Synergy between fishery expansion and oceanographic variability drives changes in central North Pacific fisheries catch

Phoebe Woodworth-Jefcoats
NOAA Fisheries – Pacific Islands Fisheries Science Center
University of Hawaii at Manoa

Jeff Polovina
NOAA Fisheries – Pacific Islands Fisheries Science Center

Jeff Drazen
University of Hawaii at Manoa
Hawaii-based Longline Fishery - 2015

- Total Landings:
  - $97 million (6th in US)
  - 32 million pounds (27th in US)
- 142 vessels
- 49 million hooks
- 13 million km²
- 229,221 bigeye
- 20,381 swordfish
Deep-Set Bigeye Fishery

Deep Sets
- ≥ 10 hooks per float
- Daytime
- Hooks set between 100 – 400 m below surface
- Median hook depth: 250 m

Bigeye Tuna
- Forage at depth during the day
- Depth range of 200 – 400 m
- Dive to temperatures between 8 – 14 °C
- Oxygen threshold for performance: ~ 1 mL L\(^{-1}\)

Beverly et al. 2003

FishWatch.gov

Objective

• How has oceanographic variability – both spatial and temporal – impacted Hawaii’s longline fishery?

Data Used

- Hawaii-based longline data
  - Logbook data: all effort & commercial catch
  - Observer data: effort & full catch, 20% fishery coverage
- International longline effort data
  - Western and Central Pacific Fisheries Commission (WCPFC) & Inter-American Tropical Tuna Commission (IATTC) publically available data
- Oceanographic data
  - Global Ocean Data Assimilation System (GODAS) reanalysis: four-dimensional temperature
  - World Ocean Atlas 2013 (WOA13): three-dimensional oxygen
- 1995 – 2015
- Gridded to 1° × 1° horizontal resolution

Garcia et al. 2014, Saha et al. 2006
Methodology

- Quarterly temporal resolution
- Regional spatial resolution
Shift in Fishing Distribution

SW: -23%
CW: -20%
NW: +16%
NE: +26%
Drivers of Fishery Expansion

• High target catch, relatively low discard rates, and little international competition

• Synergy with oceanographic variability
Oceanographic Variability - Spatial

Average depth of preferred bigeye thermal habitat, 8 – 14 °C

Average 300 m oxygen concentration

Deep-set hook depth: 100 – 400 m with median depth of 250 m
Oceanographic Variability - Temporal

- Average depth of preferred bigeye thermal habitat, 8 – 14 °C, across all grid cells fished

----- Significant linear fit ($p < 0.05$)
Oceanographic Variability - Temporal

- Effort-weighted average depth of preferred bigeye thermal habitat, 8 – 14 °C

---- Significant linear fit ($p < 0.05$)
Oceanographic Variability - Spatiotemporal

Depth of preferred bigeye thermal habitat, 8 – 14 °C

Time Series Mean

2014 – 2015 Anomaly
Lancetfish

- Catch rates increased in response to fishery expansion: NW region
- Very little know about this species, but work is underway
  - Influence of local oceanography? Transition zone?
  - Seasonal behavior?
Conclusions

• Regional oceanography a driving factor in fishery movement
• Fishery movement has shaped catch magnitude and composition
• Interannual oceanographic variability has also influenced catch
• Such oceanographic and spatiotemporal context can aid in ensuring ecological and financial sustainability