes. Horvitz-Thompson (HT) estimator is a better choice if inclusion probabilities can be calculated.

Taylor linearization

$\mathrm{Var}(\hat{\lambda}) \approx [s^2_t + \hat{\lambda}^2 \cdot s^2_h - 2\hat{\lambda} \cdot s_{th}] / (\bar{h}^2 \cdot n)$. Accounts for trip-level clustering in both hook counts and interaction counts. 95% CI via normal approximation.

Simple Poisson variance applied to aggregate hooks ignores trip clustering → artificially narrow CI

Hawai‘i deep-set results 2005–2024



Annual interaction rate (bars) with Taylor linearization 95% CIs.
Blue line = pooled MLE; dashed = pooled 95% CI.

0.288

Pooled mean per million hooks

0.211–0.365

95% CI per million hooks

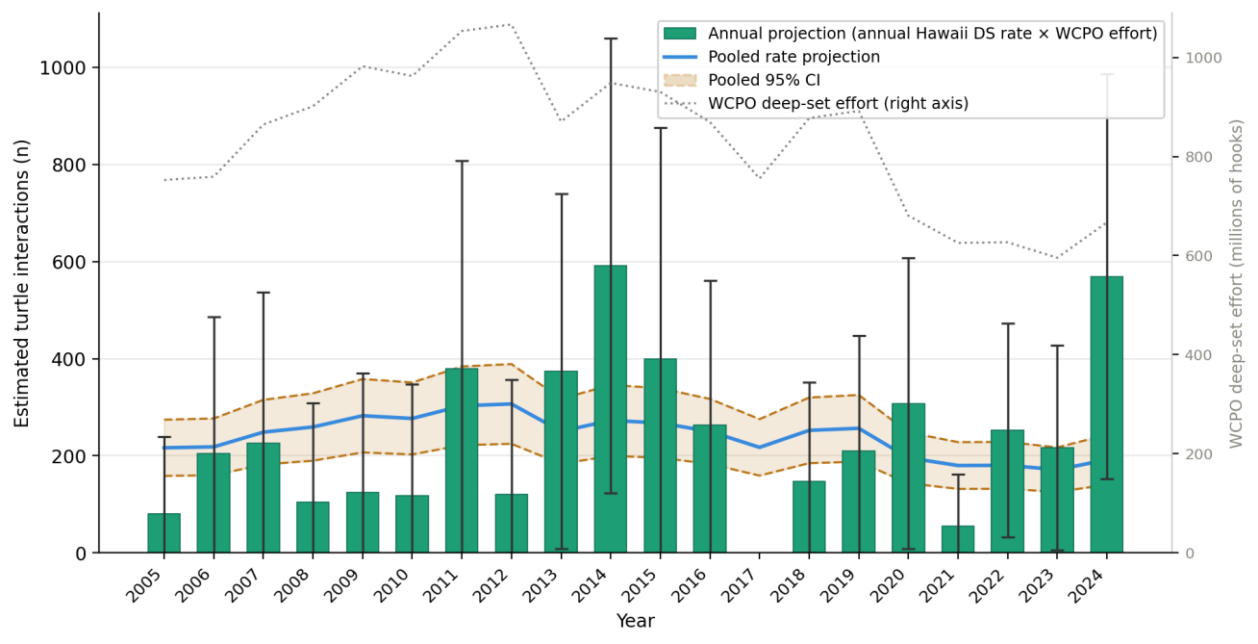
5,757

Observed trips

55

Turtles observed

WCPO regional projection 2005-2024



Projected WCPO turtle interactions using Hawaii DS pooled rate × WCPO deep-set effort.
Pooled CI band shown; dotted line = WCPO effort (right axis).

Key findings

- ~172–303 turtles/yr projected across WCPO (pooled rate)
- ~4,770 total interactions 2005–2024 (95% CI: 3,490–6,050)
- Effort peaked 2011–2012; declined post-2016

Caveat

Assumes Hawaii DS rate applies fleet-wide. Gear type, depth, and spatial overlap with turtle distributions vary across WCPO fleets. Treat as indicative estimates only.
Peatman et al. 2019
~0.74 (0.37 – 1.25) per million hooks
2.6 times higher but < 1% coverage