Effect of Sea Surface Temperature and Chlorophyll-a on the Abundance Of *Thunnus spp. and Katsuwonus pelamis* Along the Coast of Southern California

PARKER CLAY & Jennifer Prairie

Department of Environmental & Ocean Sciences, University of San Diego

University of San Diego

BACKGROUND

- Marine fisheries are affected by climate change-related alterations of oceanic conditions, including coastal upwelling, increasing water temperature, and changes in large-scale climate indices[1].
- Tunas (*Thunnus spp. and Katsuwonus pelamis*) are highly migratory, top-order predators inhabiting sub-tropical to sub-polar oceans, playing important and ecological roles[2].
- Tunas are environmentally sensitive species subject to the effects of global and regional climate change as well as anthropogenic pressures[2].

OBJECTIVE

The purpose of this study was to investigate 1) how sea surface temperature and chlorophyll-α has varied from 1959 to 2019, 2) the relationships between sea surface temperature and chlorophyll-α on the abundance of larval and adult tunas (*Thunnus spp. and Katsuwonus pelamis*), and 3) how the abundance of tunas has varied from 1959 to 2019 along the coast of Southern California.

METHODS

- Study location was limited to 31°N and 34.5°N latitude and 116°W and 120°W longitude (Figure 1).
- Ichthyoplankton and hydrographic data was obtained from CalCOFI. Mean sea surface temperature and chlorophyll-a concentrations were calculated by combining and averaging stations within study location.
- Purse seine Tuna fishery data was obtained from the IATTC. Tuna catch was combined at all locations within the study location and catch per unit effort was standardized as tonnes/set.

Figure 1. Map of CalCOFI stations (white pin drop) and IATTC sets between 31°N and 34.5°N latitude and 116°W and 120°W longitude. Blue icons represent the center of a 1°×1° sampling grid.

RESULTS

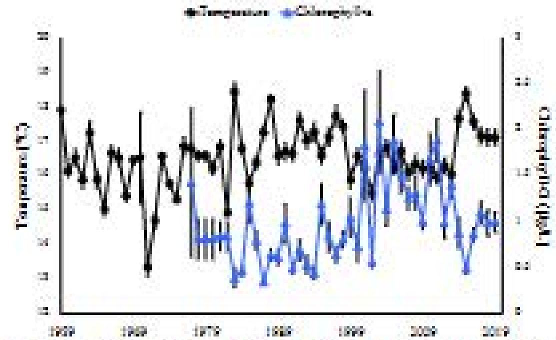

Figure 2. Black line represents the annual mean ± 1 standard error sea surface temperature (°C) from 1959 to 2019. Blue line represents the annual mean ± 1 standard error chlorophyll-α concentration (µg/L) from 1976 to 2019.

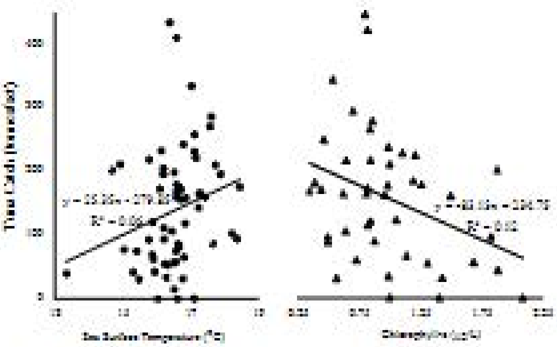

Figure 3. Relationships between annual mean sea surface temperature (°C) (left), annual mean concentration of chlorophyll-α (µg/L) (right) and total annual tuna catch (tonnes/set). Lines shows linear regression representing significant relationships ($p<0.05$ & $p<0.02$).

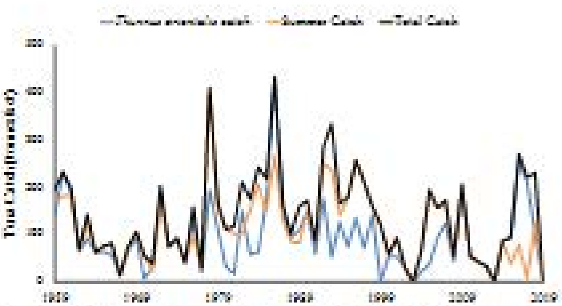

Figure 4. Annual total tuna catch (tonnes/set) by purse seine from 1959 to 2019. Blue line represents total catch of Bluefin tuna, *T. orientalis*. Orange line represents total tuna caught during the summer months, June to September. Black line represents total tuna caught per year.

RESULTS

- Mean sea surface temperature varied from 13.35±0.29 to 18.44±0.24°C, and mean chlorophyll-a concentration varied from 0.34±0.02µg/L to 2.09±0.54µg/L (Figure 2).
- There was a significant positive correlation ($p=0.0467$, $r=0.258$, $df=58$) between annual sea surface temperature and tuna catch, and a significant negative correlation ($p=0.0172$, $r=-0.360$, $df=41$) between chlorophyll-α and tuna catch (Figure 3).
- Total tuna catch varied from year to year, ranging from 0 to 434.2 tonnes/set. Approximately 82% of the total tuna caught was taken between June and September. Pacific Bluefin, *T. orientalis*, constituted 67% of the total catch (Figure 4).
- Larval *Thunnus Spp.* and *K. pelamis* was not detected throughout the study location during the 60-year history.

DISCUSSION

- In addition to sea surface temperature, variations in the population abundance of pelagic species including tunas are strongly linked to large-scale climate indices and other marine climatic events [1,2].
- The lack of abundance when chlorophyll-α concentrations are high is likely due to the tendency of tunas to feed opportunistically and prey on a diverse forage base in regions of widely varying water parameters rather than targeting only regions with high primary productivity [2].
- Most species of tuna prefer warmer waters, where chlorophyll-a concentrations are lower [2].
- The variability in the number of tunas caught each year suggests that tuna populations are sensitive to natural fluctuations in the stock population as well as anthropogenic pressures such as overfishing [2].
- A lack of detectable tuna larvae suggests a spatial and temporal disconnect. All tunas are highly migratory species [1] and are known to spawn in the warm waters off the coast of Japan and Baja California [4].

REFERENCES

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]