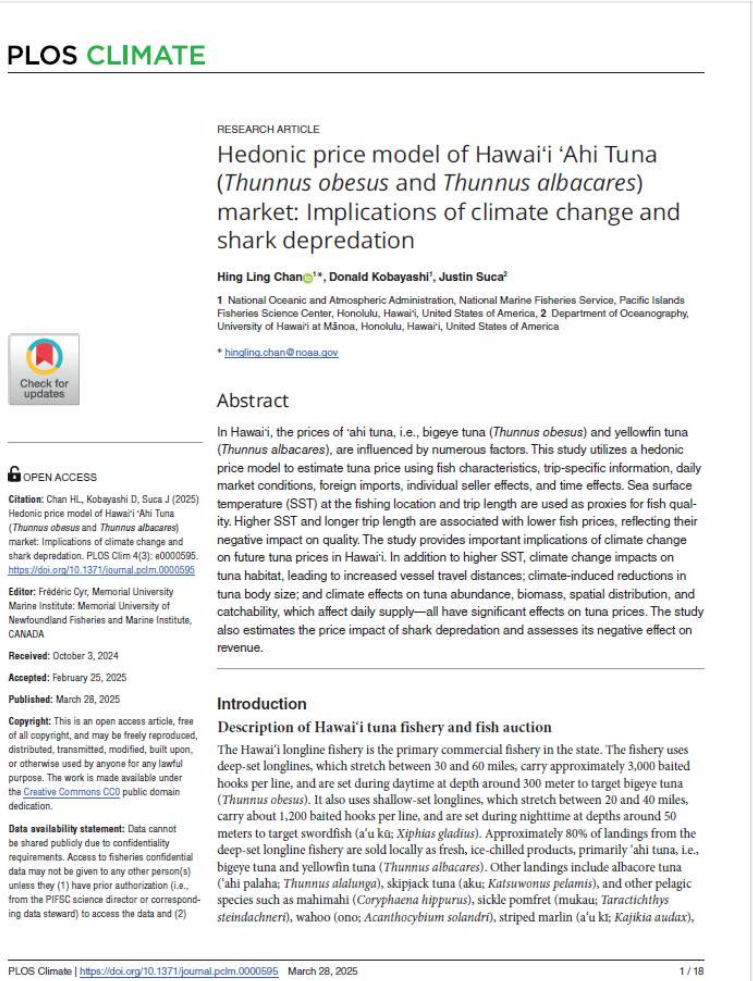
Hawai‘i Tuna Price Model

IATTC 2nd Climate Change Workshop
April 8, 2026

Hing Ling (Michel) Chan
Donald Kobayashi
Justin Suca

Publication

Chan HL, Kobayashi D, Suca J (2025) Hedonic price model of Hawai‘i ‘Ahi Tuna (*Thunnus obesus* and *Thunnus albacares*) market: Implications of climate change and shark depredation. PLOS Clim 4(3): e0000595. https://doi.org/10.1371/journal.pclm.0000595



PLOS CLIMATE

RESEARCH ARTICLE

Hedonic price model of Hawai‘i ‘Ahi Tuna (*Thunnus obesus* and *Thunnus albacares*) market: Implications of climate change and shark depredation

Hing Ling Chan[1]*, **Donald Kobayashi**[1], **Justin Suca**[2]

1 National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Pacific Islands Fisheries Science Center, Honolulu, Hawai‘i, United States of America, 2 Department of Oceanography, University of Hawai‘i at Mānoa, Honolulu, Hawai‘i, United States of America

* hingling.chan@noaa.gov

Check for updates

OPEN ACCESS

Citation: Chan HL, Kobayashi D, Suca J (2025) Hedonic price model of Hawai‘i ‘Ahi Tuna (*Thunnus obesus* and *Thunnus albacares*) market: Implications of climate change and shark depredation. PLOS Clim 4(3): e0000595. https://doi.org/10.1371/journal.pclm.0000595

Editor: Frédéric Cyr, Memorial University Marine Institute: Memorial University of Newfoundland Fisheries and Marine Institute, CANADA

Received: October 3, 2024

Accepted: February 25, 2025

Published: March 28, 2025

Copyright: This is an open access article, free of all copyright, and may be freely reproduced, distributed, transmitted, modified, built upon, or otherwise used by anyone for any lawful purpose. The work is made available under the Creative Commons CC0 public domain dedication.

Data availability statement: Data cannot be shared publicly due to confidentiality requirements. Access to fisheries confidential data may not be given to any other person(s) unless they (1) have prior authorization (i.e., from the PIFSC science director or corresponding data steward) to access the data and (2)

Abstract

In Hawai‘i, the prices of ‘ahi tuna, i.e., bigeye tuna (*Thunnus obesus*) and yellowfin tuna (*Thunnus albacares*), are influenced by numerous factors. This study utilizes a hedonic price model to estimate tuna price using fish characteristics, trip-specific information, daily market conditions, foreign imports, individual seller effects, and time effects. Sea surface temperature (SST) at the fishing location and trip length are used as proxies for fish quality. Higher SST and longer trip length are associated with lower fish prices, reflecting their negative impact on quality. The study provides important implications of climate change on future tuna prices in Hawai‘i. In addition to higher SST, climate change impacts on tuna habitat, leading to increased vessel travel distances; climate-induced reductions in tuna body size; and climate effects on tuna abundance, biomass, spatial distribution, and catchability, which affect daily supply—all have significant effects on tuna prices. The study also estimates the price impact of shark depredation and assesses its negative effect on revenue.

Introduction

Description of Hawai‘i tuna fishery and fish auction

The Hawai‘i longline fishery is the primary commercial fishery in the state. The fishery uses deep-set longlines, which stretch between 30 and 60 miles, carry approximately 3,000 baited hooks per line, and are set during daytime at depth around 300 meter to target bigeye tuna (*Thunnus obesus*). It also uses shallow-set longlines, which stretch between 20 and 40 miles, carry about 1,200 baited hooks per line, and are set during nighttime at depths around 50 meters to target swordfish (a‘u kū; *Xiphias gladius*). Approximately 80% of landings from the deep-set longline fishery are sold locally as fresh, ice-chilled products, primarily ‘ahi tuna, i.e., bigeye tuna and yellowfin tuna (*Thunnus albacares*). Other landings include albacore tuna (‘ahi palaha; *Thunnus alalunga*), skipjack tuna (aku; *Katsuwonus pelamis*), and other pelagic species such as mahimahi (*Coryphaena hippurus*), sickle pomfret (mukau; *Taractichthys steindachneri*), wahoo (ono; *Acanthocybium solandri*), striped marlin (a‘u kī; *Kajikia audax*),

PLOS Climate | https://doi.org/10.1371/journal.pclm.0000595 March 28, 2025 1 / 18

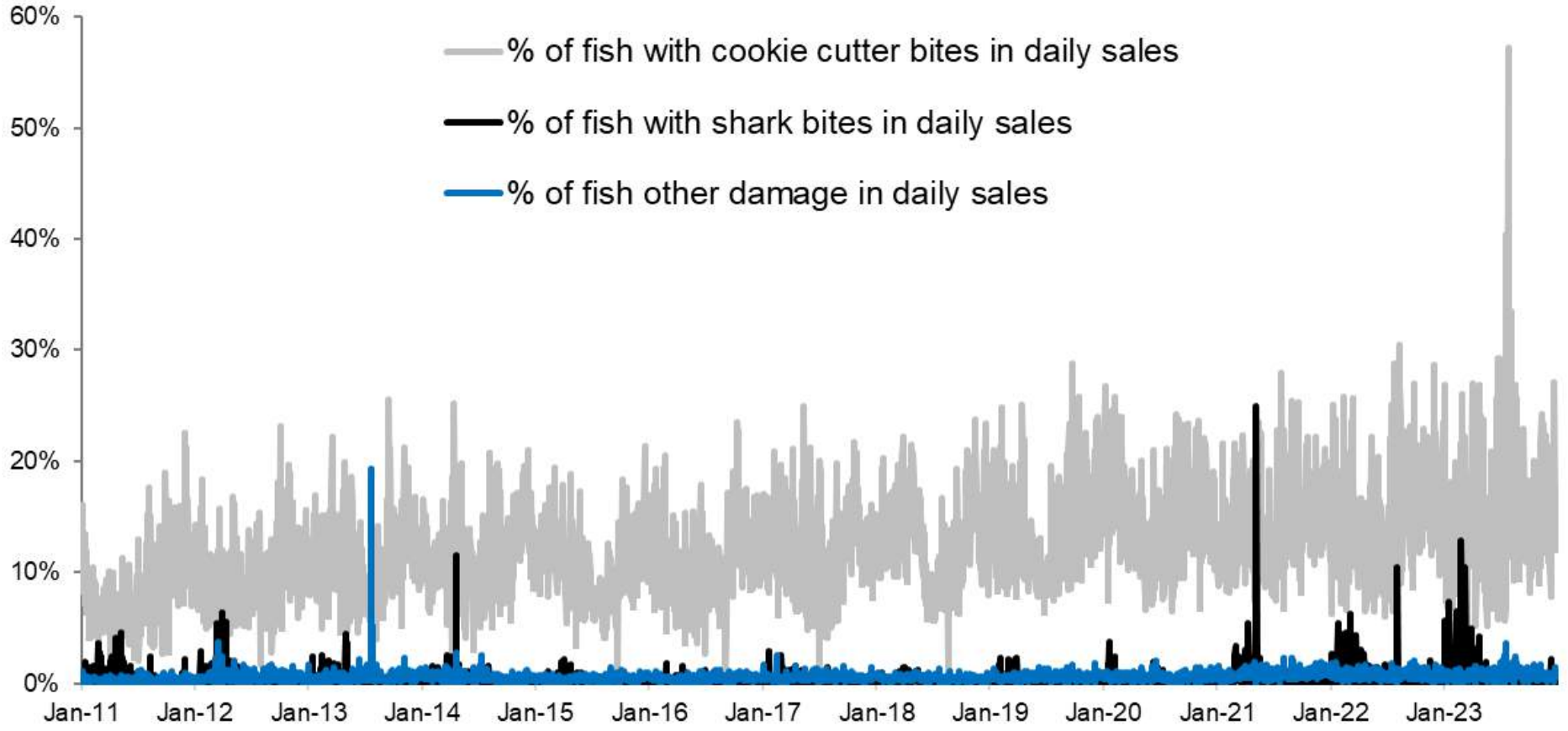
NOAA FISHERIES

Hawai‘i Tuna Price Model – Motivation

- In July 2023, Western Pacific Regional Fishery Management Council (WPRFMC) staff inquired to Pacific Islands Fisheries Science Center regarding an uptick in cookie cutter shark damage noticed by fishing industry partners: Hawai‘i Longline Association (HLA) and United Fishing Agency (UFA)
- In August 2023, our team had an initial meeting with HLA and UFA to discuss their concerns, including the potential economic impacts due to cookie cutter shark damage on fish and fish prices
- Developed a fish price model for bigeye and yellowfin tuna landed in Hawai‘i
- The model results provide several important implications regarding how climate-driven changes impact tuna prices

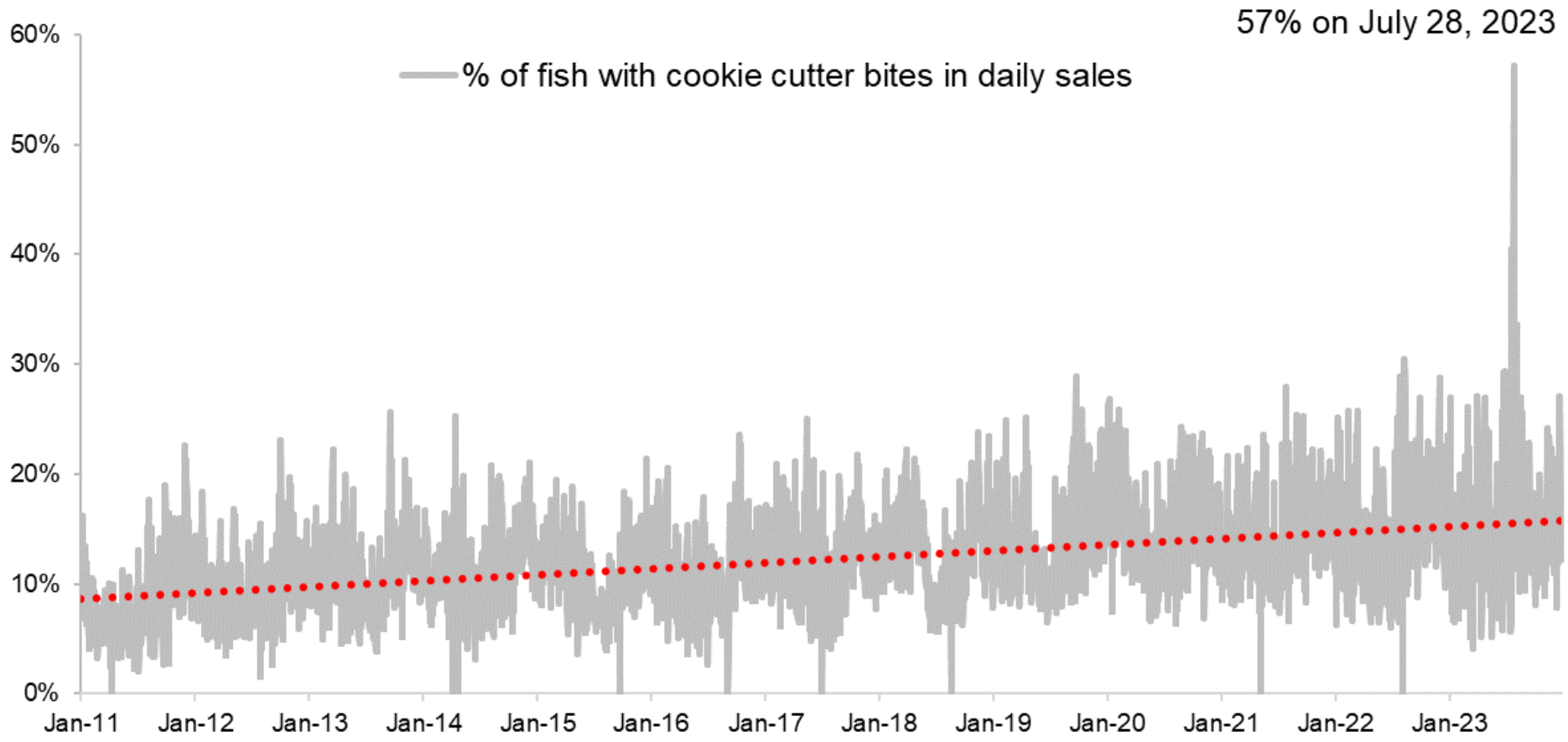
Photos courtesy of Enqi Yang (PIFSC intern) and Michael Goto (United Fishing Agency, Honolulu Fish Auction)

Incidence of Cookie Cutter Bites and Others

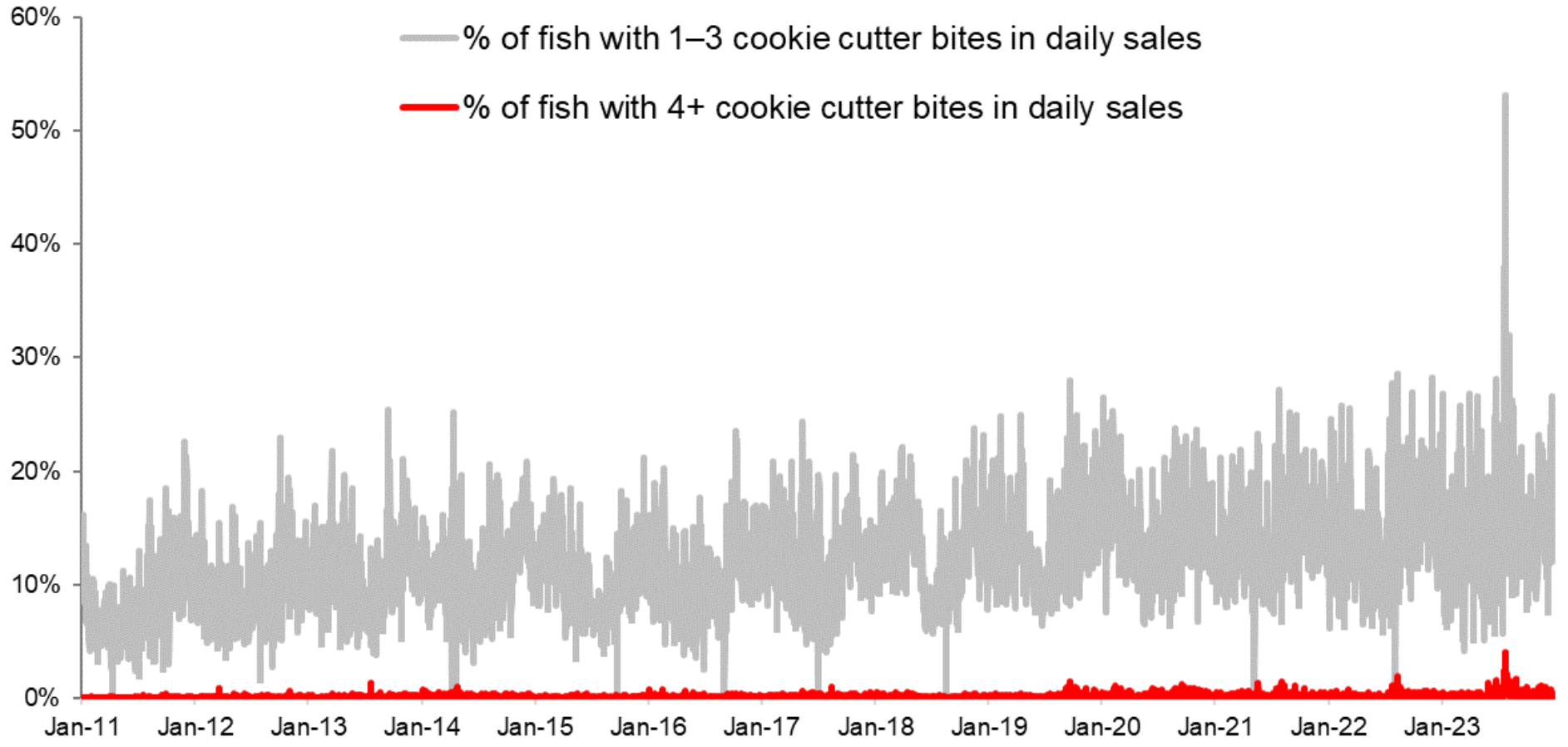


NOAA FISHERIES

Incidence of Cookie Cutter Bites (daily)



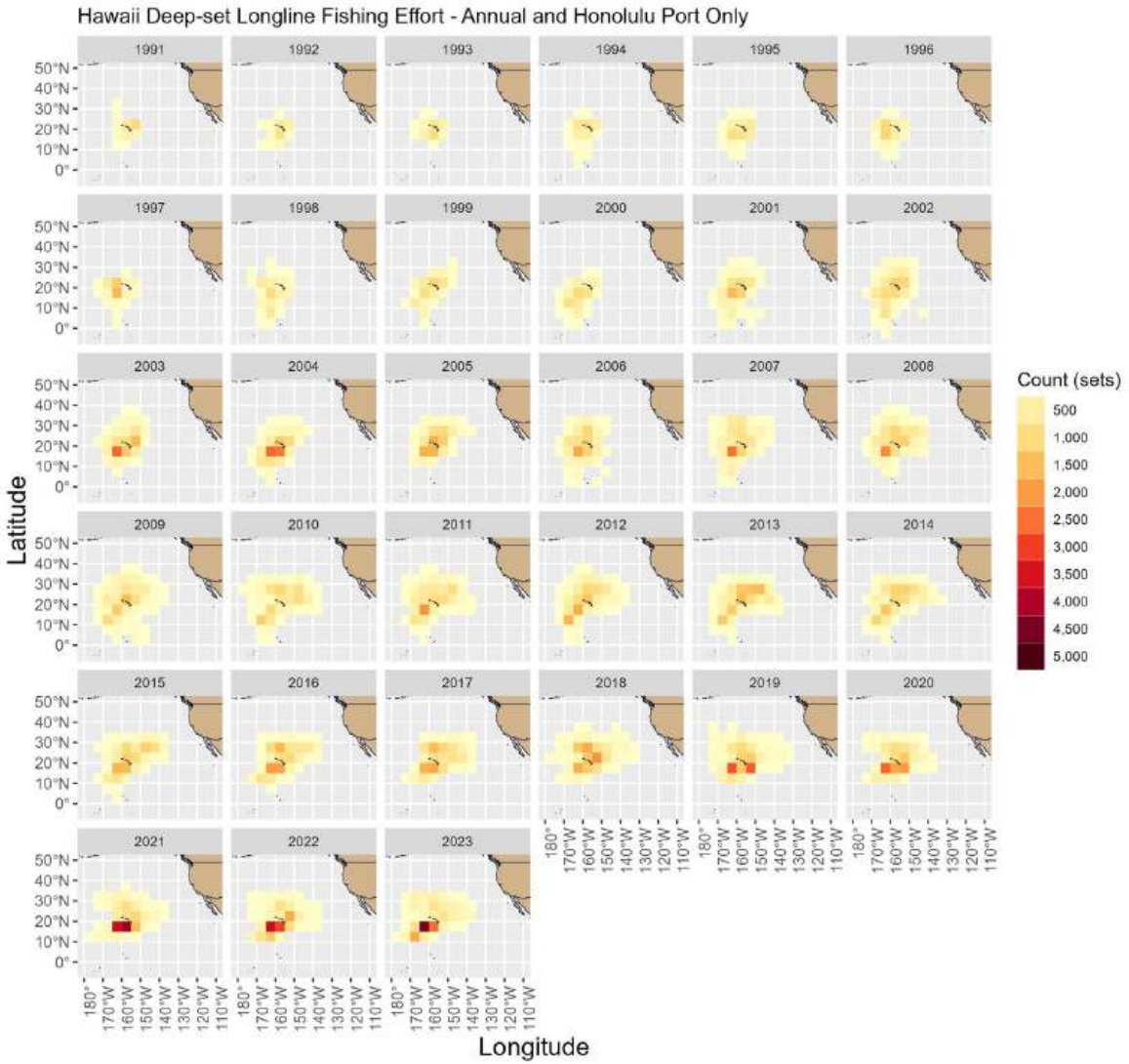
Incidence of Cookie Cutter Bites (daily)



Fishery & Market Background

- Honolulu, Hawai‘i is one of the top ranking ports in the nation
  - #6 in landed value in 2023 ($112.9 million)
  - #25 in landed pounds (26.7 million lbs)
- Hawai‘i longline fishery is the main commercial fishery in the State of Hawai‘i
  - Deep-set longline fishery operates year-round to target bigeye tuna
  - Shallow-set longline fishery targets swordfish mostly in winter
- In 2023, 147 vessels completed 1640 trips
  - 1569 deep-set trips
  - 71 shallow set trips
- A typical deep-set trip ~22 days, with seasonal spatial pattern

Fishery & Market Background



The deep-set longline spatial footprint has expanded significantly over the past three decades, spanning from 5°N to 40°N and 180°W to 130°W, with average SST for a trip ranged from 16.7°C to 28.4°C

Fishery & Market Background

- ~ 80% of landings from deep-set longline fishery are sold locally at the Honolulu Fish Auction as fresh, ice-chilled products, primarily ‘ahi tuna, i.e., bigeye and yellowfin tuna
- Auction operates daily (except Sunday) until the supply is exhausted
- High demand from visitors
  - 2023 total visitors: 9.7 million
  - Hawai‘i population: 1.4 million
- Foreign competition: local fresh tuna are often used to make poke (>$25 per lb), a more affordable version is available using previously frozen tuna from Southeast Asian countries (~$15 per lb)

Climate-Driven Implications on Price

- Freshness is an important component of quality for bigeye and yellowfin tuna as they are frequently consumed raw in Hawai‘i
- **SST:** high SST can burn tuna muscle and reduce its fatty acid content, thereby degrading overall quality. Also, tuna prefer warmer waters for spawning, which depletes their fat stores → tuna caught at higher SSTs are generally of lower quality
- **Trip length**: affects tuna quality because the Hawai‘i deep-set longline fleet ice-chilled, but does not freeze, the tuna → tuna caught on a shorter trip are generally of higher quality than those from a longer trip (given the same SST)
- **Tuna body size**: larger tuna commend a higher price per pound
- **Daily market supply**: for a given level of demand, a lower daily supply increases the market price (and vice versa)

Data

- UFA daily data 2021 to 2023
- Fresh bigeye and yellowfin only
- Sold by single piece
- Only for those with price >=$1 (model can't predict those low price). UFA agrees this is a reasonable cutoff price
- Final sample size = 571,470, representing 40.8 mill lb sold (68% of total lb sold), valued at $257.8 mill (80% of total value sold)
- UFA data contain the fishing trip and vessel for each catch; these can be linked with logbook to identify trip duration, haul locations, and associated environmental conditions

Fish Price Model

$$P_{it} = SST_j + LENGTH_p + CC + CCDAM + SHARK + DAMAGE + WEIGHT_i + CC \times WEIGHT_i + CCDAM \times WEIGHT_i + SHARK \times WEIGHT_i + DAMAGE \times WEIGHT_i + BIGEYE + BIGEYESALE_t + YELLOWFINSALE_t + VISITOR_{t-1} + IMPORT_m + TRIP + V_k + E_y + E_w + E_d + \varepsilon_{it}$$

- P_{it} : inflation-adjusted price per pound for species i at day t
- **Fish quality:** SST at the fishing haul location, trip length
- **Characteristic of the fish:** dummies for cookie cutter bite (1–3 bites), cookie cutter damage (4+ bites), shark bite, and other damage, interaction terms for dummies and fish weight, total weight of the fish, species
- Market condition: total daily landings of bigeye, total daily landings of yellowfin, daily visitors to Hawai‘i (lag by 1 day), monthly foreign frozen imports
- T_t : trip type, V_k : individual seller effects, E_y : annual fixed effects, E_w : week-of-year fixed effects, E_d : day-of-week fixed effects

Climate-Driven Implication on Price: SST

1°C increase in SST is associated with $0.08 decrease in fish price. The average SST for a trip ranged from 15.9°C to 28.4°C → $0.96 difference in price (bigeye ~$6/lb, yellowfin ~$5/lb)

	Price effect per lb ($)	Estimated lost revenue per year ($)	Estimated lost revenue (%)
Increase SST by 1°C	-0.08	-1,119,203	-1.3%

- Higher SST in the future could lower tuna prices

Climate-Driven Implication on Price: Trip Length

- Significant negative price effect for Trip Length (-$0.14 for LENGTH and 0.0013 for LENGTH^2) → Climate-driven shifts in tuna habitats in NPO have pushed fishing grounds poleward, leading to increased travel distances for the Hawai‘i longline fleet (Chan 2023), and negatively impacting both fish freshness and prices
- Chan (2023) estimated that a 1°C increase in SST corresponded to a 4.2% increase in deep-set longline trip distance → 23.5 days between trip departure and fish sale, a 1°C increase SST extends trip length by ~1 day

	Price effect per lb ($)	**Estimated lost revenue per year ($)**	**Estimated lost revenue (%)**
Increase trip length by 1 day	-0.14	-1,857,579	-2.2%

Climate-Driven Implication on Price: Tuna Size

- Significant positive price effect for Weight (+$0.09 for Weight and -0.0003 for Weight^2) (price premium for bigger fish) → Climate-induced reductions in tuna body size negatively impact fish prices
- Projected body sizes of bigeye and yellowfin in the WCPO will decrease by 16% and 15% by mid-century (Erauskin-Extramiana et al. 2023) → average fish weight of 71.3 lb in the sample, this translates to ~11 lb decrease in body size

	Price effect ($)	Estimated lost revenue per year ($)	Estimated lost revenue (%)
Decrease body size by 11 lb	-0.93	-12,677,881	-14.8%

Climate-Driven Implication on Price: Daily Supply

- Significant negative price effect for Daily Supply
  - +$0.79/lb for 10,000 lb decrease in bigeye daily supply
  - +$0.59/lb for 10,000 lb decrease in yellowfin daily supply

  → Climate-driven effects on tuna abundance, biomass, spatial distribution, and catchability lower Daily Supply would drive up fish prices
- Price flexibilities (% change in price ÷ % change in quantity) are -0.53 for bigeye and -0.18 for yellowfin, this means price increases proportionally less than tuna supply decreases

  → when supply decreases, fishers will be worse off as their revenue will fall

Next Steps

- Integrate the model results and climate and ecosystem predictions for the Hawai‘i longline fishing grounds into the Hawai‘i longline fishery’s location choice modeling → the dynamic relationships between fish price, SST, body size, and trip length can be considered in the location decisions
- How could changing environment affect the Hawai‘i longline fishery’s location choices?

THANK YOU!

NOAA FISHERIES