More than bycatch

Understanding catch dynamics of two understudied pelagic fishes across Hawai'i's fisheries





Jessica N. Perelman, Janelle L. Morano, Justin J. Suca, Jason Helyer, Marc Nadon, Ryan R. Rykaczewski

Mahimahi and ono are major icons in Hawai‘i fisheries

- Highly migratory species
- Offshore circumtropical/subtropical distribution
- Subsistence for Hawai‘i families
- Commercial importance to tourism and consumer demand





HICEAS 2023, PC Y. Barkley





Mahimahi and ono are major icons in Hawai'i fisheries

Coryphaena hippurus 

- *Mahi* → strength, energy, and vigor
- Very fast-growing, short life span, epipelagic visual predators (and prey)
- Warm waters > 23°C (central Pacific)

Kraul, 1999





HICEAS 2023, PC Y. Barkley





Mahimahi and ono are major icons in Hawai'i fisheries

Coryphaena hippurus



- *Mahi* → strength, energy, and vigor
- Very fast-growing, short life span, epipelagic visual predators (and prey)
- Warm waters > 23°C (central Pacific)

Kraul, 1999

Acanthocybium solandri



- *Ono* → delicious, tasty
- Fast-growing, fast-swimming epipelagic predators
- Warm waters >24-25°C (east/south/west Pacific)

Sepulveda et al., 2011; Zischke et al., 2013; Gao et a., 2020





HICEAS 2023, PC Y. Barkley





Today, they are primarily caught via troll and longline fisheries, but are not the primary targets of either fishery

>$3 million USD commercial annual revenue each



>700,000 lbs annually



>1 million lbs annually

"Targets"





"Bycatch"





Today, they are primarily caught via troll and longline fisheries, but are not the primary targets of either fishery

>$3 million USD commercial annual revenue each



>700,000 lbs annually



>1 million lbs annually

Currently unassessed in the central North Pacific & U.S. Pacific Islands

"Targets"



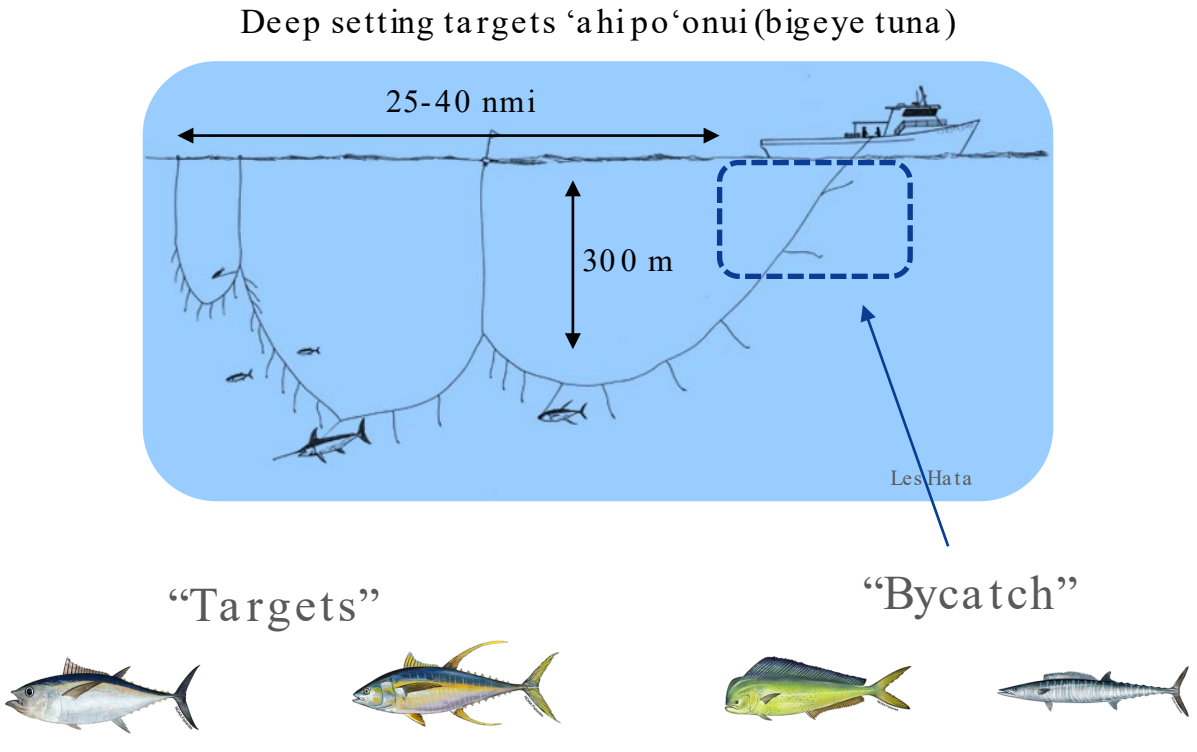


"Bycatch"

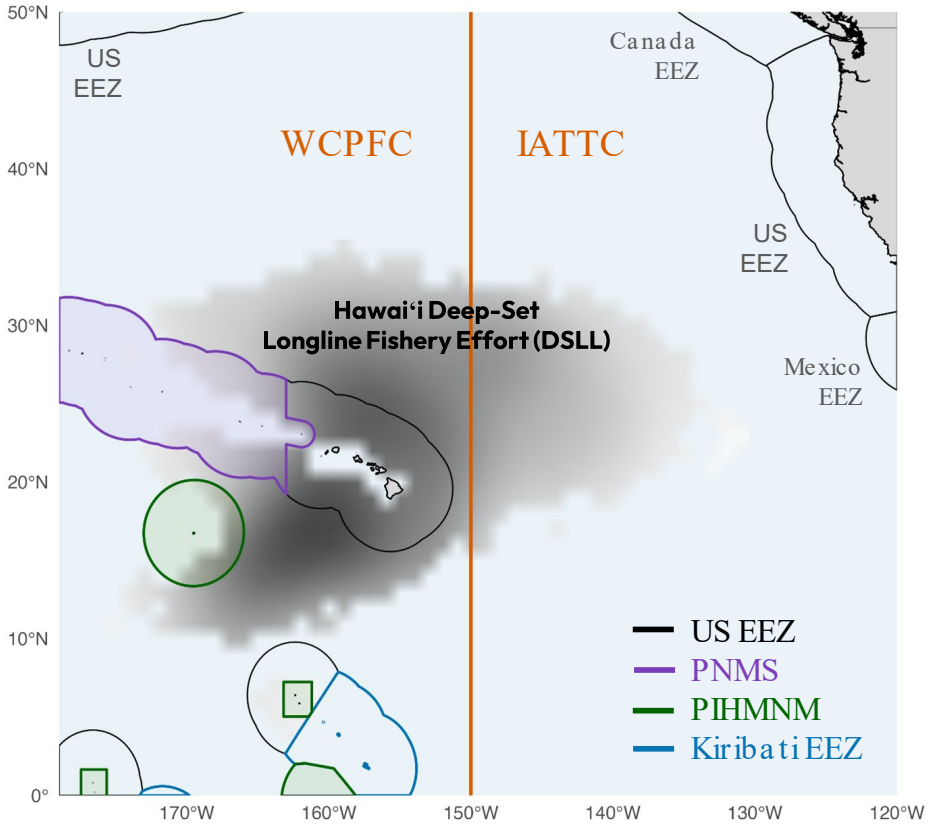


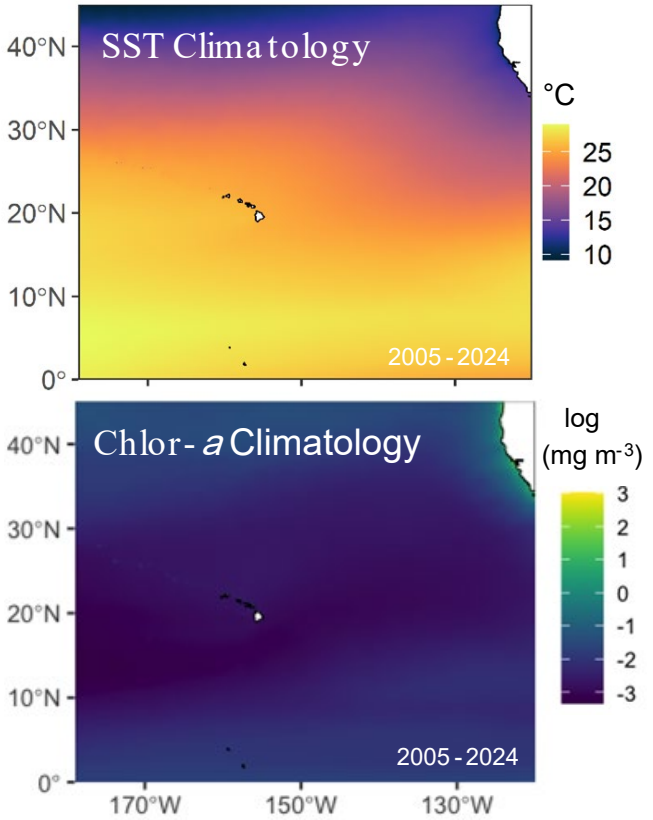


Today, they are primarily caught via troll and **longline** fisheries, but are not the primary targets of either fishery



Hawai‘i’s **deep-set longline fishery** spans many jurisdictions and oceanographic gradients across the central North Pacific

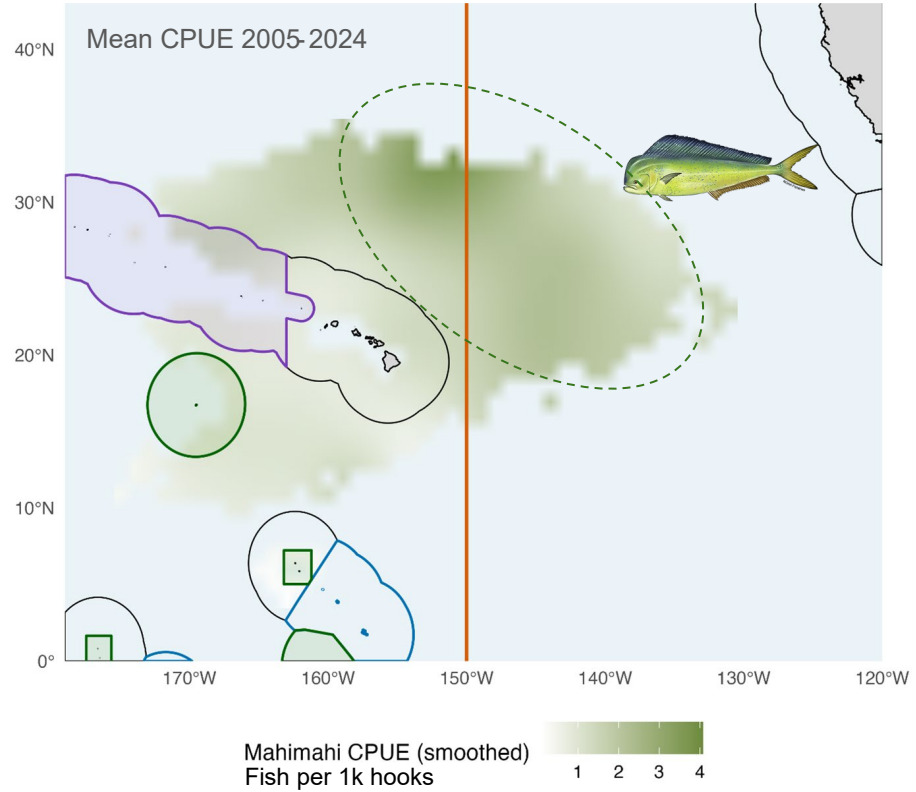


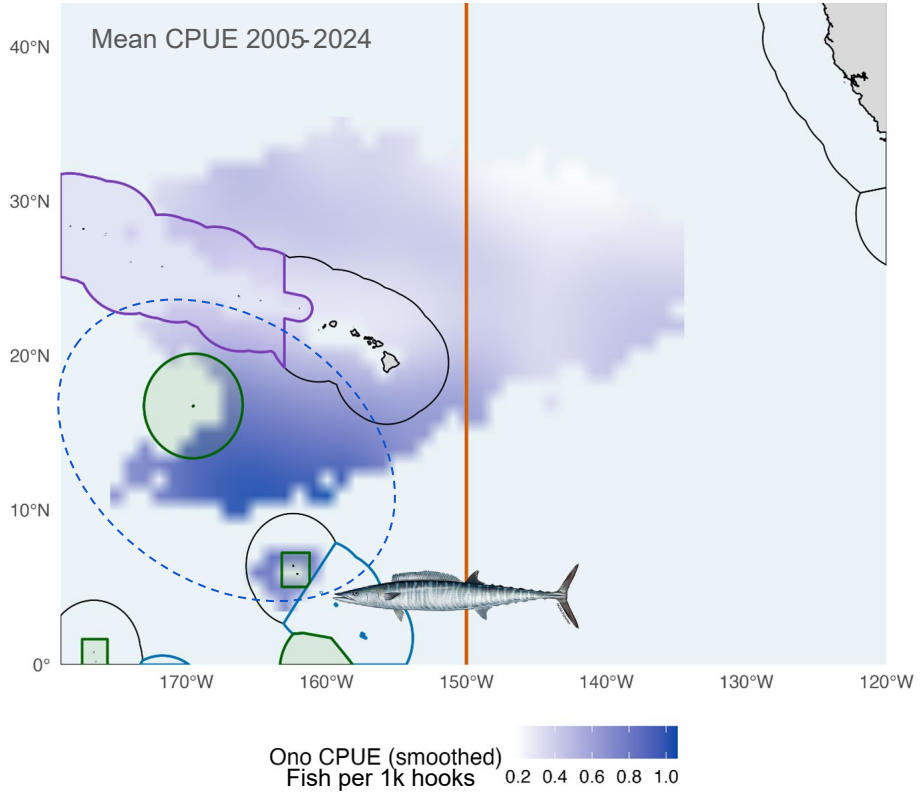


Fishing effort is aggregated and smoothed over 1°x1° bins, and shown only for fishing locations with >3 captains

Spatial patterns in CPUE suggest differences in core availability

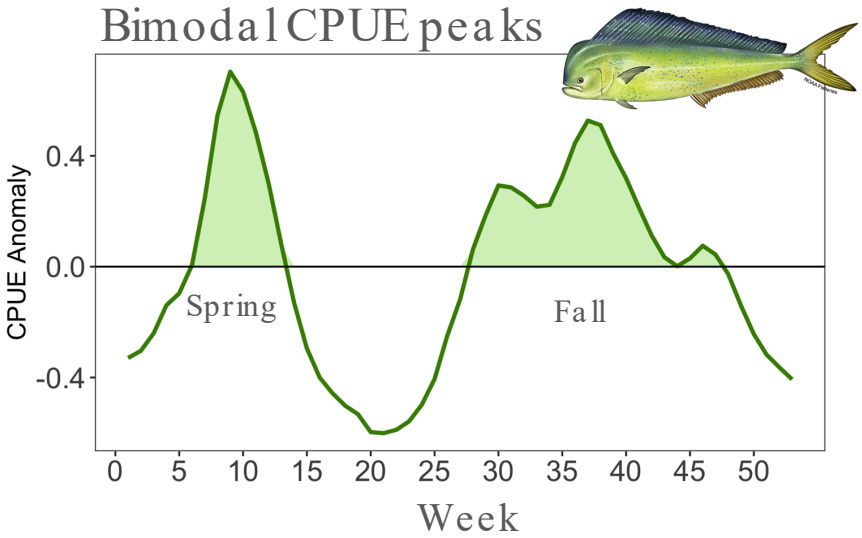
Population and stock structures across the central North Pacific are not well understood

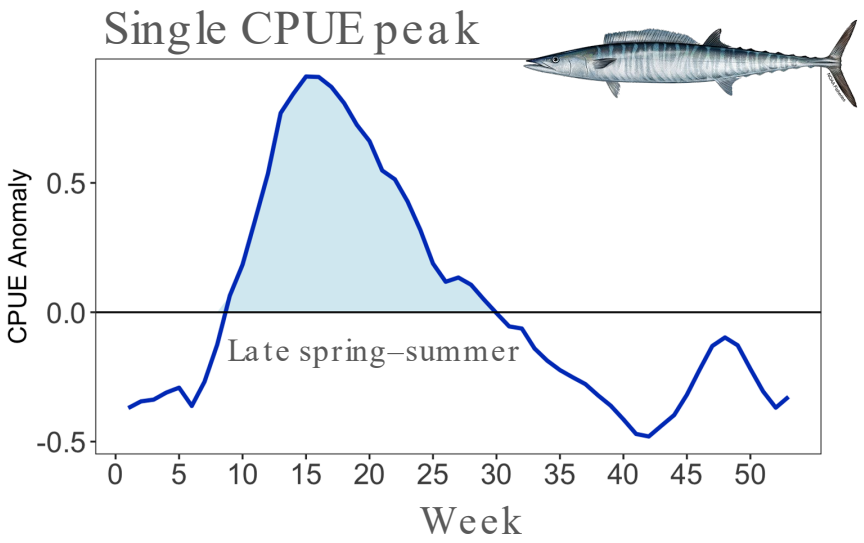




CPUE is aggregated and smoothed over 1°x1° bins, and shown only for fishing locations with >3 captains

Predictable seasonal catch patterns since the early days of the longline fishery, with proposed underlying mechanisms including temperature variability, migration, and spawning.





e.g. Kraul, 1999; Uchiyama & Boggs, 2006

What can 20 years of expanded fishery data reveal about these spatial and temporal catch patterns?

What can 20 years of expanded fishery data reveal about these spatial and temporal catch patterns?

1) How do oceanographic conditions influence catch rates at the **time of capture** ?

What can 20 years of expanded fishery data reveal about these spatial and temporal catch patterns?

1) How do oceanographic conditions influence catch rates at the **time of capture** ?

1) What do **seasonal** catch patterns suggest about underlying processes such as migration and habitat suitability?

What can 20 years of expanded fishery data reveal about these spatial and temporal catch patterns?

1) How do oceanographic conditions influence catch rates at the **time of capture** ?

1) What do **seasonal** catch patterns suggest about underlying processes such as migration and habitat suitability?

1) What do **long-term trends** reveal about fishery-habitat overlap and potential basin-scale changes in availability?

1) Influence of oceanographic conditions on realtime catch rates

NOAA Pacific Islands Regional Observer Program

- ~70,000 sets between 2005 - 2024
- 20% observer coverage until recently

1) Influence of oceanographic conditions on realtime catch rates

NOAA Pacific Islands Regional Observer Program

- ~70,000 sets between 2005 - 2024
- 20% observer coverage until recently

Generalized Additive Mixed Models • 10 - fold cross validation

$$g(\mu(x)) = \alpha + \sum_{i=1}^{p} f_i(x_i)$$

CPUE ~ Fishing behavior variables + Day-of-year + Year + Lat/Long + Oceanographic variables

Tweedie distribution (log link) → zero - inflated dataset

Three latitudinal domains: North (> 23°N) | Mid (18 - 23°N) | South (< 18°N)

Fishing behavior

- Fisher or captain
- Gear configurations
- Species targeting
- Wind

Oceanography

(GLORYS-12-V1, GlobColour, DUACS)

- SST
- Turbidity/Productivity
- Salinity
- SLA
- Current speed
- Lunar phase

1) Influence of oceanographic conditions on realtime catch rates

NOAA Pacific Islands Regional Observer Program

- ~70,000 sets between 2005-2024
- 20% observer coverage until recently

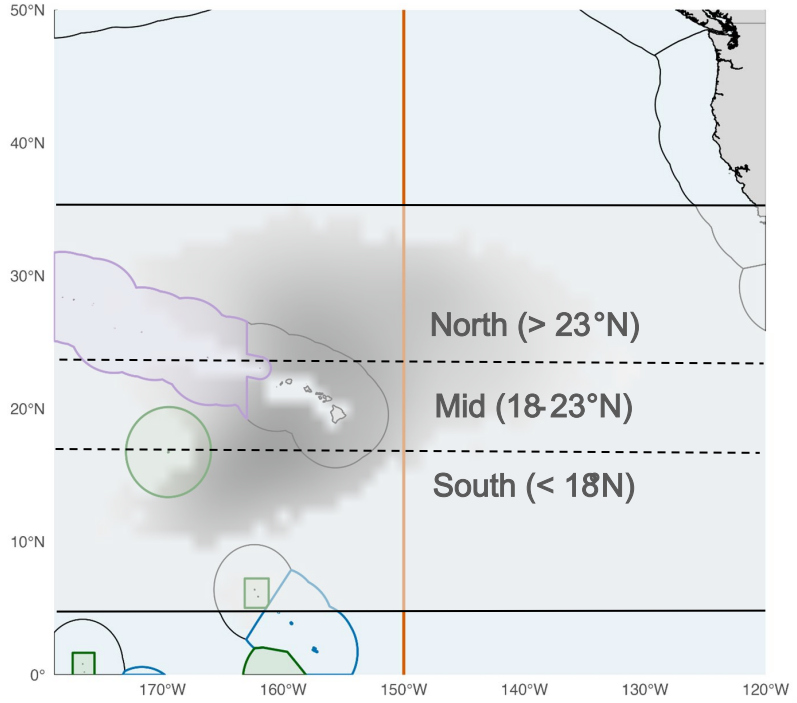
Generalized Additive Mixed Models • 10-fold cross validation

$$g(\mu(x)) = \alpha + \sum_{i=1}^{p} f_i(x_i)$$

CPUE ~ Fishing behavior variables + Day-of-year + Year + Lat/Long + Oceanographic variables

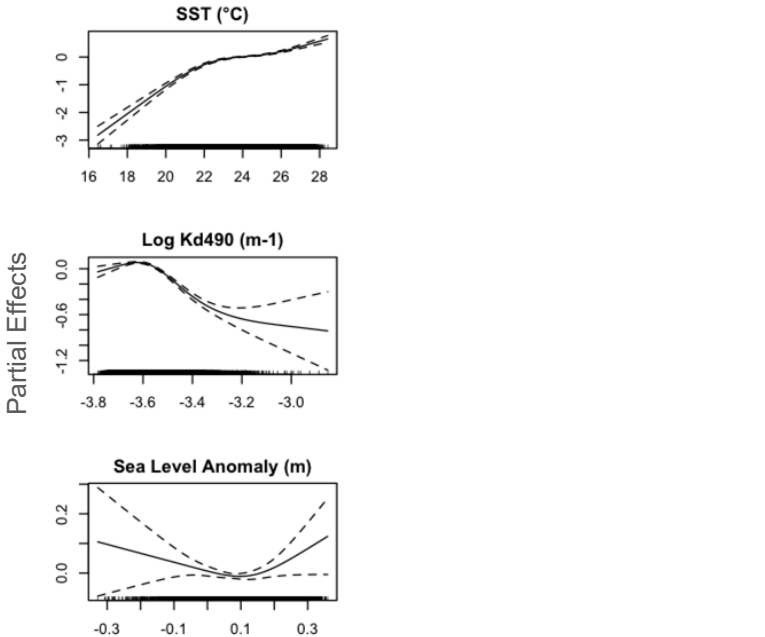
Tweedie distribution (log link) → zero-inflated dataset

Three latitudinal domains: North (> 23°N) | Mid (18-23°N) | South (< 18°N)



Mahimahi 

Mahimahi

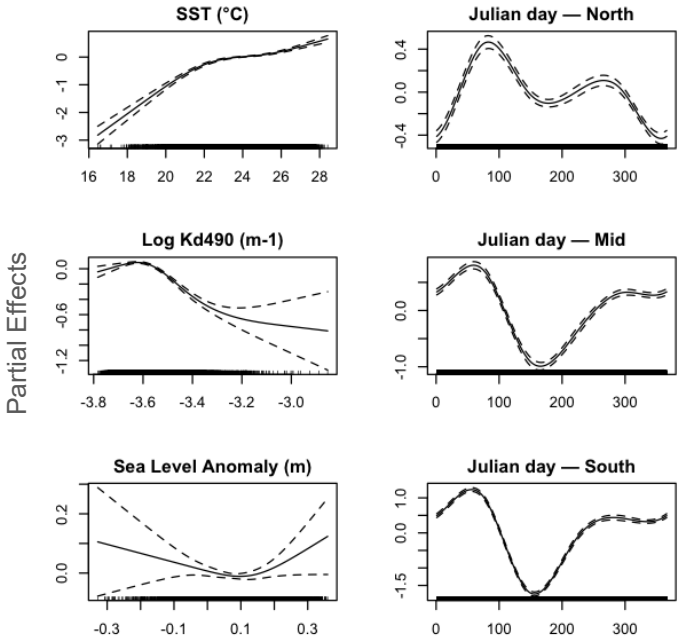


Primary Influences

- Warm temperatures (>23°C)
- Low turbidity (< 0.03 m^{-1})

Dev. Explained = 38%; R^2 = 0.31

Mahimahi



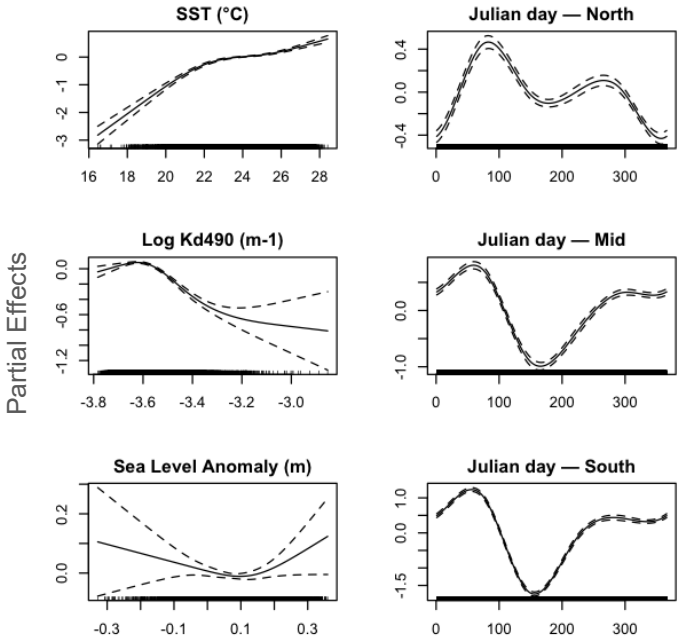
Primary Influences

- Warm temperatures (>23°C)
- Low turbidity (< 0.03 m^{-1})
- Persistent seasonality, shifts across latitude

Dev. Explained = 38%; R^2 = 0.31

Mahimahi





Primary Influences

- Warm temperatures (>23°C)
- Low turbidity (< 0.03 m^{-1})
- Persistent seasonality, shifts across latitude

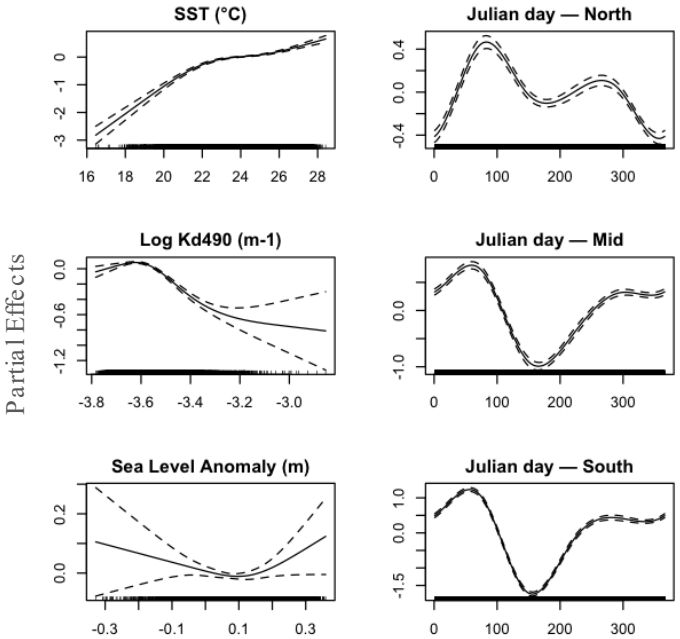
Dev. Explained = 38%; R^2 = 0.31

Ono



Mahimahi





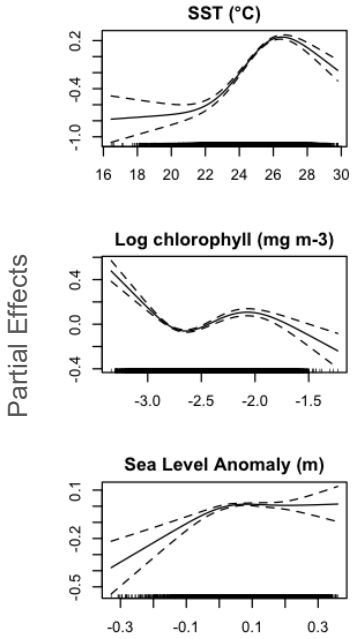
Primary Influences

- Warm temperatures (>23°C)
- Low turbidity (< 0.03 m^{-1})
- Persistent seasonality, shifts across latitude

Dev. Explained = 38%; R^2 = 0.31

Ono





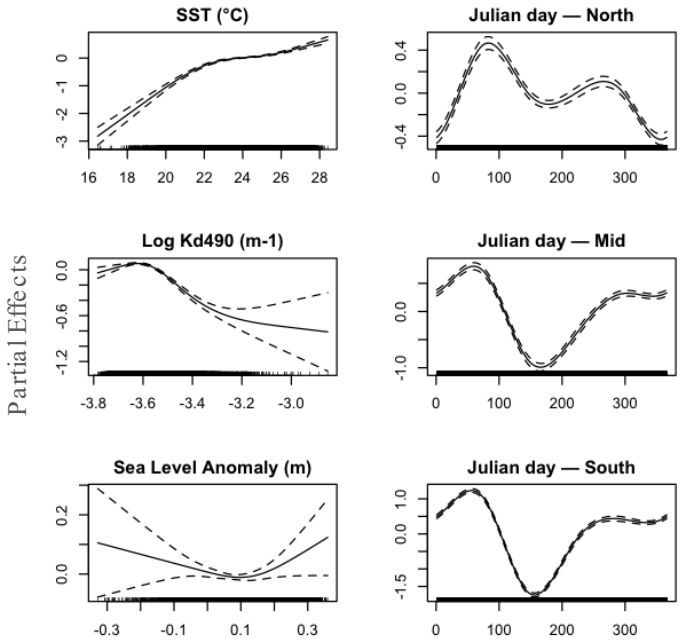
Primary Influences

- Warm temperatures (>25-26°C)
- Low productivity, positive SLA

Dev. Explained = 30%; R^2 = 0.31

Mahimahi





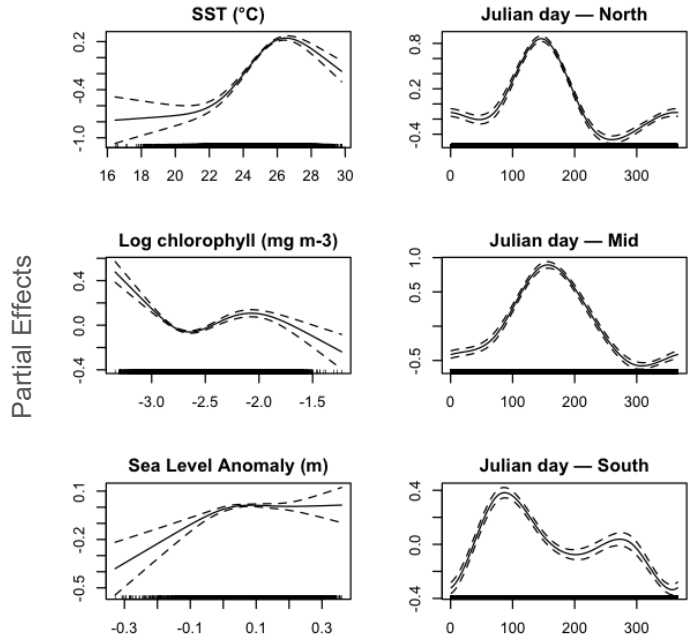
Primary Influences

- Warm temperatures (>23°C)
- Low turbidity (< 0.03 m^{-1})
- Persistent seasonality, shifts across latitude

Dev. Explained = 38%, R^2 = 0.31

Ono





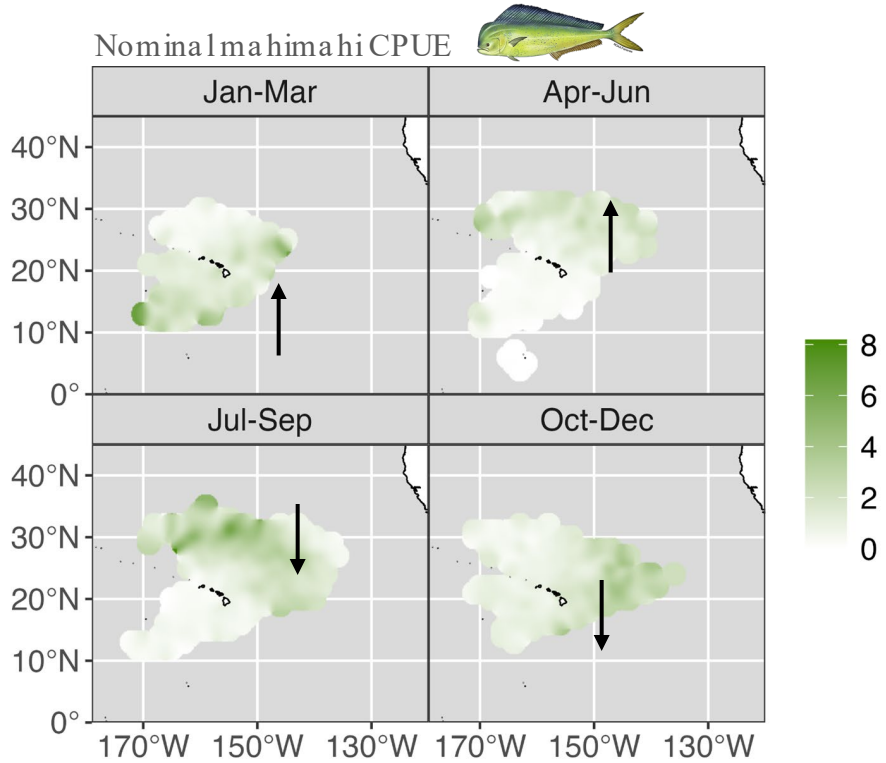
Primary Influences

- Warm temperatures (>25-26°C)
- Low productivity, positive SLA
- Persistent seasonality, varies across latitude

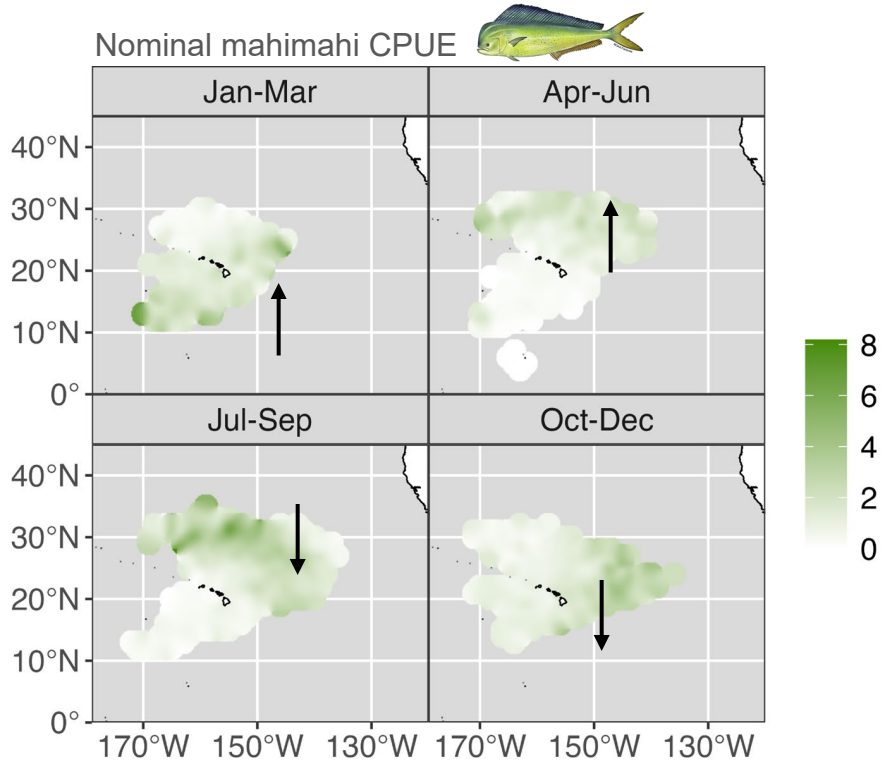
Dev. Explained = 30%, R^2 = 0.31

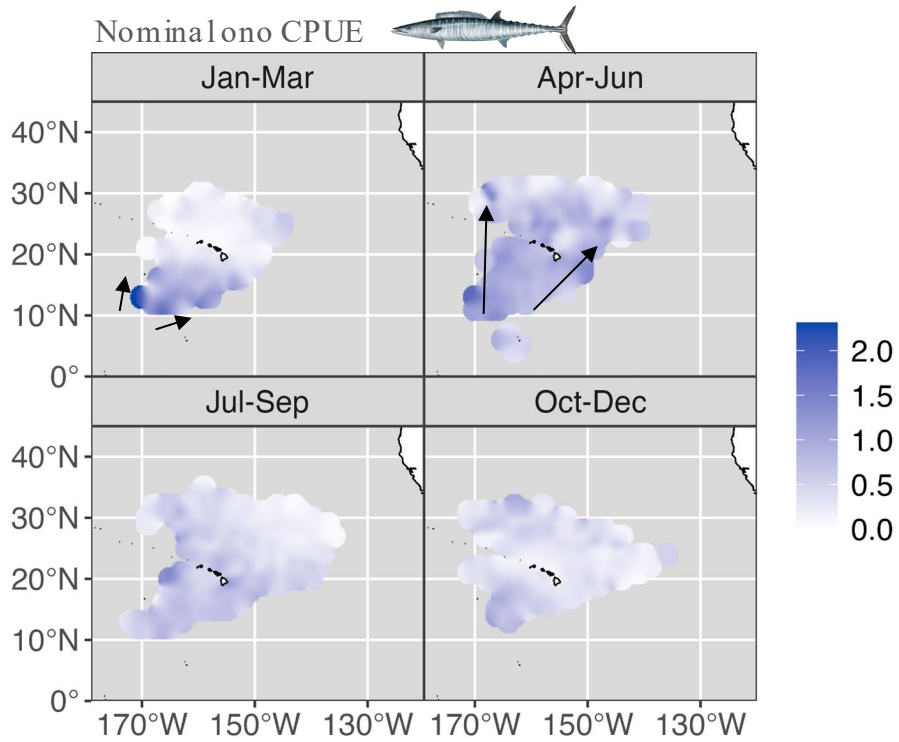
2) Seasonal catch patterns

2) Seasonal catch patterns

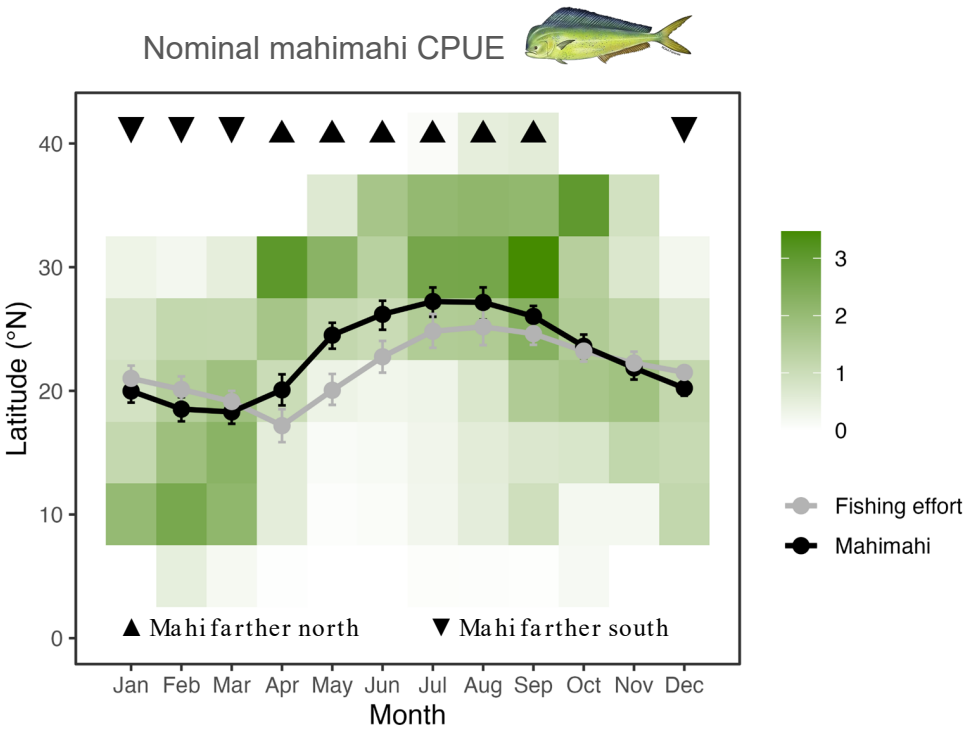


2) Seasonal catch patterns



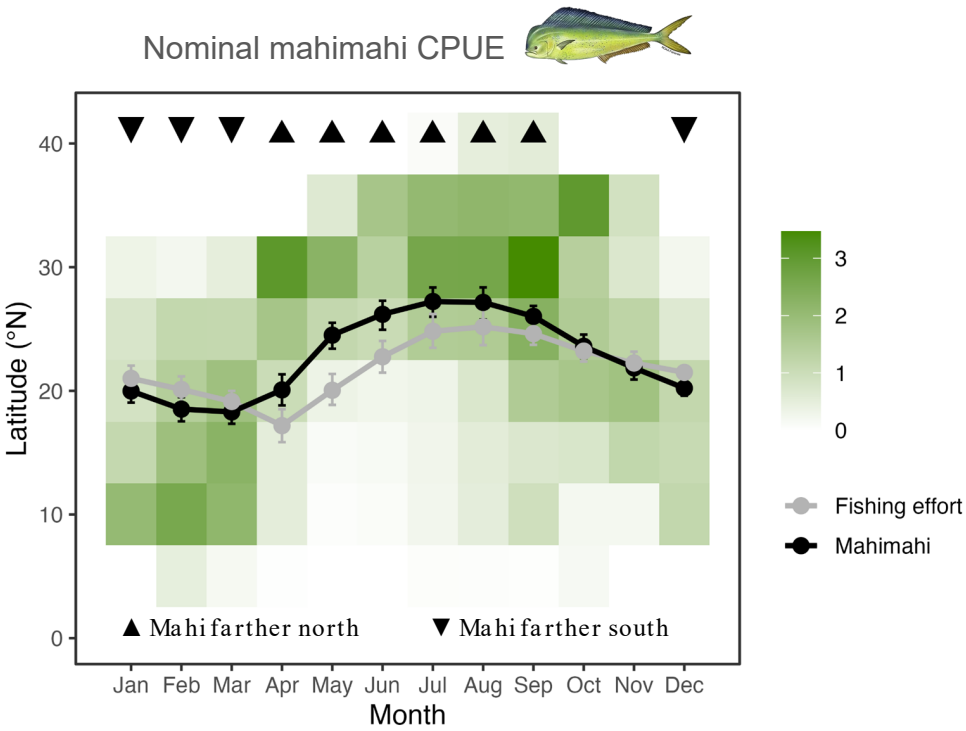


2) Seasonal catch patterns



Seasonal CPUE and fishing effort by latitude: Mean monthly CPUE and 5° latitude bins; lines show monthly latitudinal centers of gravity (COG) with bootstrap 95% CIs across years. Black triangles mark significant differences between effort and CPUE COGs (Bonferroni-adjusted; ($p < 0.05$).

2) Seasonal catch patterns

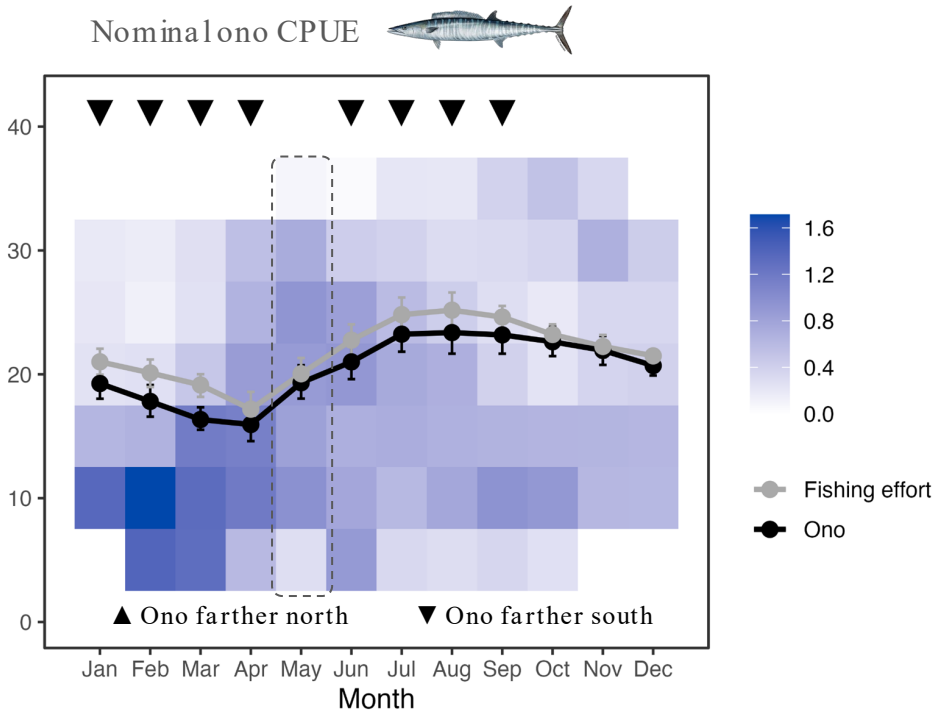


Seasonal patterns are consistent with previously proposed meridional migration

Kraul, S. (1999). Seasonal abundance of the dolphinfish, *Coryphaena hippurus*, in Hawaii and the tropical Pacific Ocean. *Scientia Marina*, *63*(3-4), 261-266.

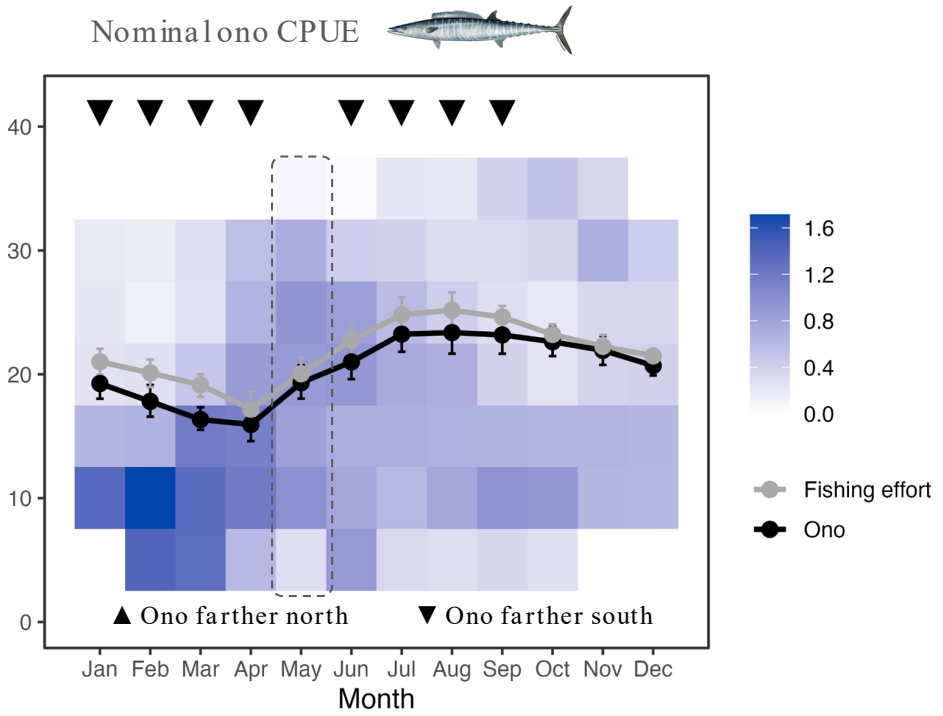
Seasonal CPUE and fishing effort by latitude: Mean monthly CPUE and 5° latitude bins; lines show monthly latitudinal centers of gravity (COG) with bootstrap 95% CIs across years. Black triangles mark significant differences between effort and CPUE COGs (Bonferroni-adjusted; ($p < 0.05$).

2) Seasonal catch patterns



2) Seasonal catch patterns

Seasonal patterns are consistent with changes in fishery-habitat overlap

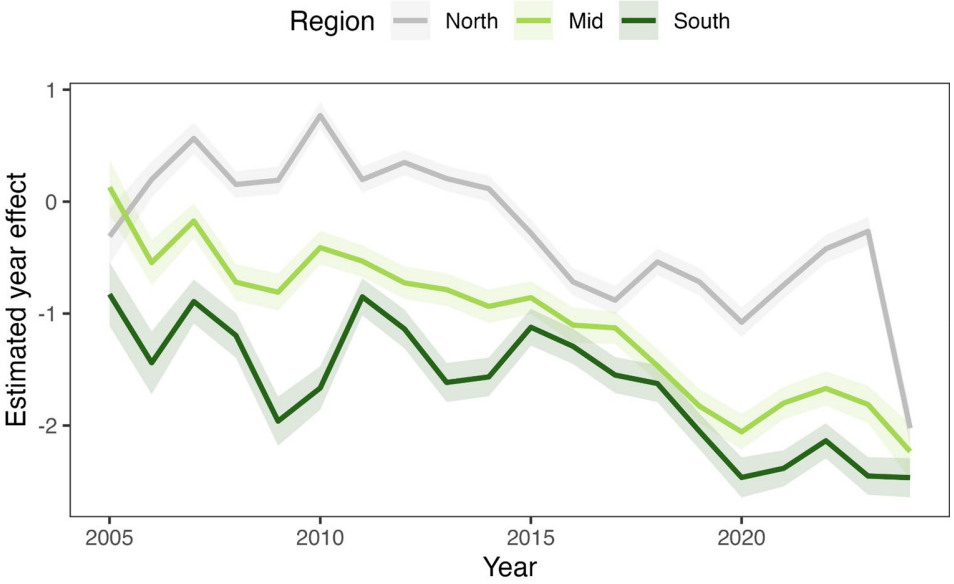


3) Longterm availability trends

Mahimahi 

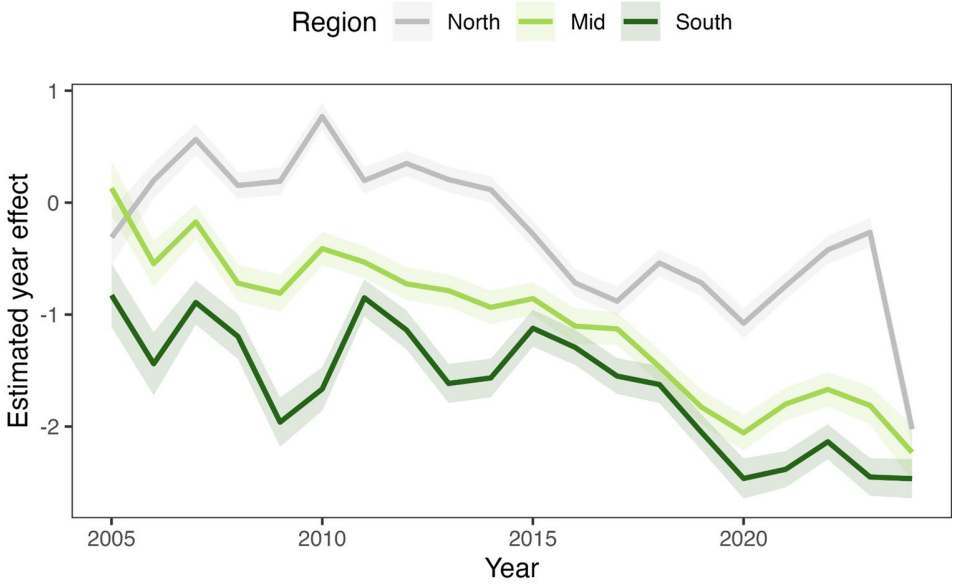
3) Long-term availability trends

Mahimahi



3) Long-term availability trends

Mahimahi 

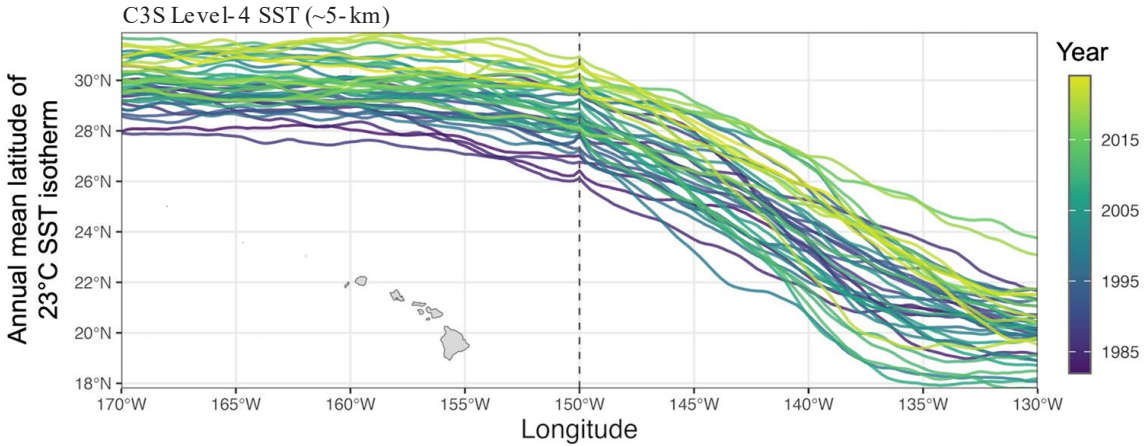


Are previously proposed thermal constraints relevant to mahimahi availability?

Kraul, 1999 → **23°C**

3) Long-term availability trends

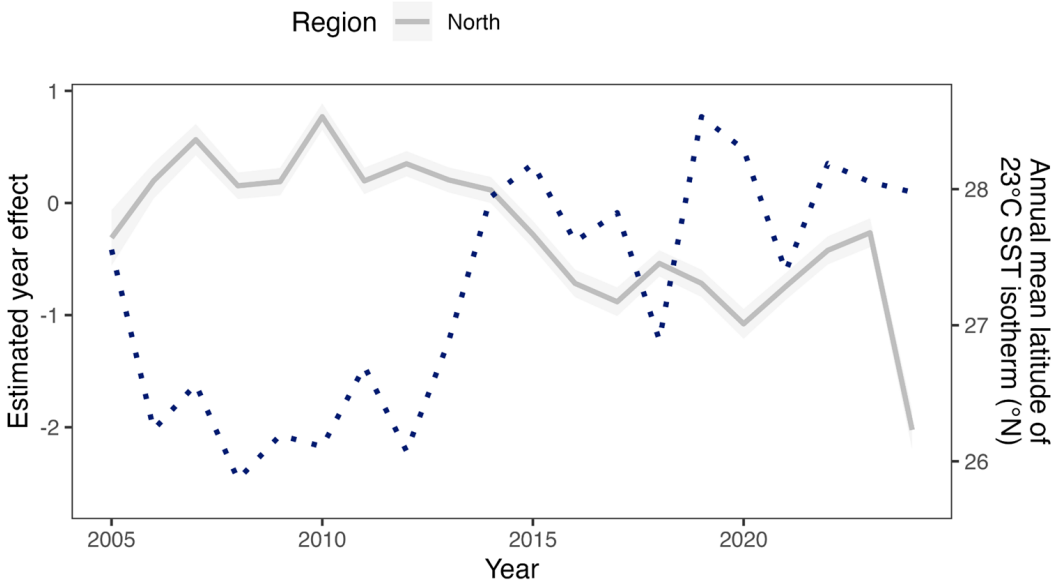
Mahimahi 

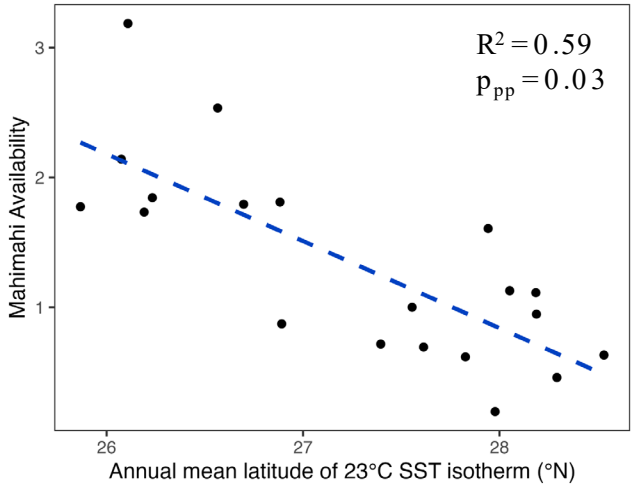


The 23 °C isotherm has shifted significantly poleward by since 1985, when it was proposed as a mechanism driving mahimahi migration around Hawai‘i

3) Long-term availability trends

Mahimahi

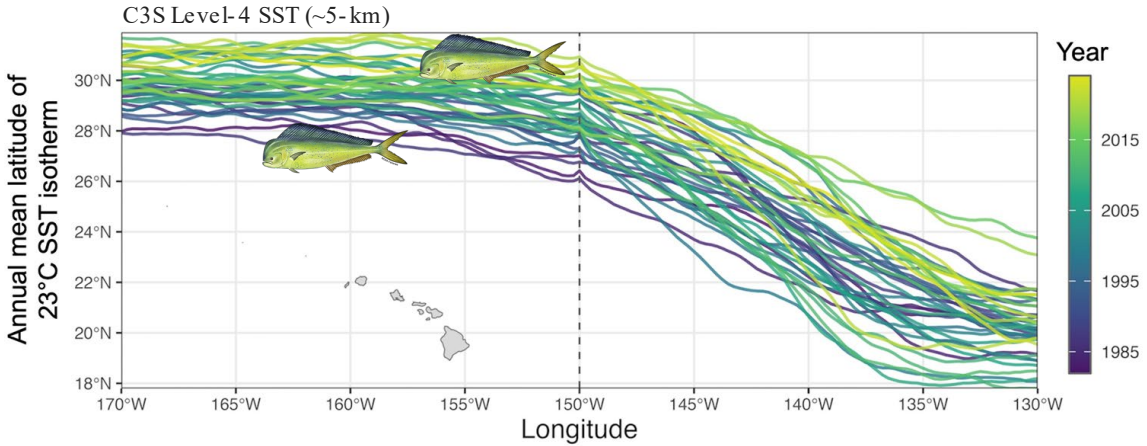


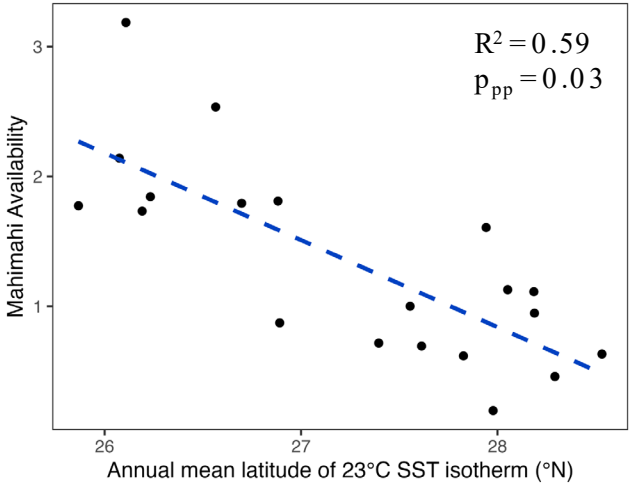


p_{pp} = significance values corrected for temporal autocorrelation following Pyper & Peterman (1998)

3) Long-term availability trends

Mahimahi 





Habitat expands northward → Reduced fishery–habitat overlap → **Declining** mahimahi availability due to dilution within the fishery.

p_{pp} = significance values corrected for temporal autocorrelation following Pyper & Peterman (1998)

3) Long-term availability trends

Mahimahi 

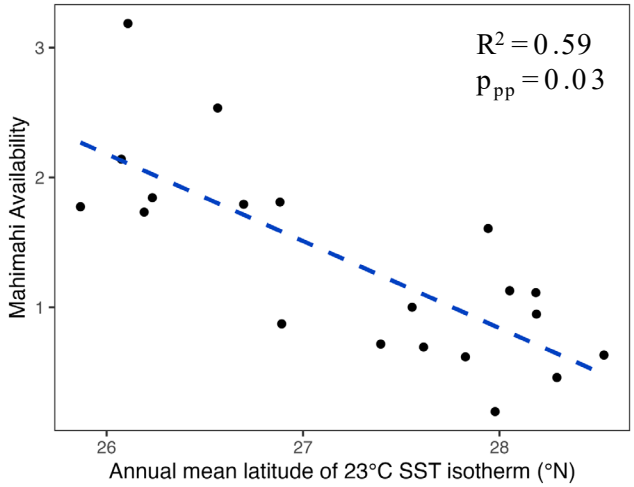
ICES Journal of Marine Science, 2026, Vol. 83, Issue 10, fsag213
https://doi.org/10.1093/icesjms/fsag213
Original article

ICES CIEM International Council for the Exploration of the Sea / Conseil International pour l'Exploration de la Mer — OXFORD

Seasonal persistence and interannual declines in mahimahi (*Coryphaena hippurus*) availability across multiple fisheries in the central North Pacific

Jessica N. Perelman[1,2,*], Justin J. Suca[3], Jason Helyer[4], Janelle L. Morano[1,2], Marc Nadon[2], Ryan R. Rykaczewski[2,3]

[1]Cooperative Institute for Marine and Atmospheric Research, University of Hawai'i, Honolulu, HI 96822, United States
[2]NOAA Pacific Islands Fisheries Science Center, National Marine Fisheries Service, Honolulu, HI 96818, United States
[3]Department of Oceanography, University of Hawai'i at Mānoa, Honolulu, HI 96822, United States
[4]Department of Land and Natural Resources, Hawai'i Division of Aquatic Resources, Honolulu, HI 96813, United States
*Corresponding author. Cooperative Institute for Marine and Atmospheric Research, University of Hawai'i, 1000 Pope Rd, Honolulu, HI 96822, United States.
E-mail: jessica.perelman@noaa.gov; jeprlmn@gmail.com



p_{pp} = significance values corrected for temporal autocorrelation following Pyper & Peterman (1998)

Long-term availability trends

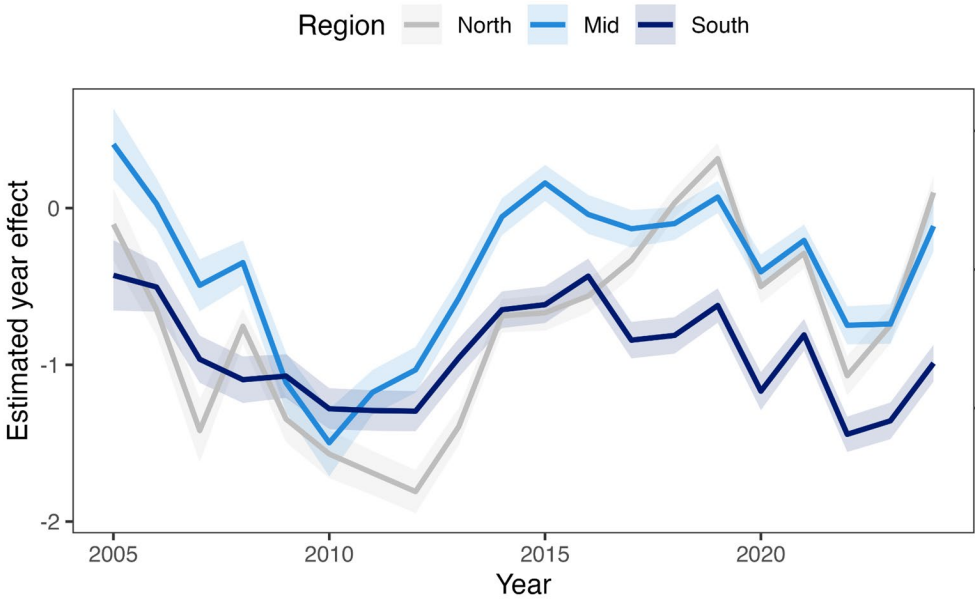
Ono



Long-term availability trends

Ono

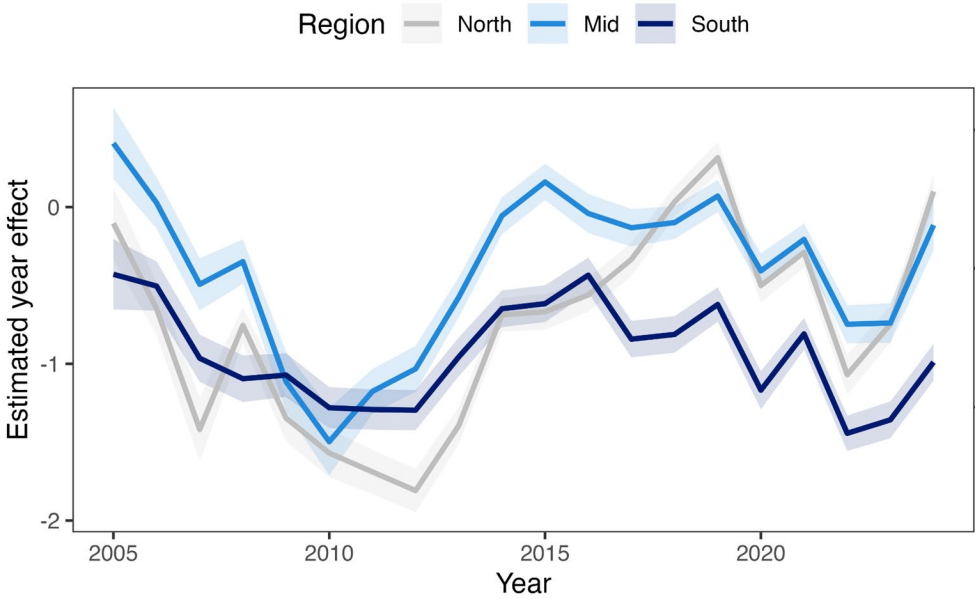




Long-term availability trends

Ono





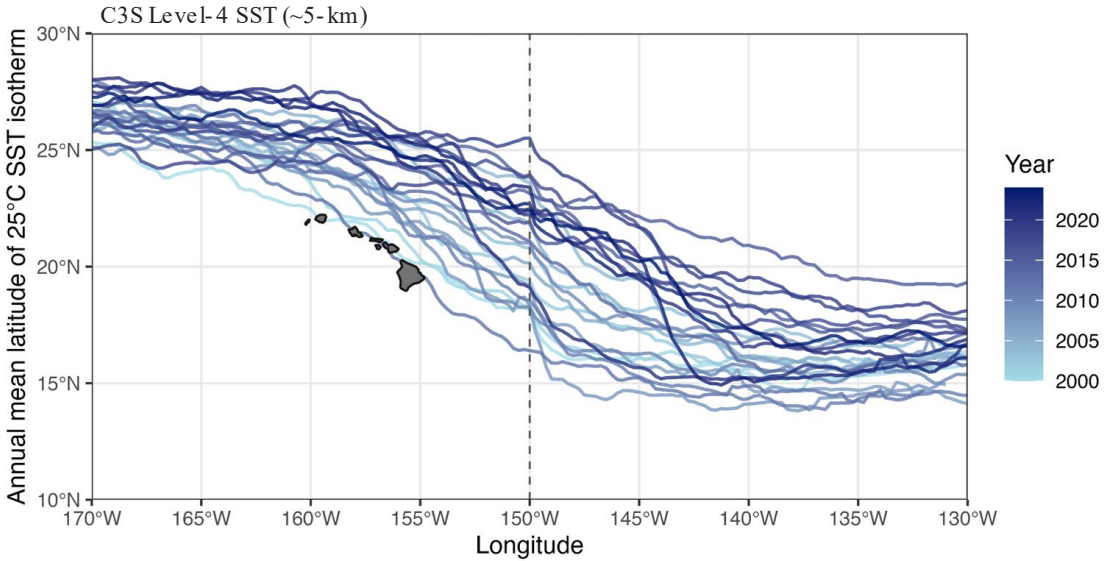
Are previously proposed thermal constraints relevant to ono availability?

Sepulveda et al., 2011 | Zischke et al., 2013 → **25°C**

Long-term availability trends

Ono



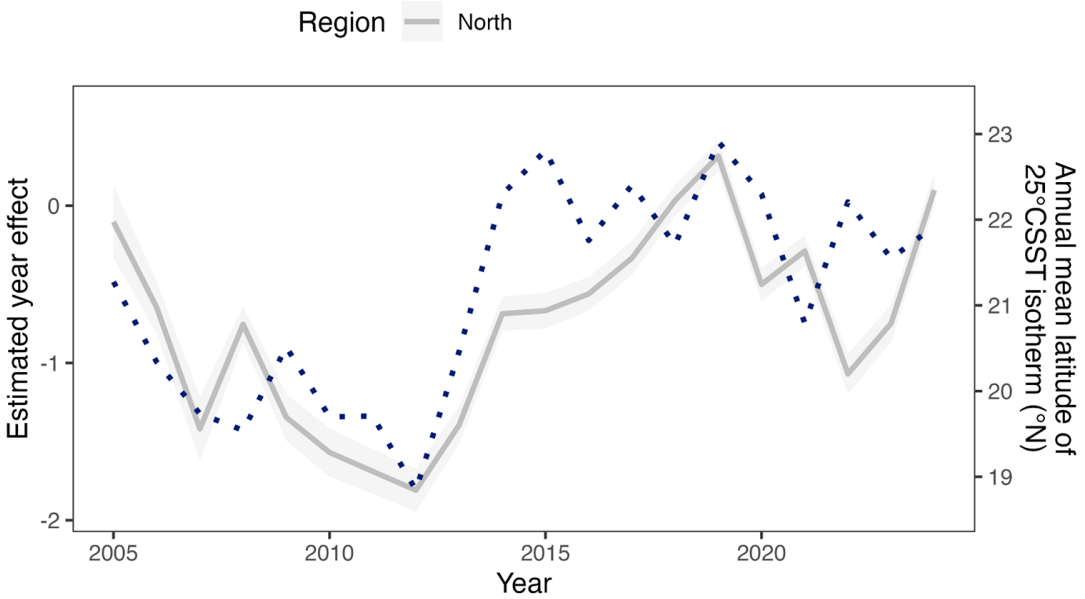


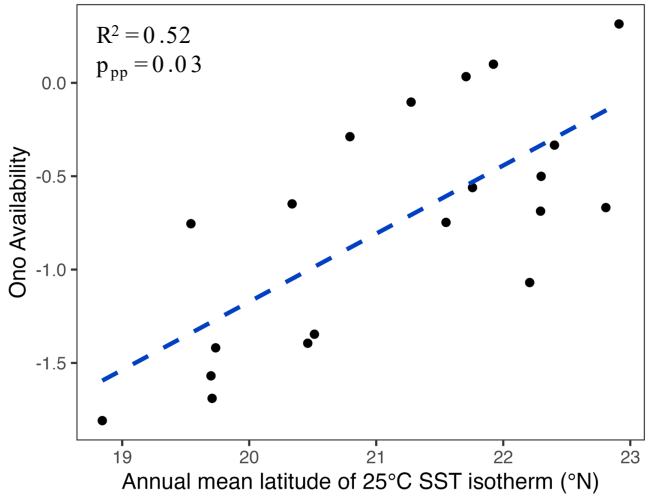
The 25 °C isotherm has shifted significantly poleward over the 20 year study period

Long-term availability trends

Ono





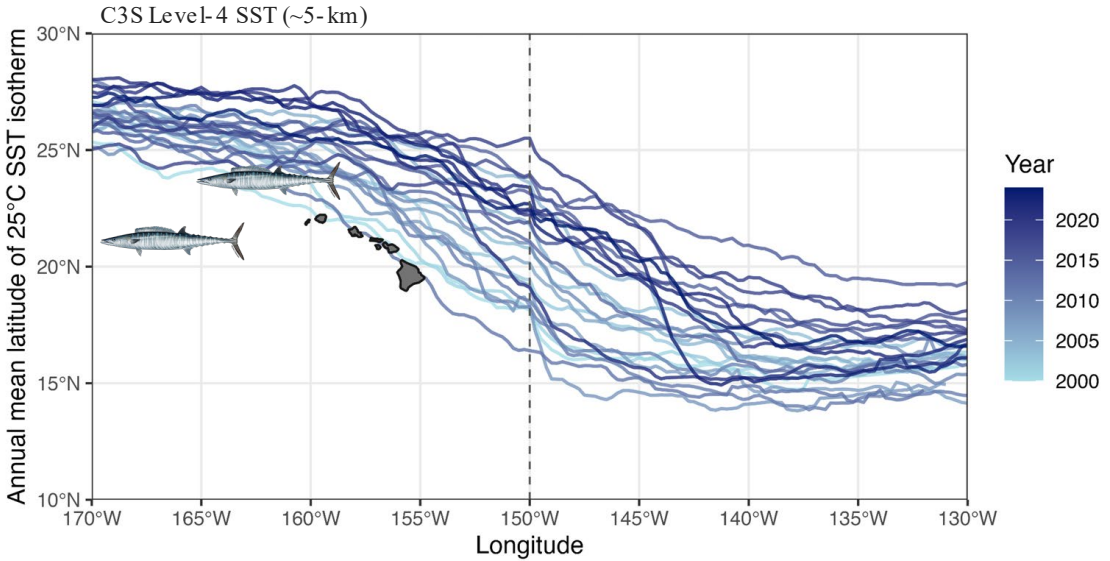


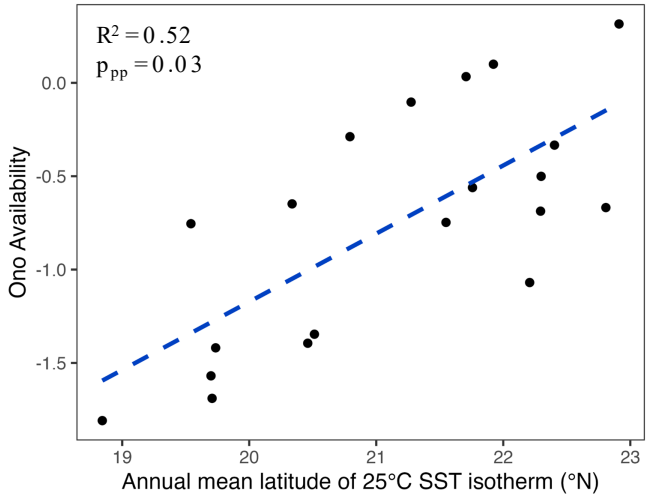
p_{pp} = significance values corrected for temporal autocorrelation following Pyper & Peterman (1998)

Long-term availability trends

Ono







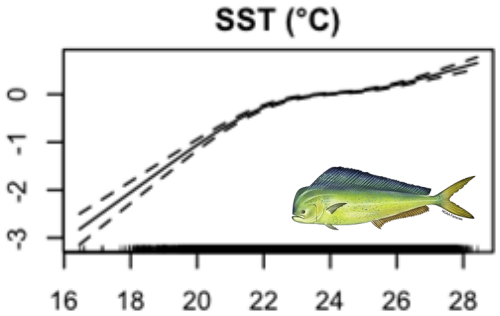
Habitat expands northward → Increased fishery–habitat overlap → **Increasing** ono availability due to expansion within the fishery.

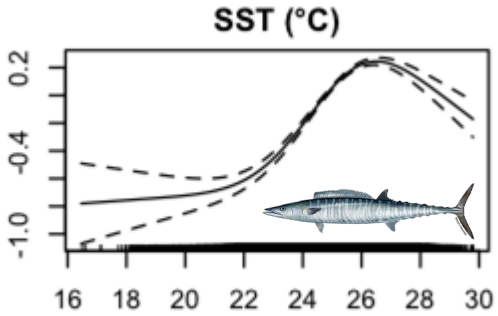
p_{pp} = significance values corrected for temporal autocorrelation following Pyper & Peterman (1998)

Summary

Summary

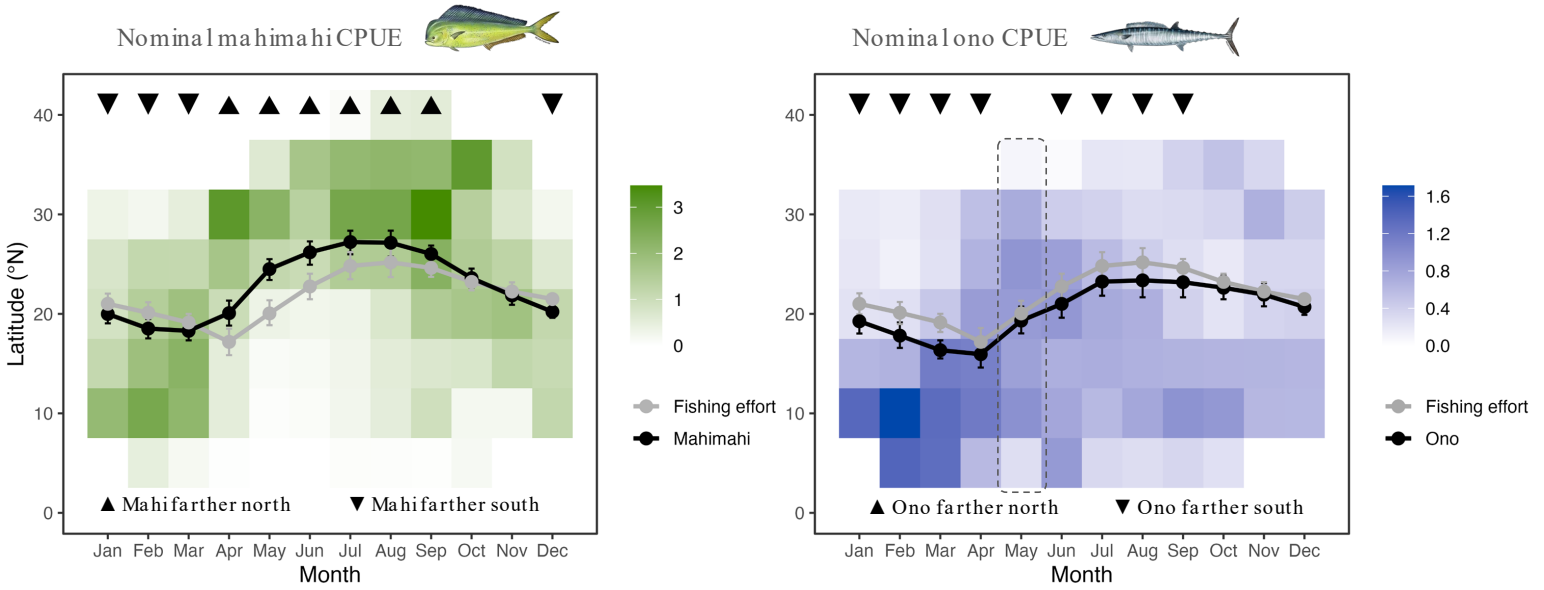
Warm temperatures are an important driver of mahimahi and ono catch rates





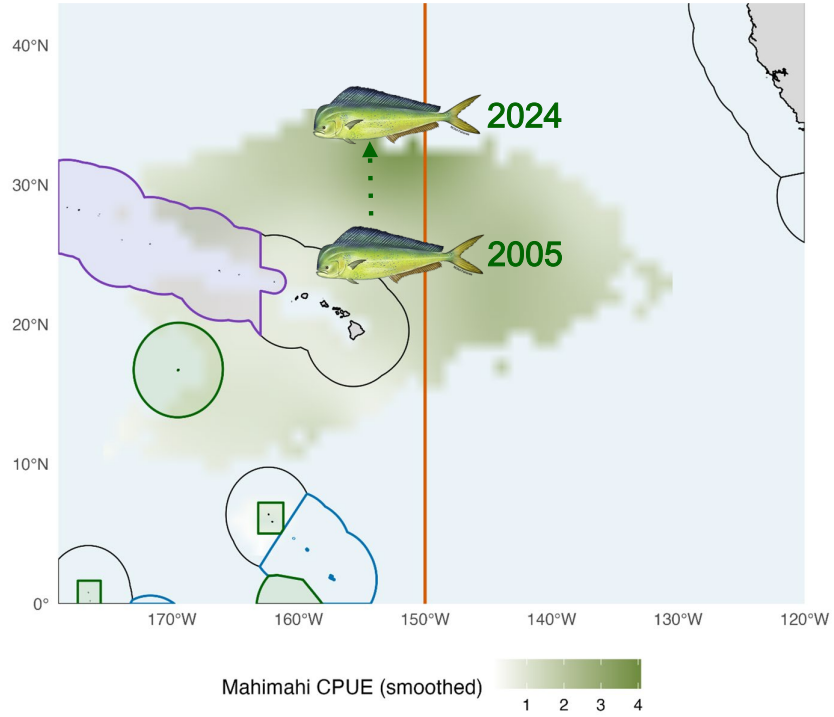
Summary

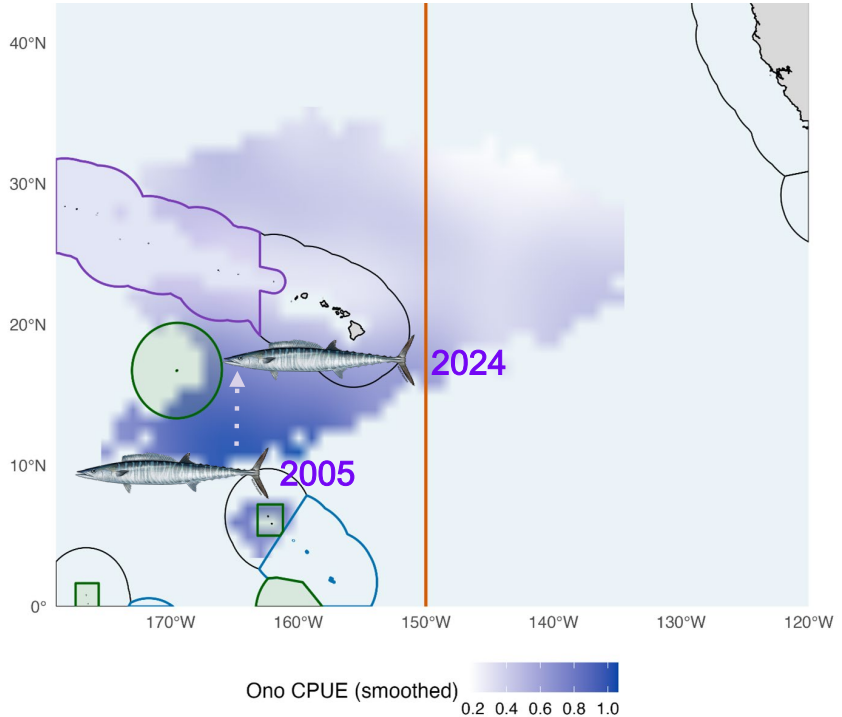
Strong seasonal patterns support meridional migration and fishery - habitat overlap as underlying processes



Summary

Northward shifts in habitat and availability have different fishery outcomes for different species





Mahalo nui

Co-authors & Collaborators

Justin Suca
Jason Helyer
Janelle Morano
Marc Nadon
Don Kobayashi
Ryan Rykaczewski
Michelle Sculley
Hawai‘i fishers
Nicholas Ducharme-Barth
Keith Kamikawa
Marlowe Sabater
Felipe Carvalho
Bradley Gough
Amanda Dillon Merritt
HI Small Boat Fisheries Working Group

Funding, data, host institutions

Contact: jessica.perelman@noaa.gov