



Modeling Marine Debris Incidents Associated with the Hawai'i-based Pelagic Longline Fishery



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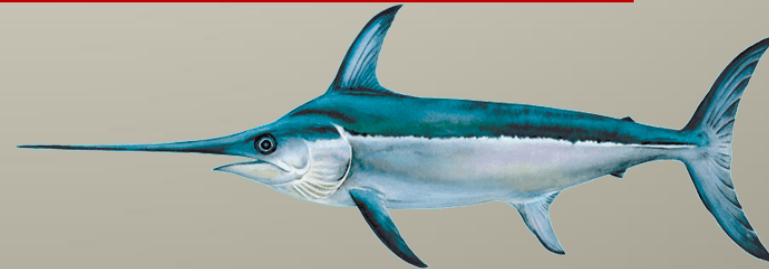
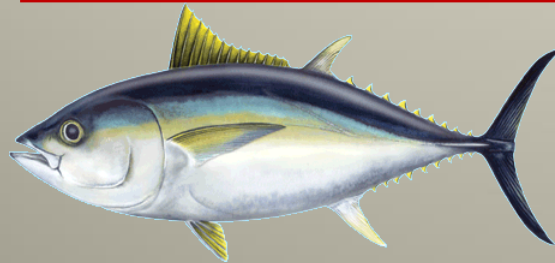
Hawai'i-based Pelagic Longline Fishery

Deep Sector

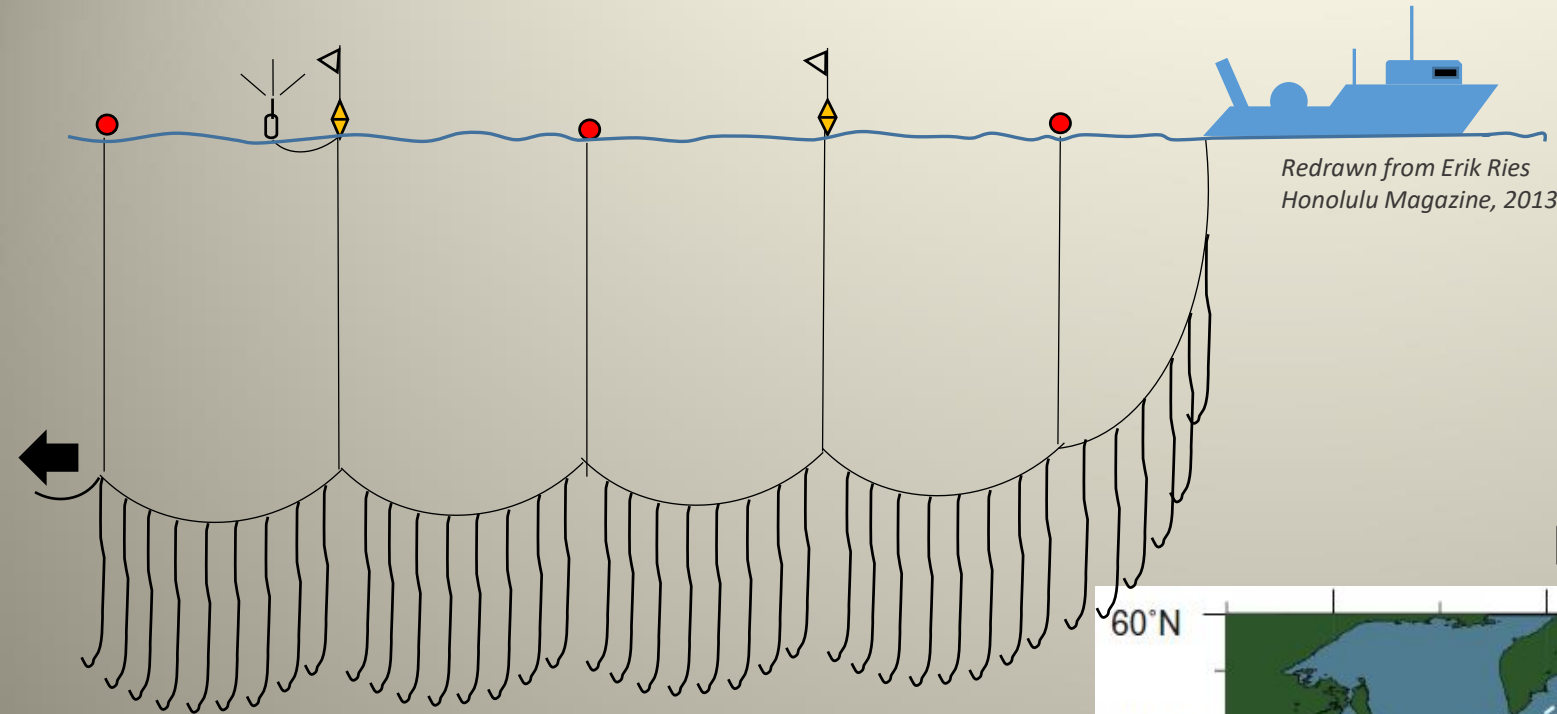
- Bigeye tuna
- 243m depth
- ≥ 15 hooks per float
- 2000 hooks total
- Deploy after dawn
- Annual
- Below 30°N

Shallow Sector

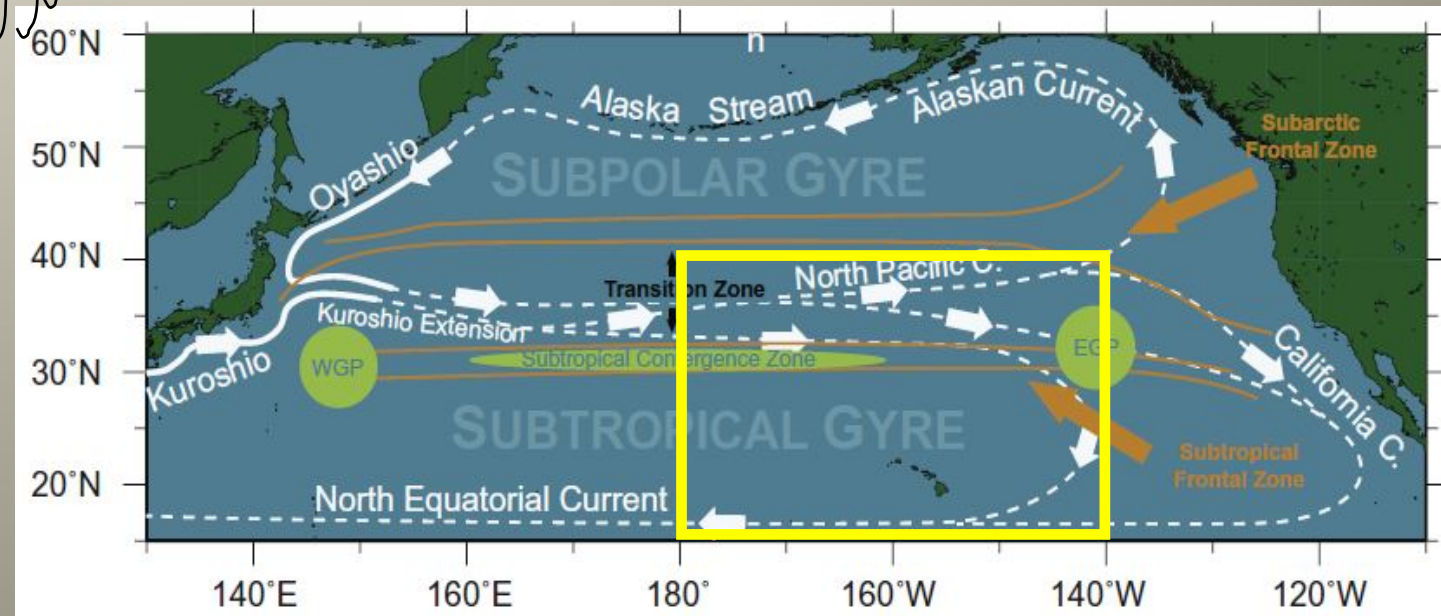
- Swordfish
- 64m depth
- < 15 hooks per float
- 1000 hooks total
- Deploy at sunset
- Winter
- Above 30°N latitude



Hawai'i-based Pelagic Longline Fishery



North Pacific Ocean



NOAA Pacific Islands Regional Observer Program

- Onboard longline observations initiated 1994
 - Priority focus on longline gear and protected species interactions
- Marine debris longline observations initiated late 2007
 - Report debris interactions with longline gear & types of debris



Objectives

- Quantify abundance and type of marine debris by standardizing for fishery effort
- Similar to catch-per-unit-effort methods used in fishery stock assessments
- Control for effort to understand how debris catch represents debris abundance



Data Collection 2008-2016

- Marine Debris Encounter Reports
- Counts of marine debris by set
 1. net
 2. rope/line
 3. monofilament
 4. metal
 5. cloth
 6. plastic sheeting
 7. floats / buoys
 8. fish aggregating device
 9. lumber
 10. natural
 11. other
- Merge with master observer database
- N = 40,572 longline sets

NOAA Pacific Islands Regional Office, Observer Program

Marine Debris Encounter Report

This information is being used to help determine the economic cost of marine debris impacts to fisheries.

Trip Number: _____

Position of Encounter with Debris (includes vessel, gear and animals)

Latitude: ___° ___' N / S Longitude: ___° ___' E / W (positions to nearest whole minute)

Date: _____ Time: _____

Incident Type:

- Gear Interaction Noteworthy Sightings (e.g., large collection of small debris items, large debris objects, etc.)
 Vessel Interaction
 Entangled Species Caught (e.g. entangled swordfish) Other (includes recovered ingested debris items): _____

Debris Type:

- Net Cloth
 Rope Plastic sheeting
 Monofilament line Floats
 Metal (describe): _____ FAD (Fish Aggregating Device)
 Other (describe): _____

Biota Type (on or living in net) – List species names if known:

- Fish _____
 Crustaceans _____
 Encrusting organisms _____

Description of incident type and debris object/material: (describe the type of incident in more detail, diameter or width, length, colors and biota living on the debris)

Weight: (est.) _____ lbs Photos: Y / N Debris brought on board? Y / N

Length of downtime: _____ hrs

Description of downtime and cost (describe what was done during downtime (e.g. propeller disengaged by divers) and details of cost):

Statistical Analysis

- **Zero-inflated negative binomial model**
 - count data that is clumped
 - extra zeros from reporting error or survey error (or both)
 - 2 model components: positive counts + probabilities of extra zeros
 - standardized for number of hooks per set
 - sampling unit = individual longline set

Response variables

- Counts of marine debris

Predictor variables

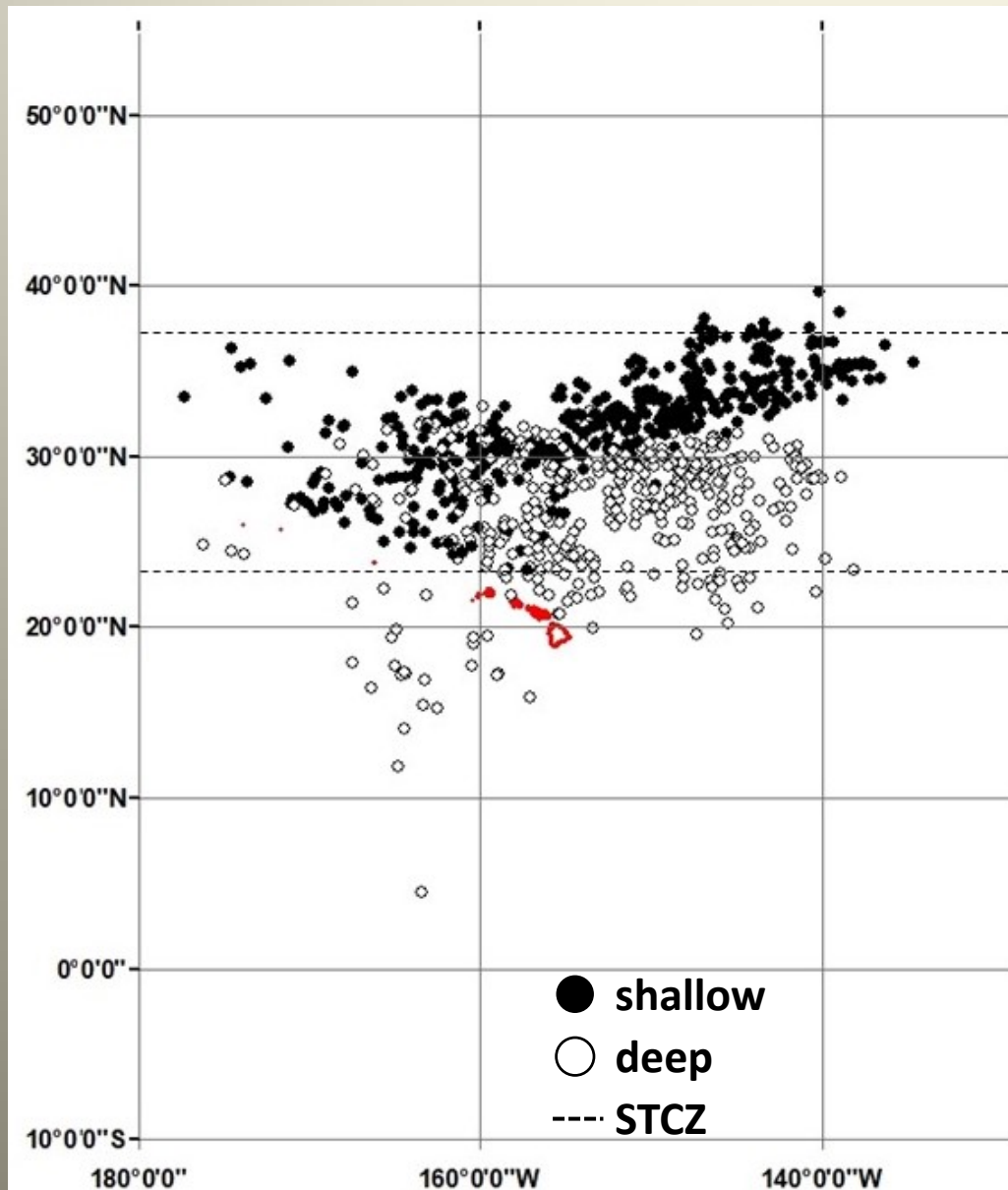
- Year (2008-2016)
- Quarter (1st – 4th)
- Sector (shallow, deep)
- Observer type (high, low)
- Convergence zone (in, out)
- Begin-set latitude
- Begin-set longitude

How Much & What Type

- 858 sets with captured debris
- 1326 total items
 - 51.8% net
 - 26.7% rope, line
- 1.2 - 1.6 items per set
 - min: 1
 - max: 9



Spatial Distribution



- **Total sets observed**
 - shallow: 8442
 - deep: 32,130
- **Sets w/ debris**
 - shallow: 440
 - deep: 418
- **Distribution**
 - shallow: above 30°N
 - deep: below 30°N

Negative binomial count model: expected positive counts per set

- Increasing counts through 2011, decreasing thereafter
- More counts in Q1 (Jan - Mar)
- Fewer counts in deep sector - 40.5% decrease in expected counts
- More counts as you move northward – 12% increase for 1-degree latitude



Logistic zero-inflation model: odds of zero counts per set

- Fewer zeros moving eastward - *5% decrease in odds (of a zero count)*
- Fewer zeros inside convergence zone - *56% decrease in odds*
- Fewer zeros reported by experienced observers - *79% decrease in odds*
- More zeros in deep sector - *127% greater odds*



Mean Annual Catch-Per Unit Effort

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Summary / Next Steps

- Bias toward derelict fishing gear, prevalent in convergence zone
 - opportunities for incentivizing removal
- Highest debris in 2011; declining thereafter
 - related to tsunami?
- More debris in shallow sector despite less effort
 - less debris at deeper depths
 - target shallow sector for removal
- Experienced observers reported more debris, fewer zeros
 - evaluate training protocols