



Seasonally stratified ocean features influence seasonal availability of Sailfish to sport fisheries

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and
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Presentation Organization

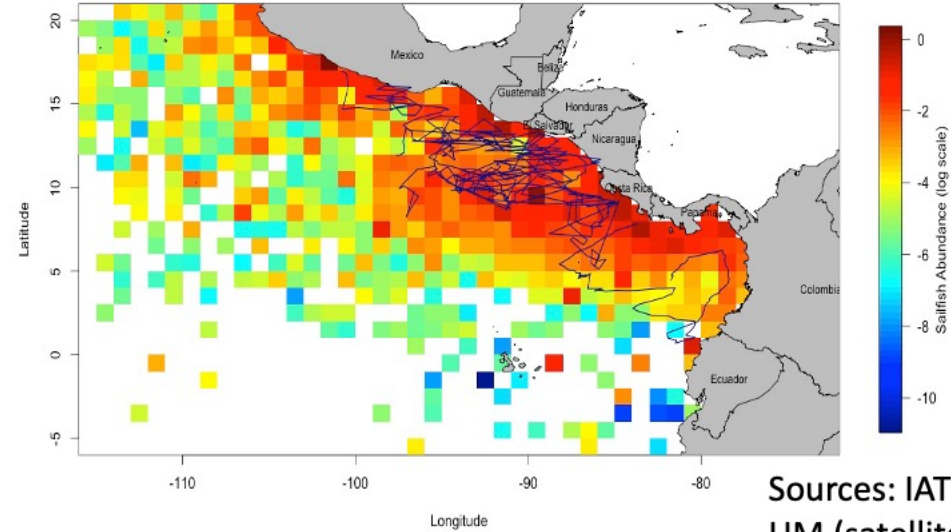
1. Sailfish distribution and environmental features contributing to habitat stratifications
2. Sailfish habitat use driven by seasonal ocean features
3. The Guatemalan Sailfish sport fisheries and forced hyperstability characteristics of catch per trip



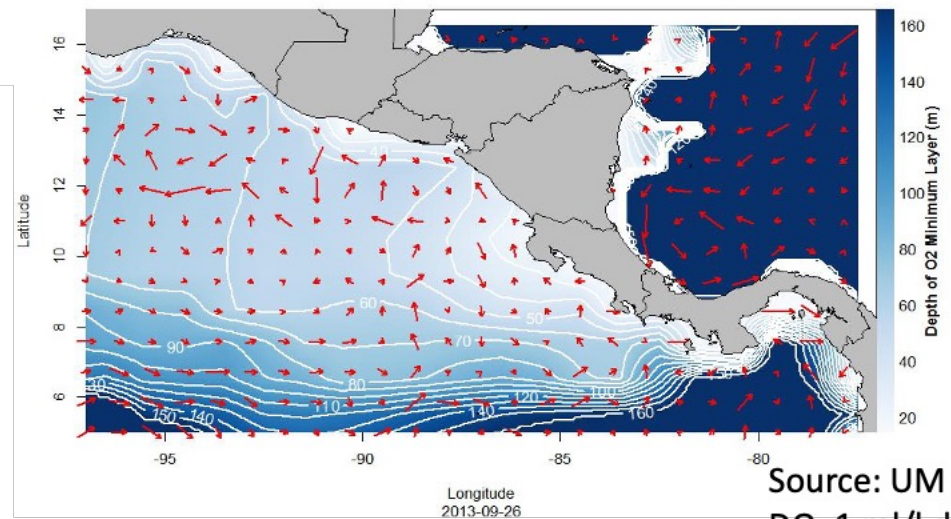
UM tagging sailfish in the eastern Pacific

Sailfish distribution in the Eastern Pacific Ocean (EPO)

Sailfish relative abundance and satellite tag tracks have similar population distribution (upper figure) over habitat compressed coastal ecosystems (lower figure) in the EPO



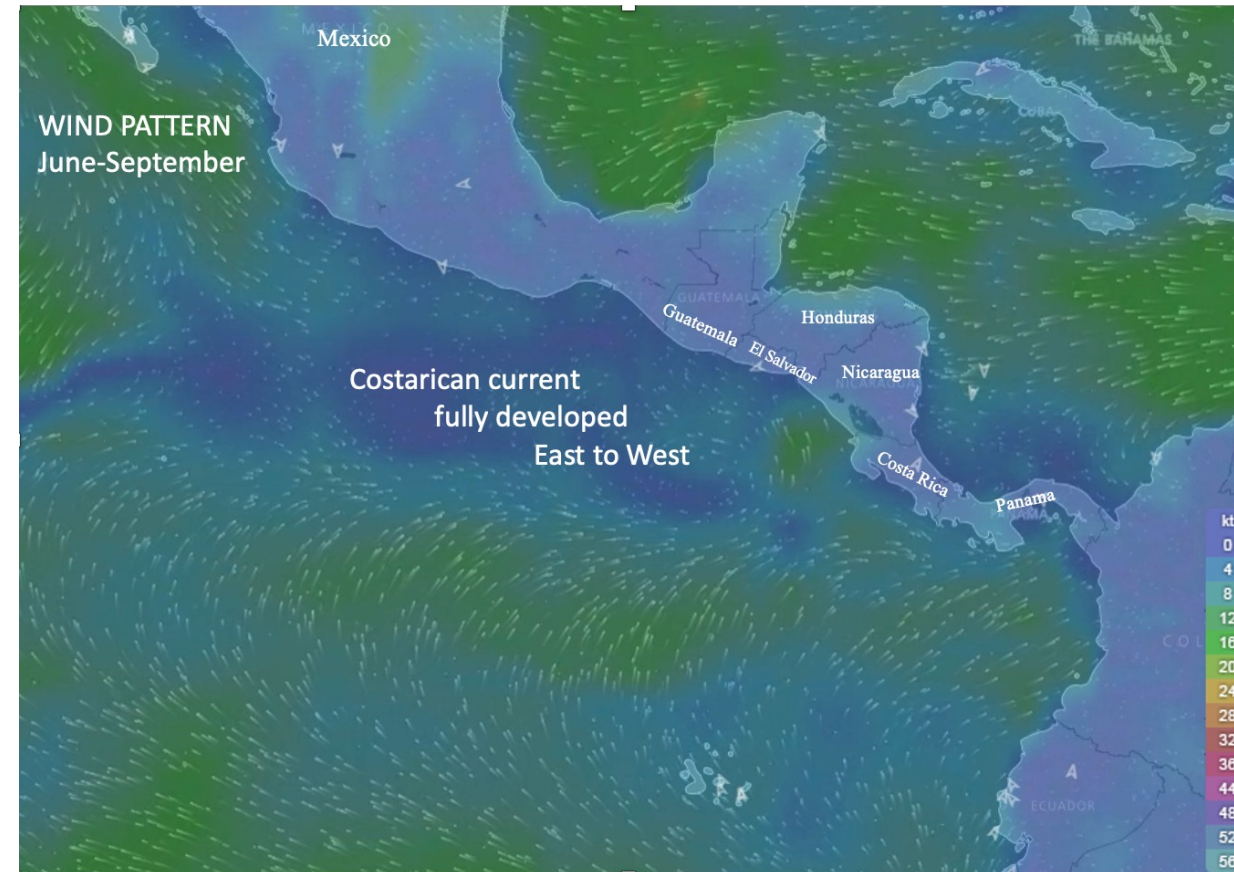
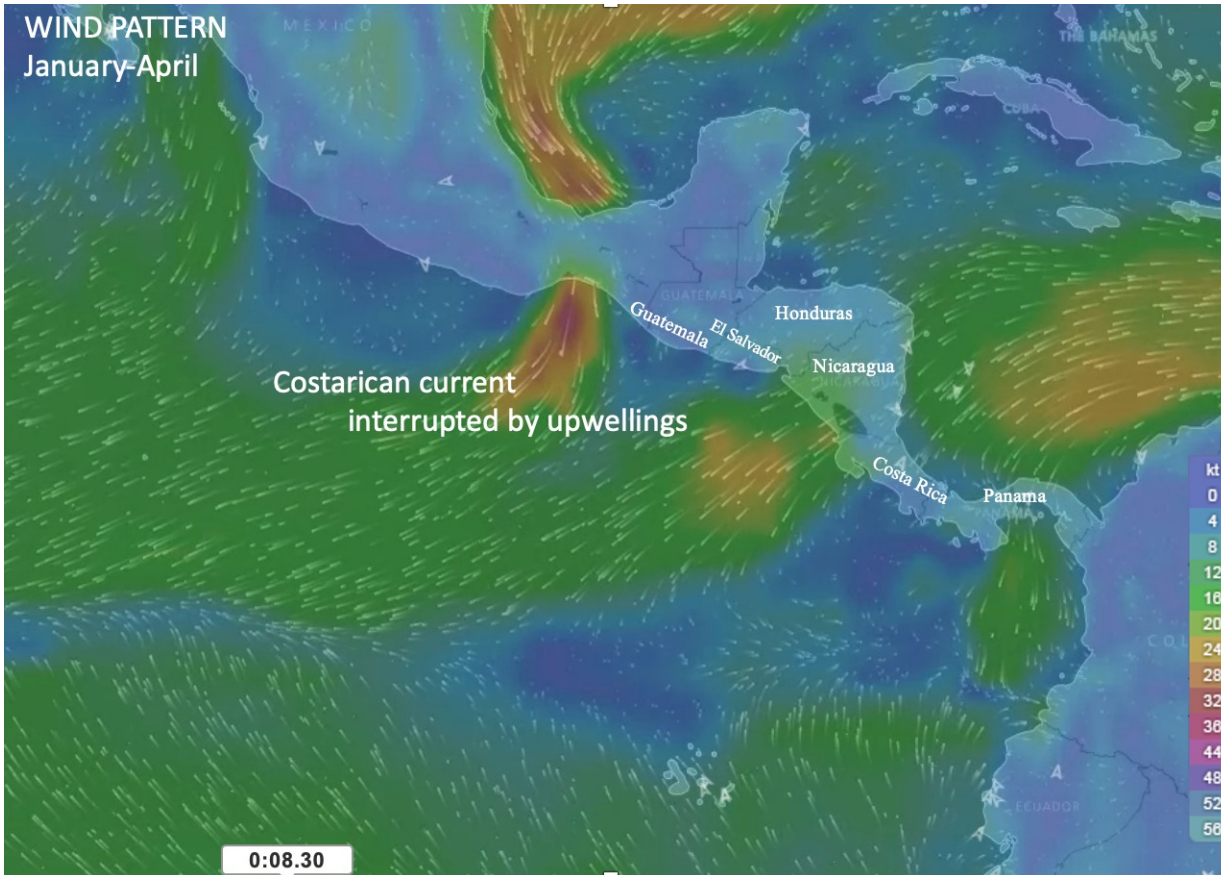
Sources: IATTC (CPUE data)
UM (satellite tag data)



Source: UM (mapping minimum DO₂ 1 ml/l depth)

Atmospheric and Ocean features contributing to habitat stratifications

1. Seasonal wind patterns in the Eastern Pacific Ocean create stratifications impacting coastal ocean currents

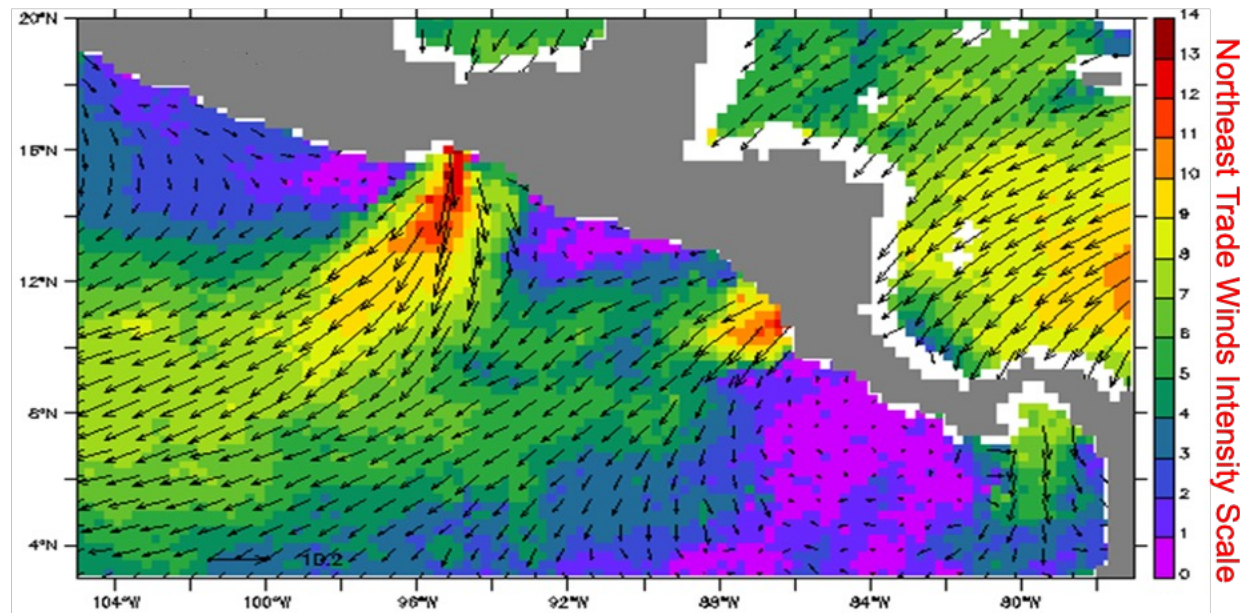


Source NOAA

Atmospheric and Ocean features contributing to habitat stratifications

2. Seasonal December-April winds stress (left figure) forces upwelling of cooler deep water (right figure) generating “horizontal” and vertical stratifications of seawater masses

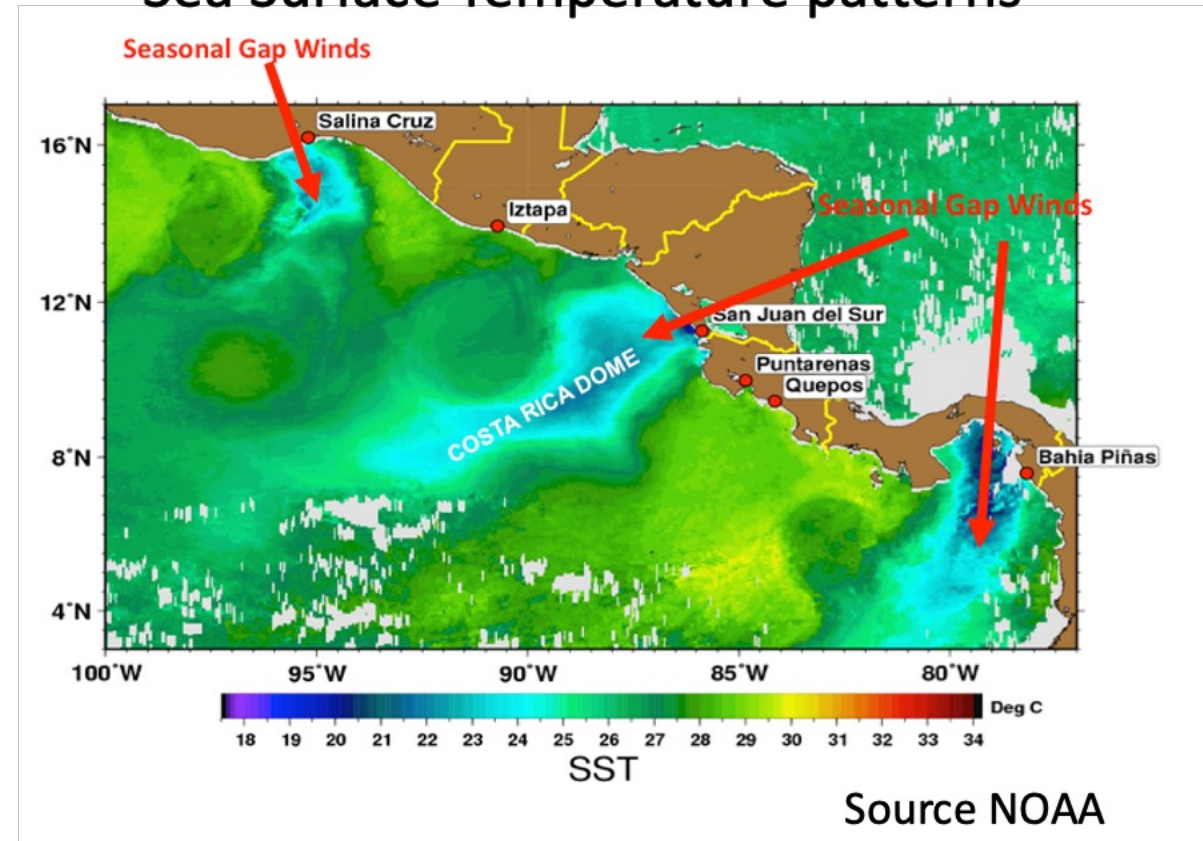
Wind patterns



WIND INTENSITY

Source NOAA

Sea Surface Temperature patterns



SST

Source NOAA

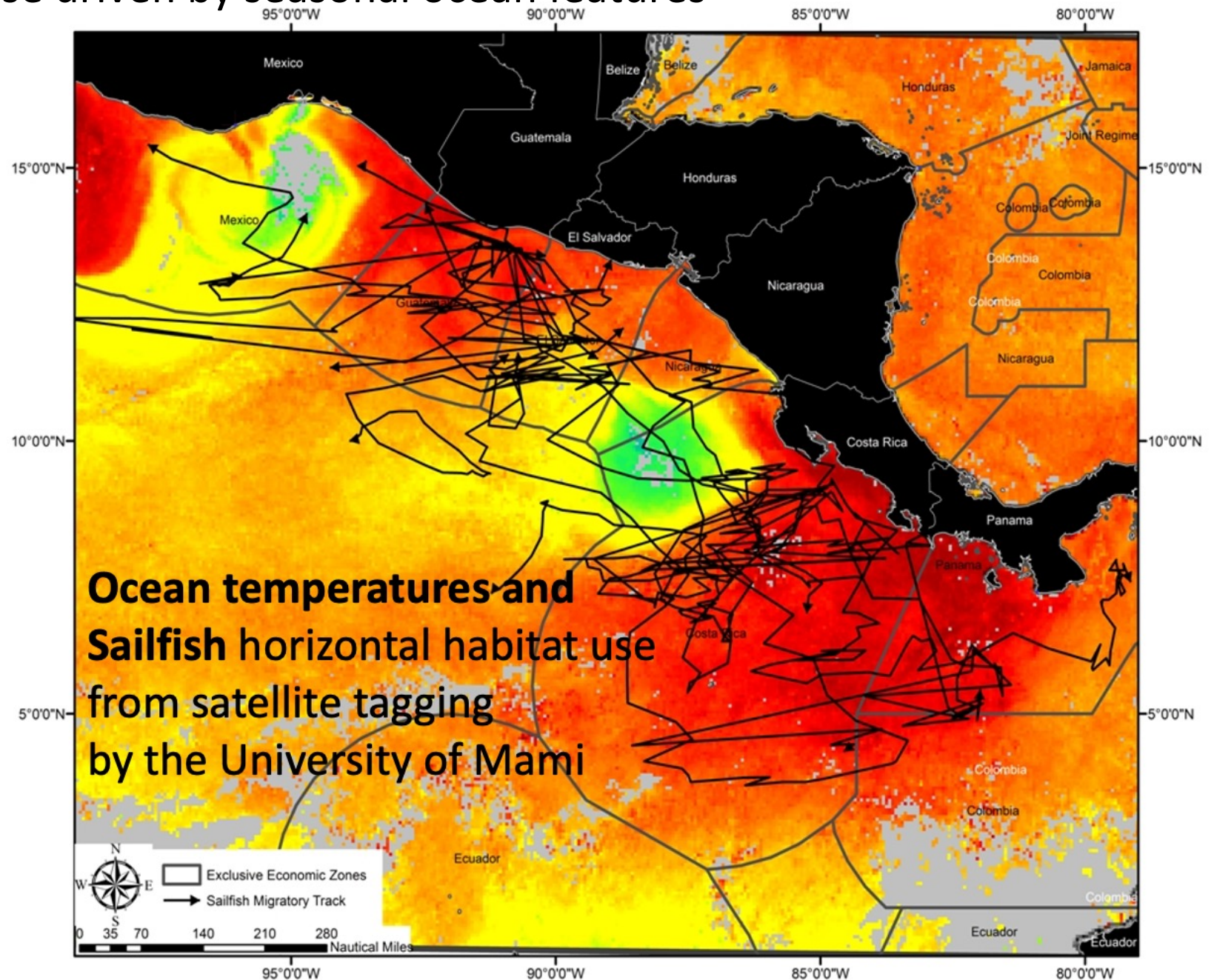
Sailfish habitat use driven by seasonal ocean features

Sea Surface Temperature regimes and Sailfish migratory tracks

Sailfish follow search track patterns in non upwelling regions

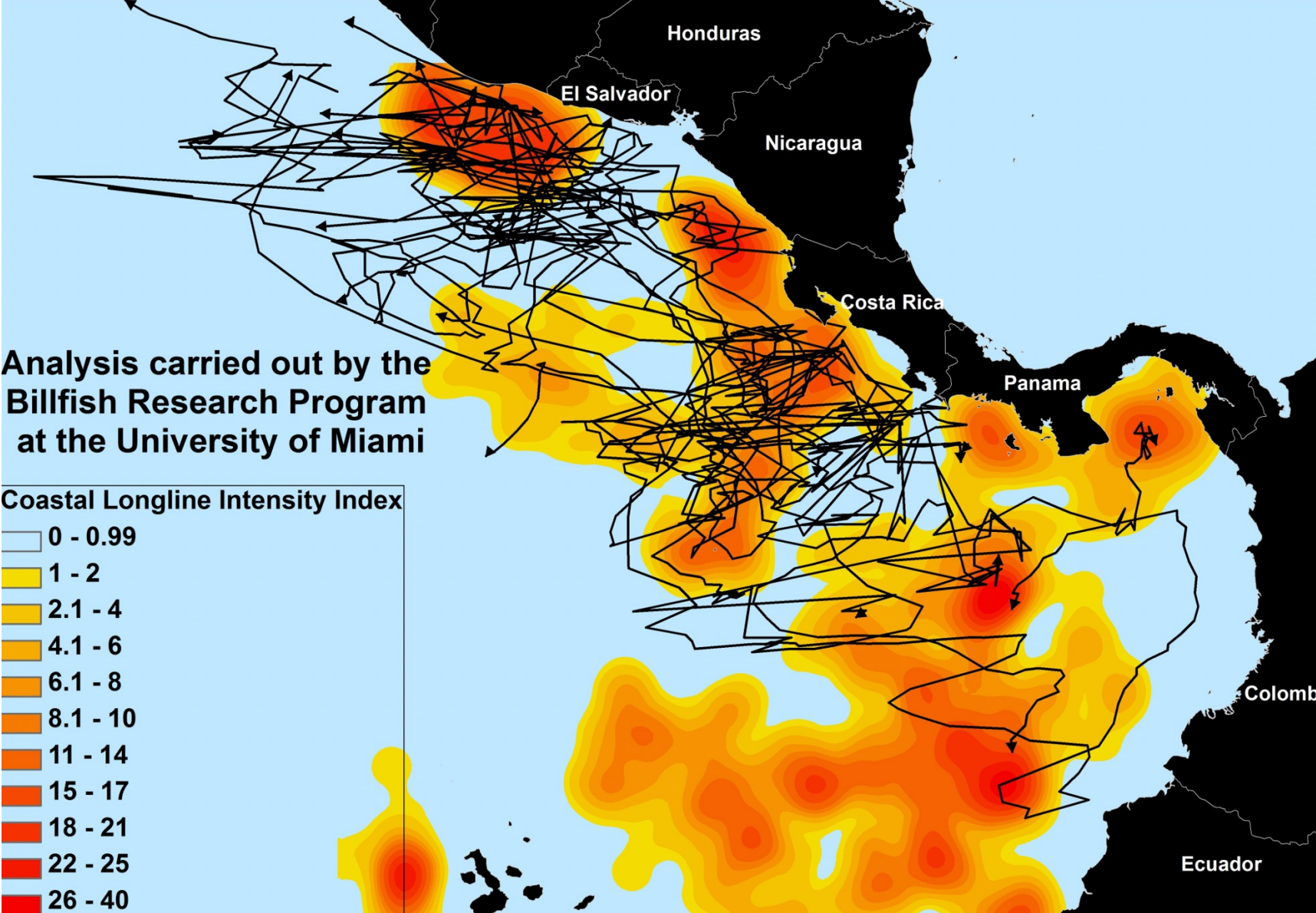
Sailfish crosses upwelling regions more directly and Faster

Such search patterns may be associated to feeding strategies



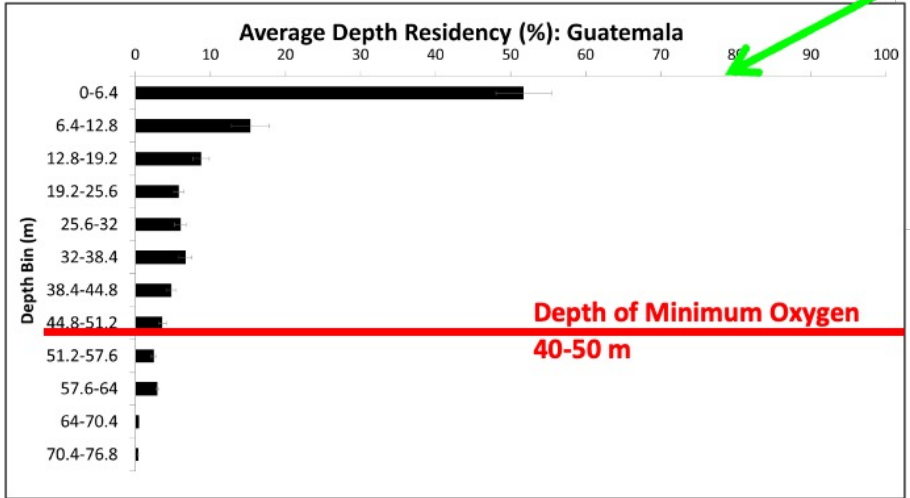
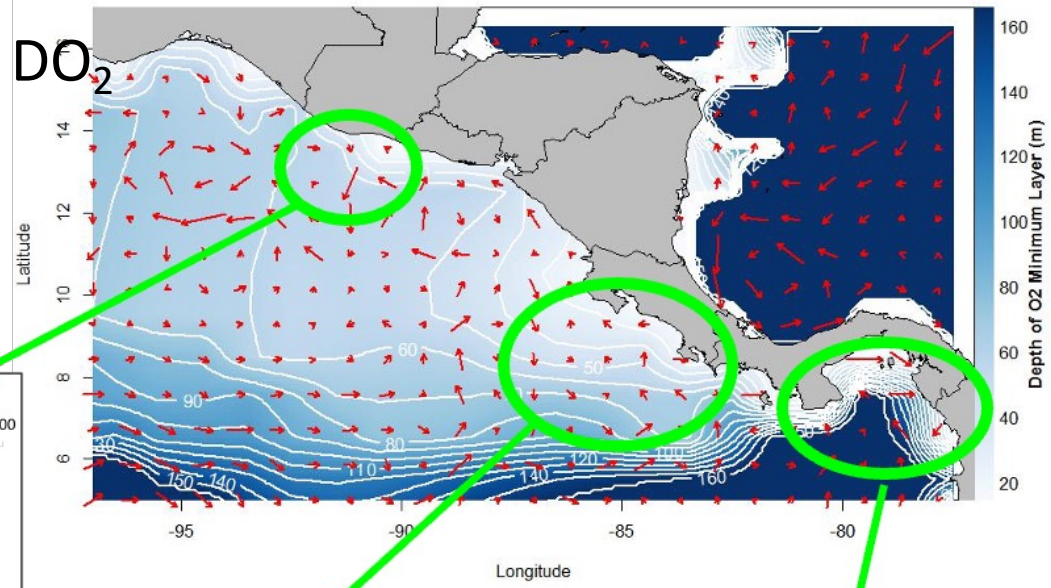
UM Sailfish tag tracks overlaid on a map of coastal longline fishing operations (Source IATTC)

Density of Sailfish tracks and of semi-industrial longline fishing grounds mostly overlap over non upwelling areas off the coasts of Central America and Panama

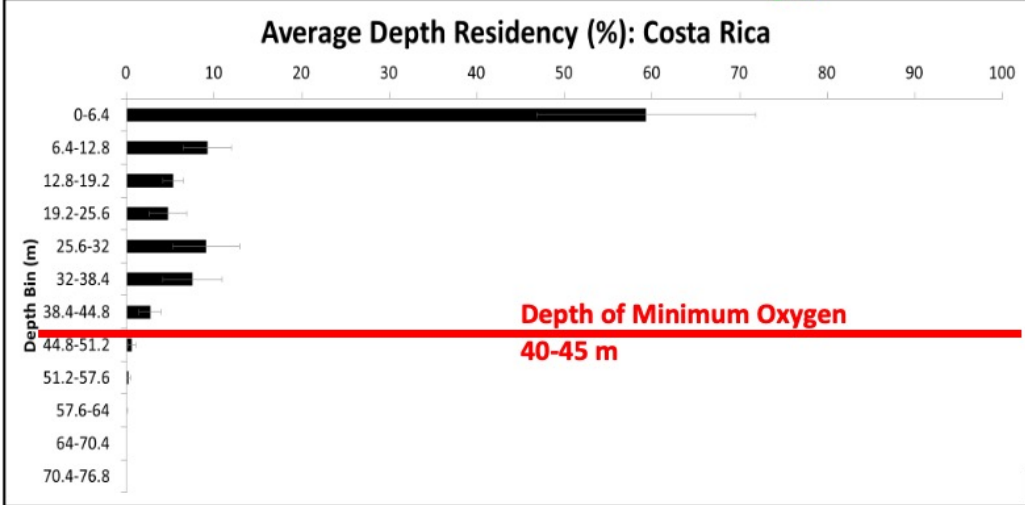
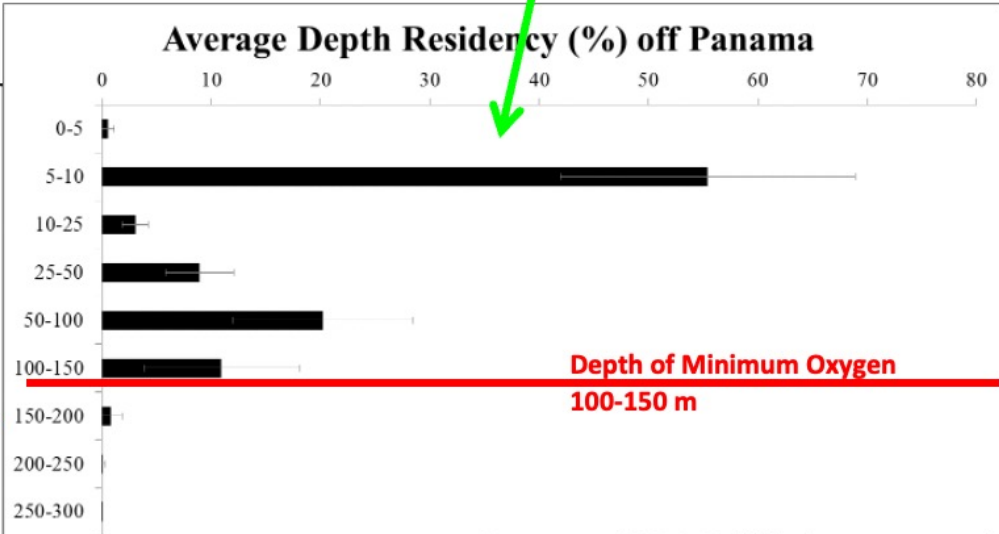


SAI vertical distribution under stratified DO₂

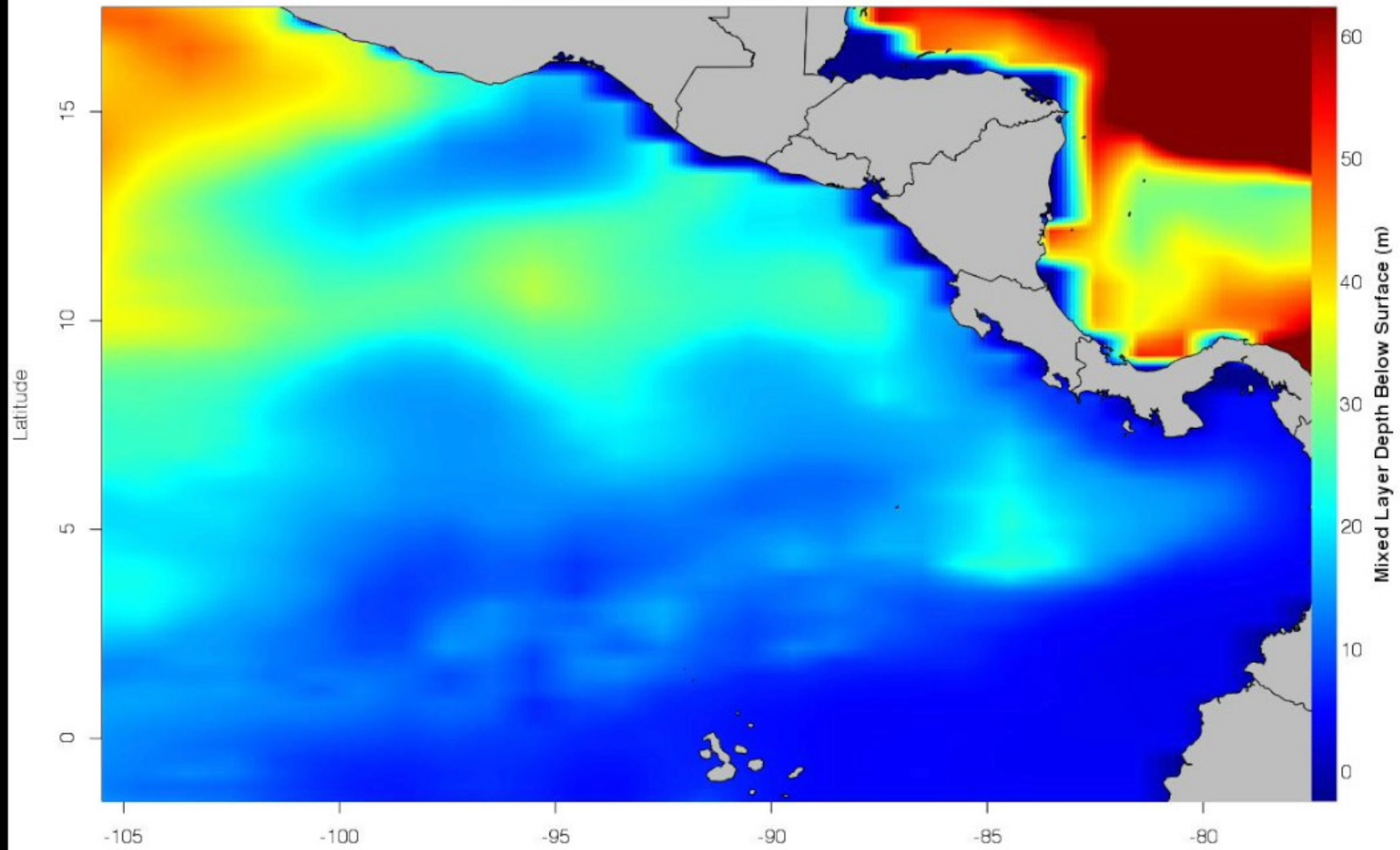
Tagged Sailfish off Guatemala and Costa Rica distributed shallower due to low available DO₂ at shallower depths



Sailfish off Panama went deeper due to more available DO₂ at depth

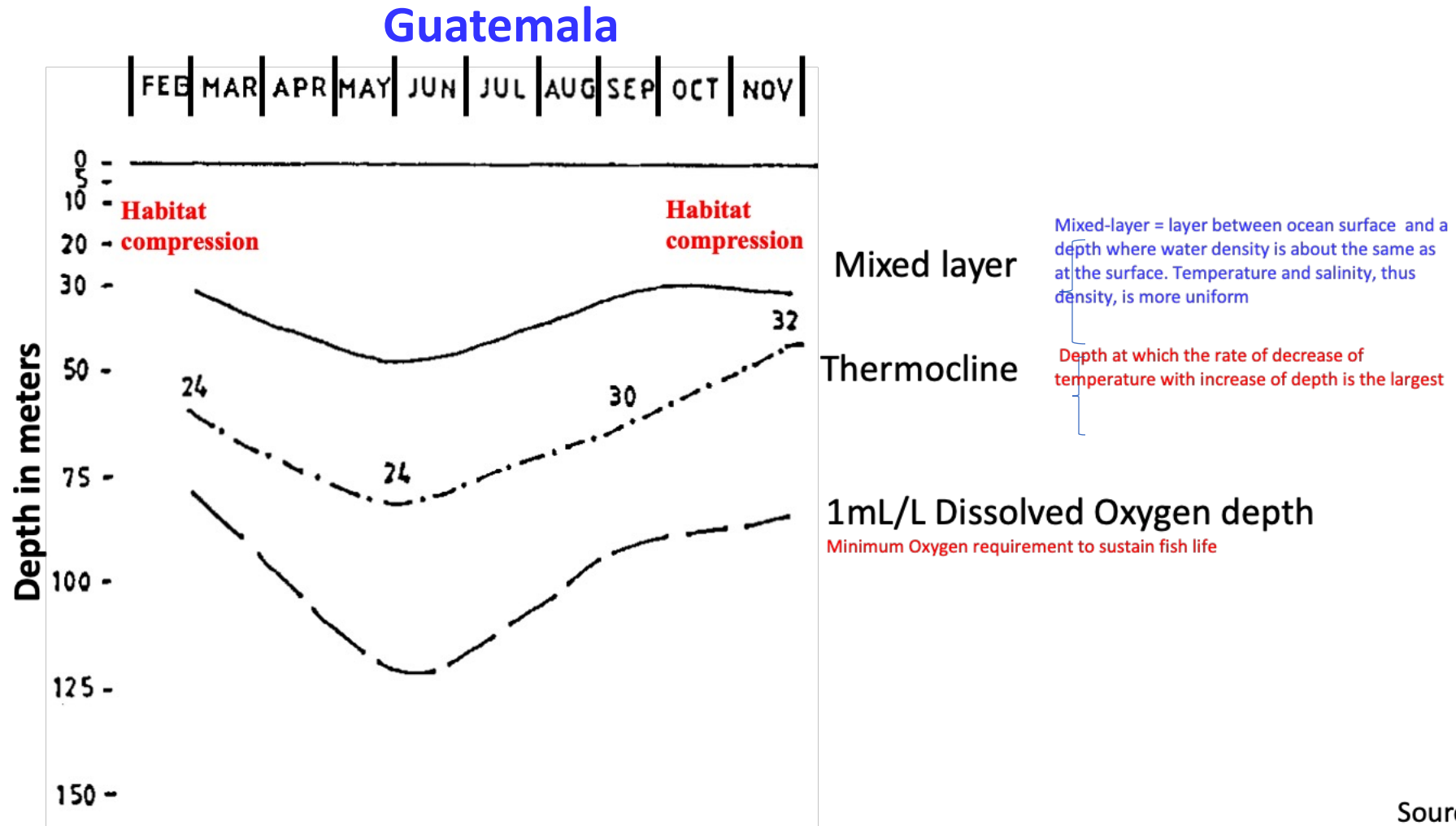


Mixed Layer Depth and Tag Tracks



Longitude
2014-03-11

Seasonal “vertical” distribution of Mixed layer, Thermocline and depth of minimum DO₂ mostly forced by seasonal wind patterns and ocean current circulation

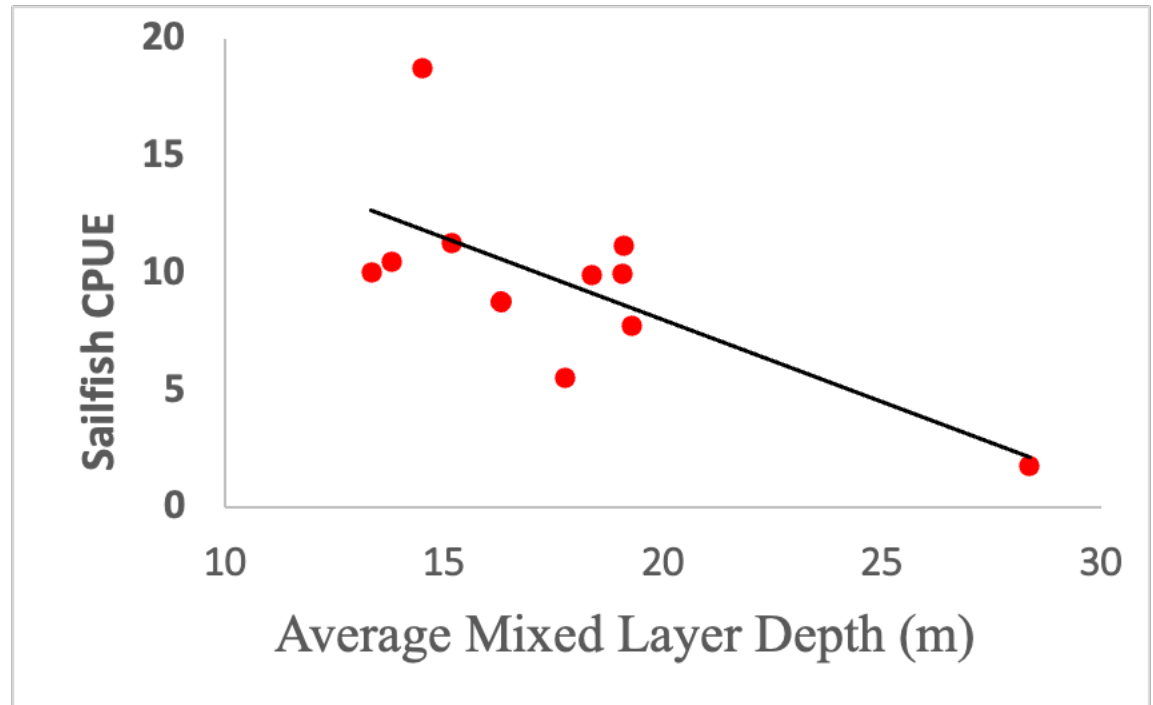
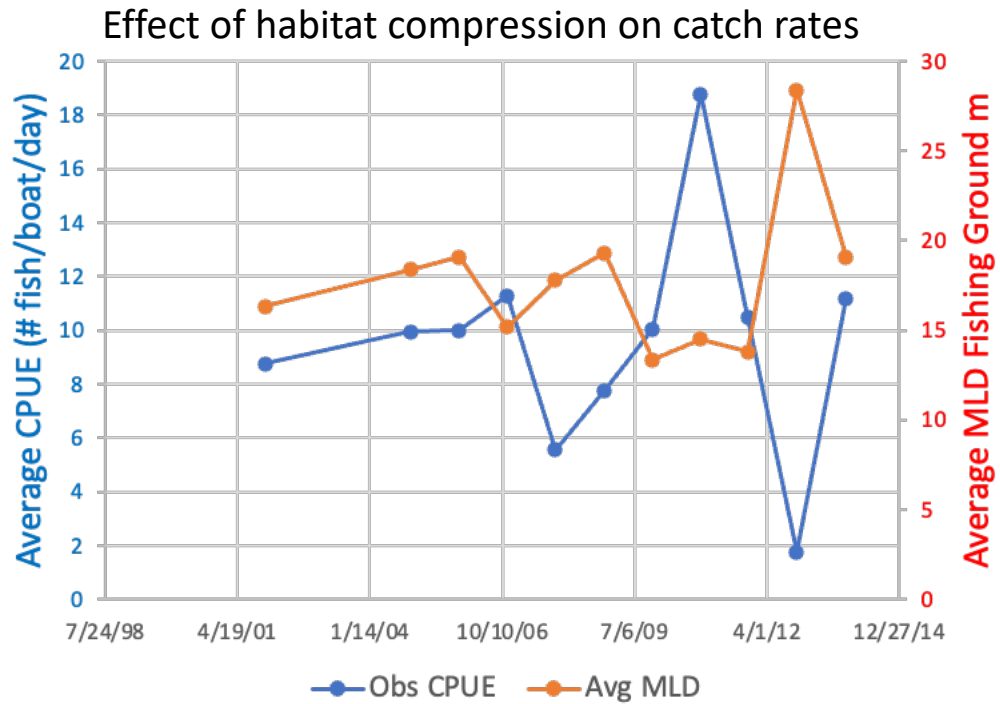


Source: NORAD
UM Billfish research

Habitat compression in the Guatemala region

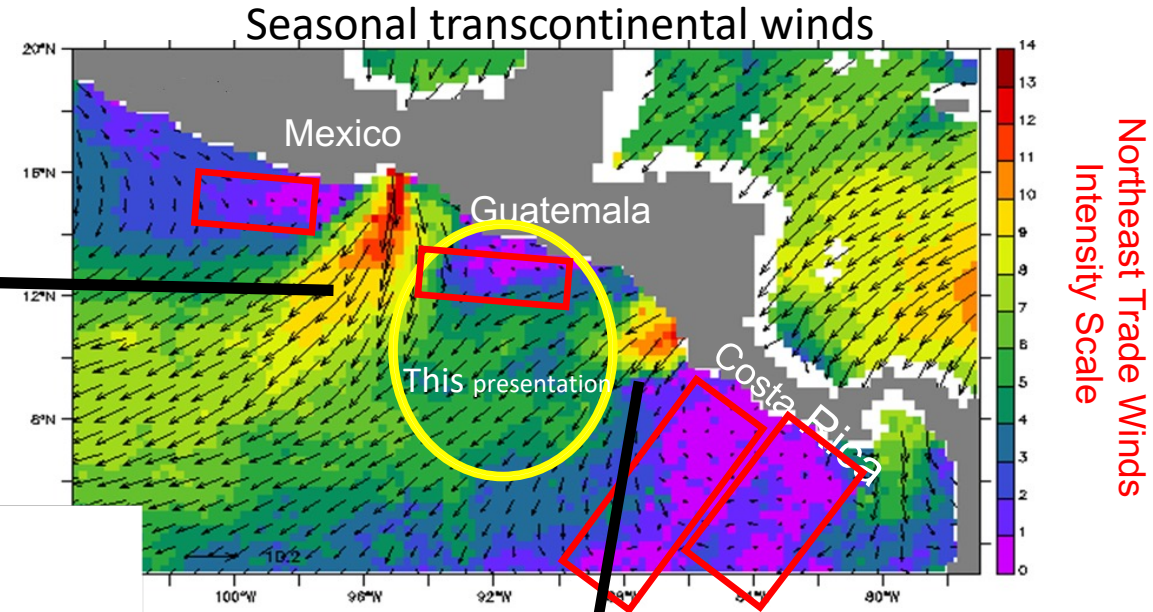
Relationships of CPUE and the average Mixed Layer Depth within a 70-mile radius fishing zone

Guatemala Presidential Challenge 2004-2013
Catch in numbers of Sailfish per boat per day

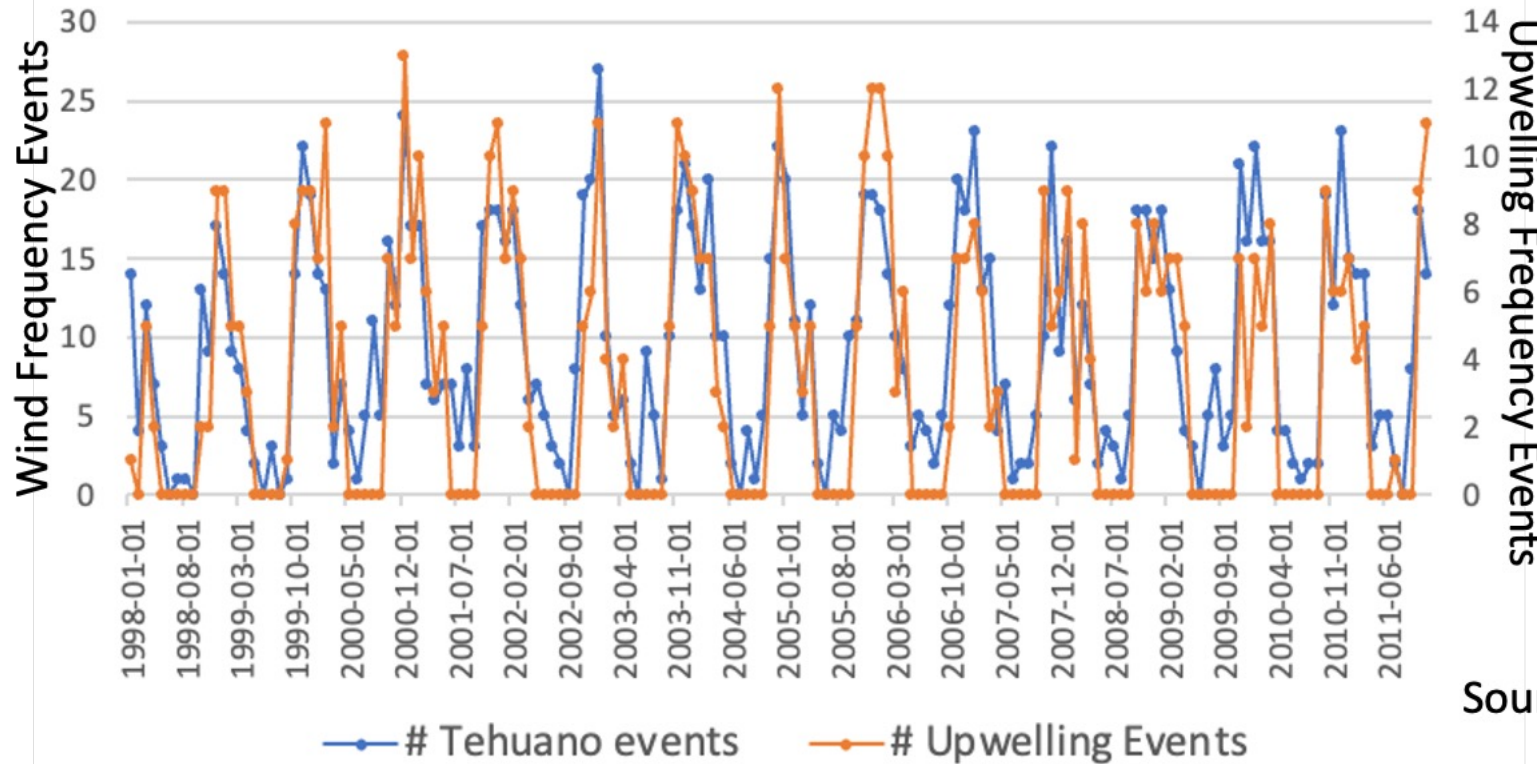


Source: UM PhD Dissertation
J.E. Brown

Seasonal Tehuantepec wind events, the “Tehuanos”, create upwelling events off the Southeastern coast of Mexico and Guatemala



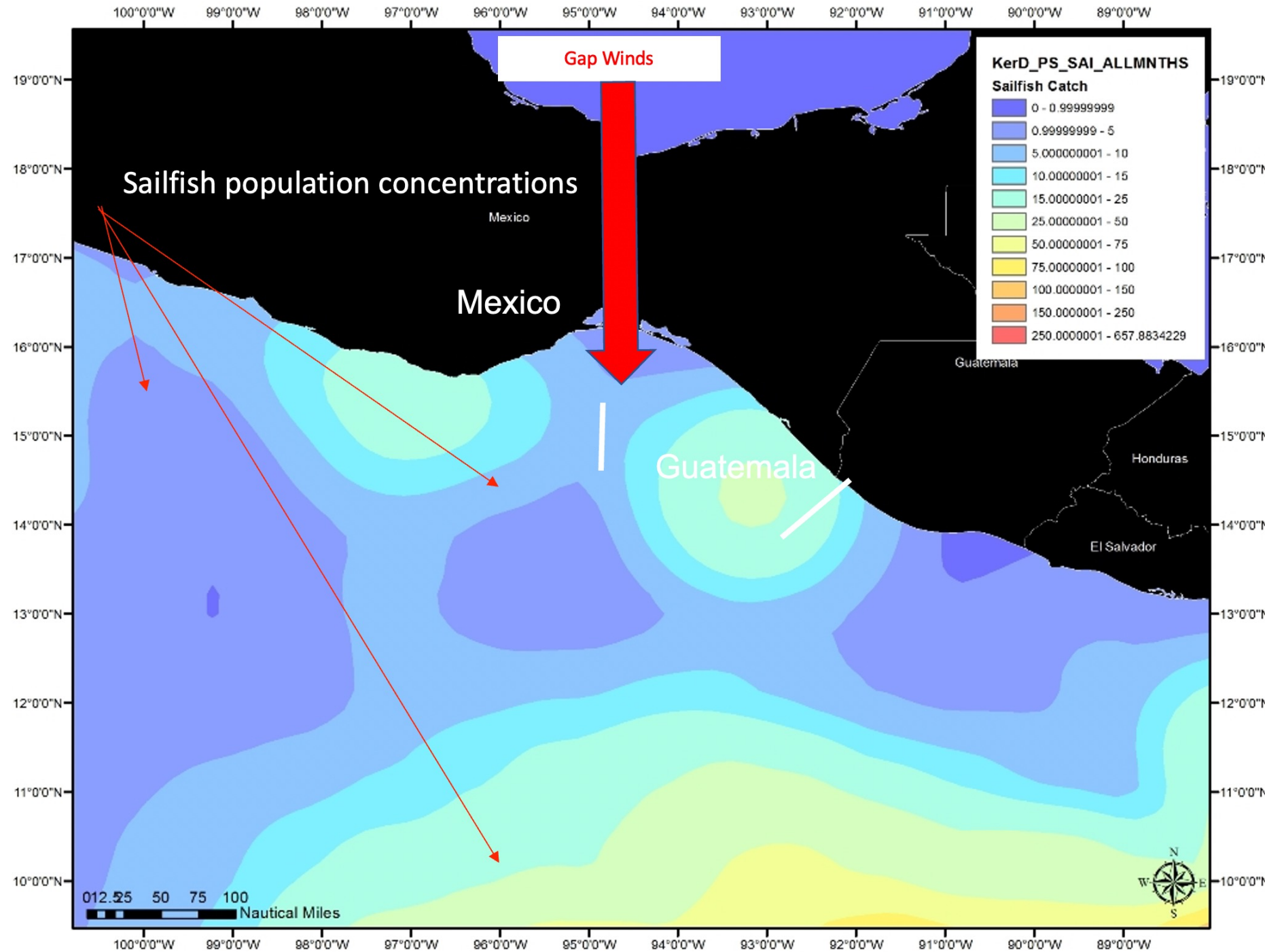
Tehuantepec wind dynamics



Seasonal winds through the great Lake of Nicaragua, the “Papagayo winds”, create a semi permanent upwelling feature, the “Costarican Dome”.

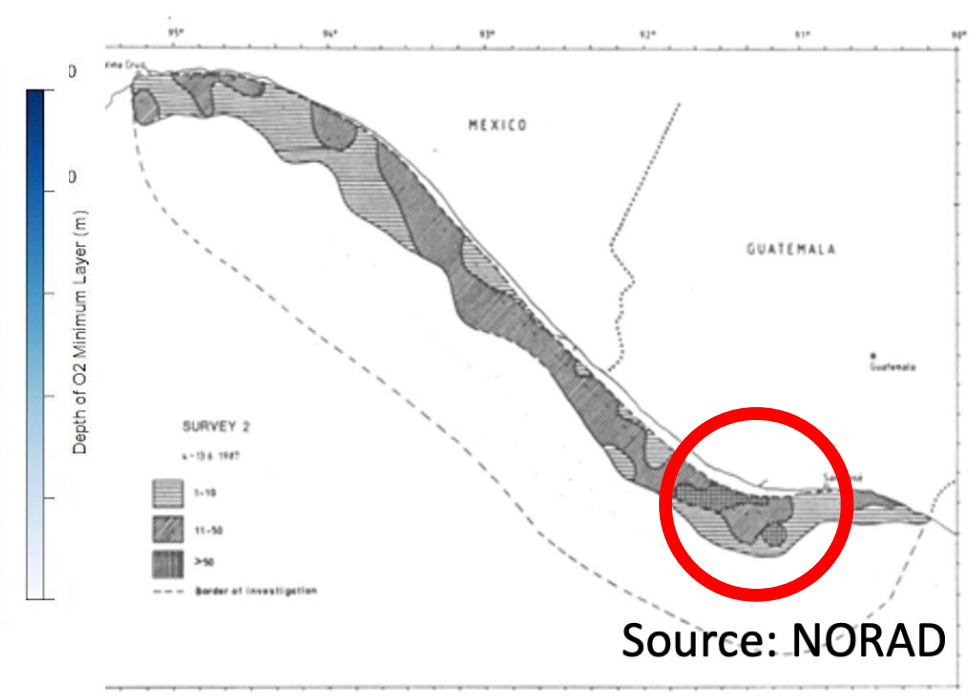
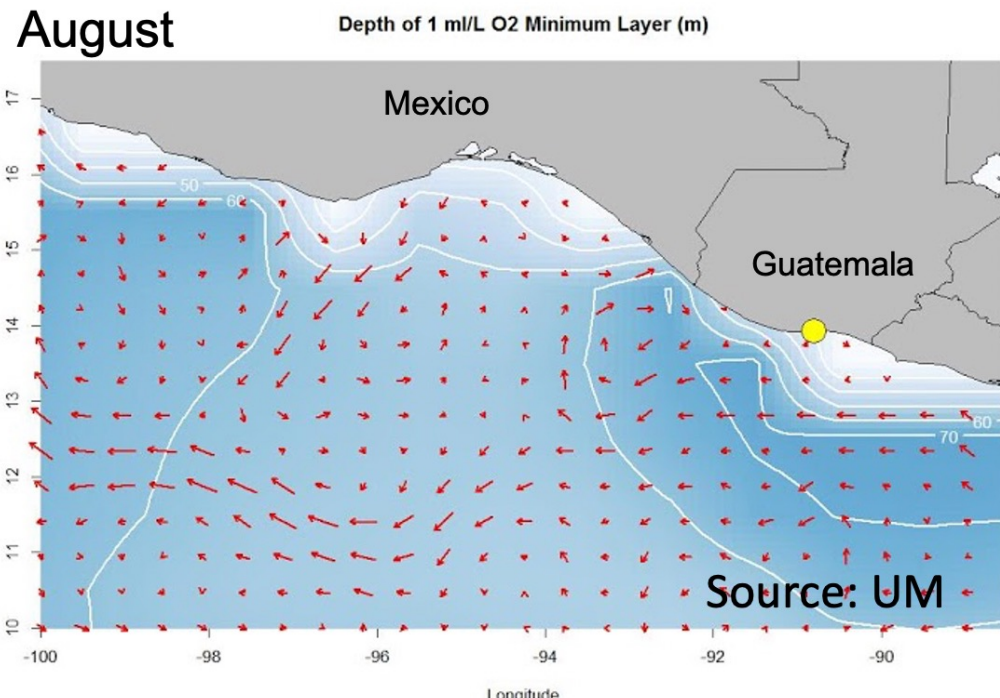
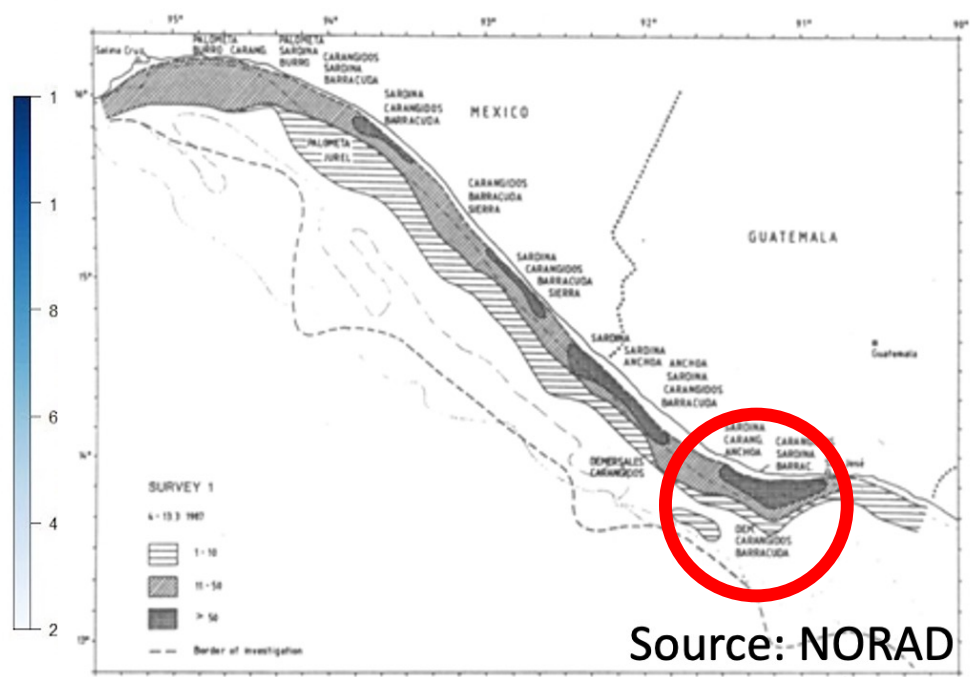
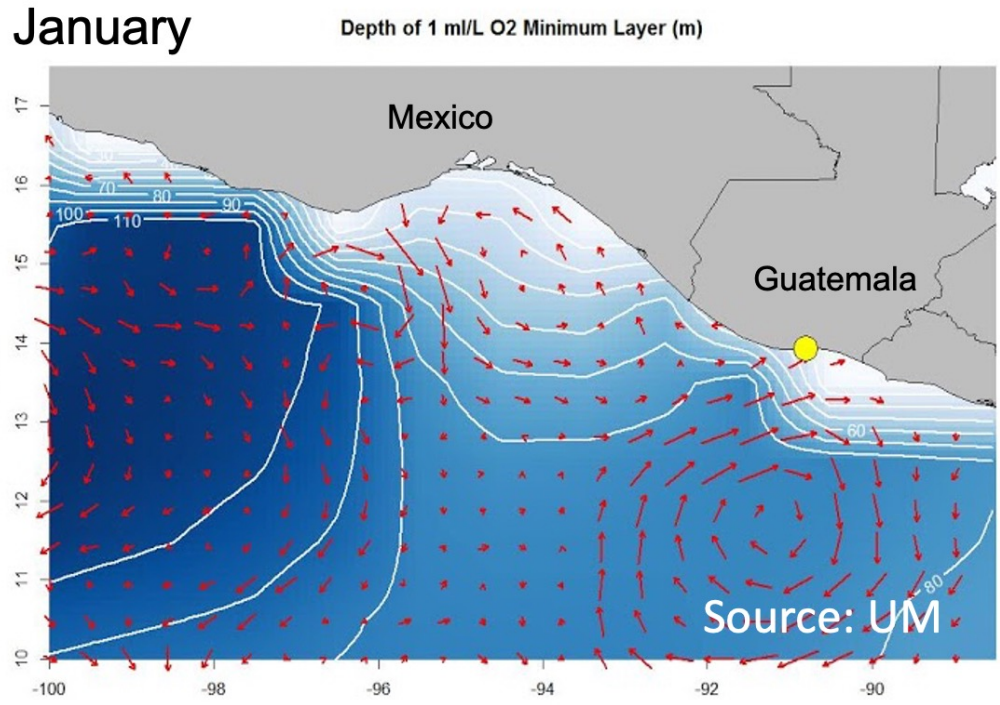
Sources NOAA
Ehrhardt ongoing billfish research

Tehuantepec gap winds influence the seasonal distribution of Sailfish resources off the coasts of southeastern Mexico and Guatemala

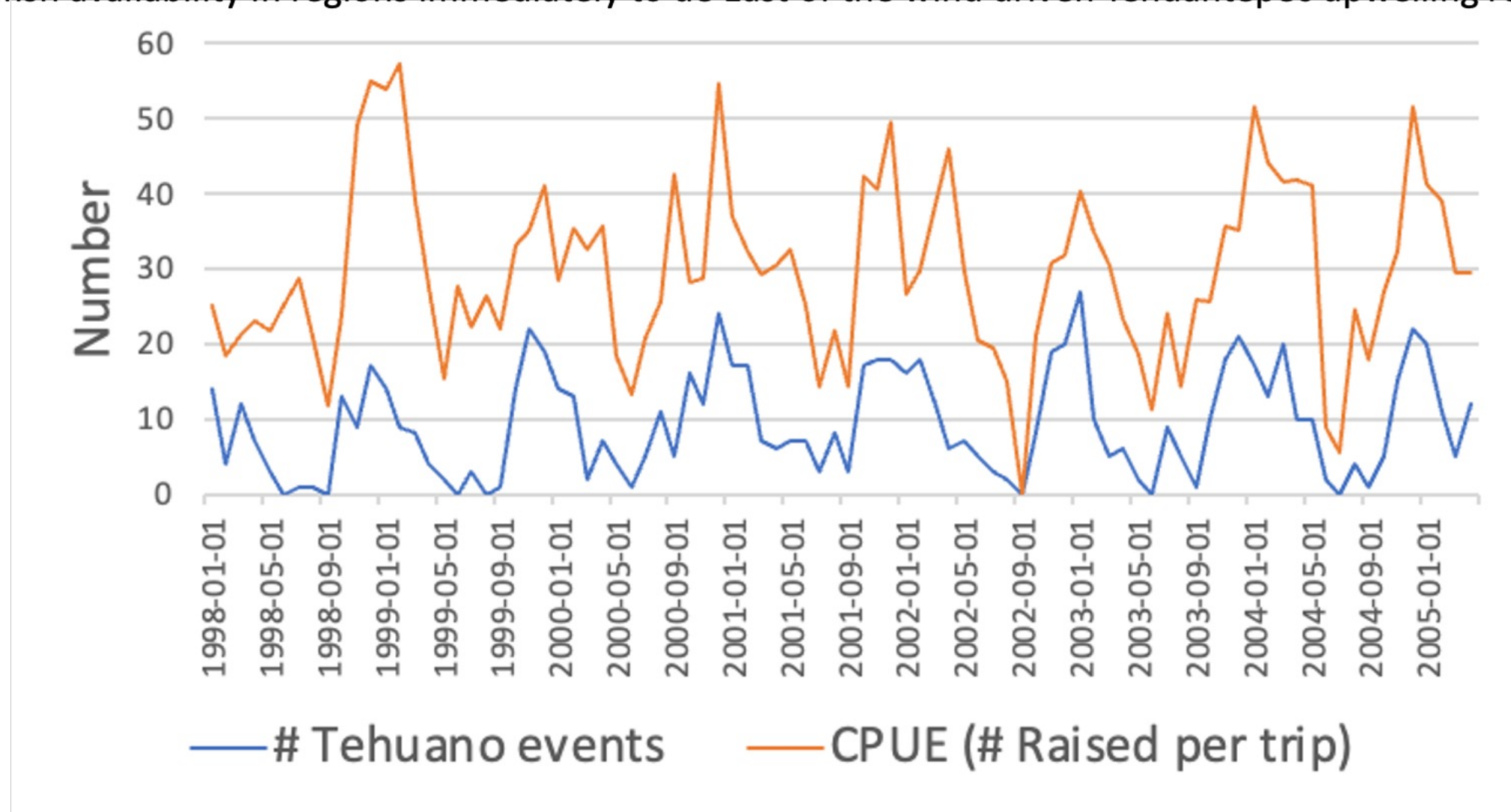


Source: IATTC
UM Billfish Research

Seasonal stratifications of small pelagic species influenced by habitat compression dynamics



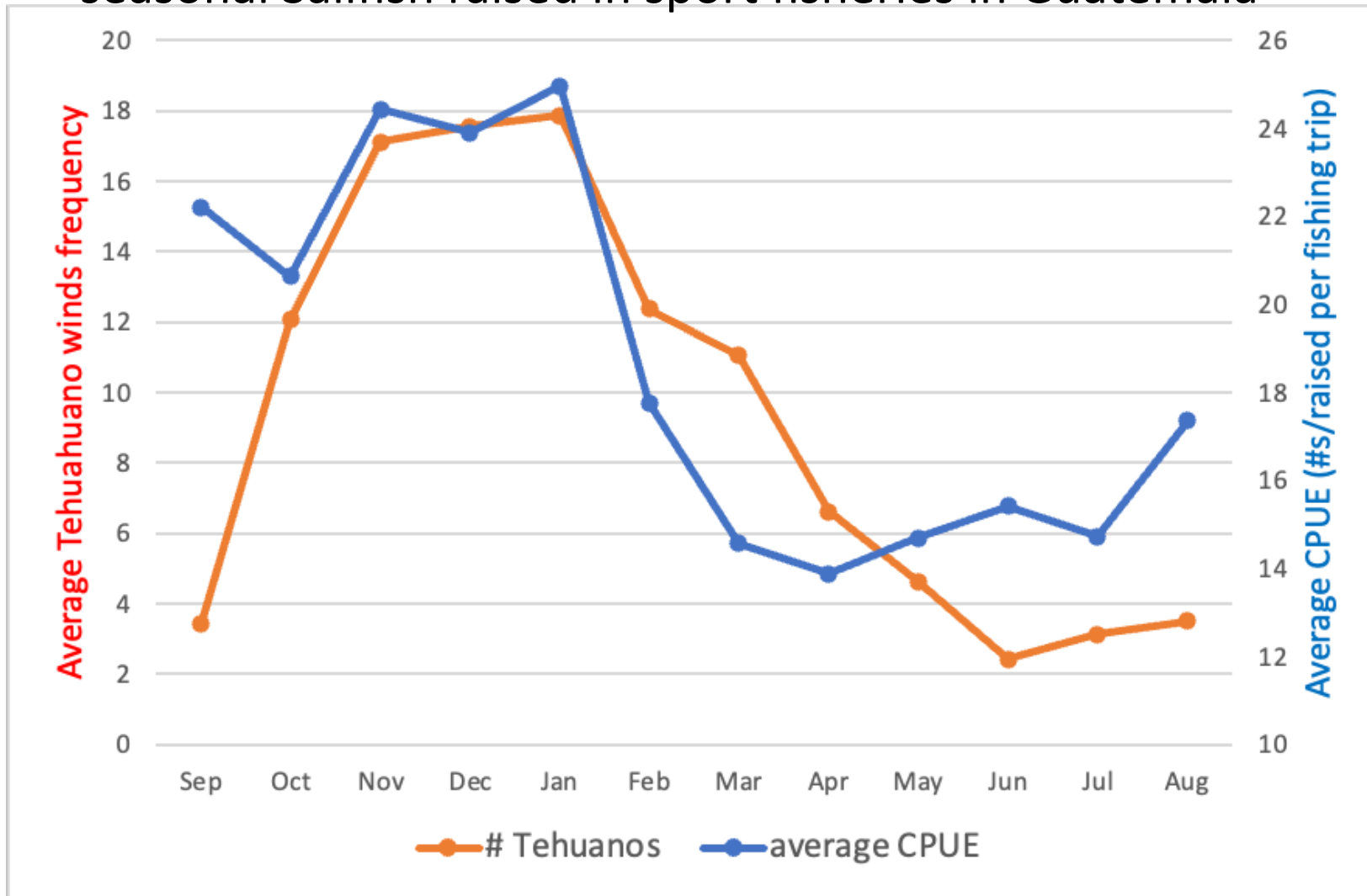
Seasonal number of Tehuano wind events trigger ecosystem boundaries creating seasonal Sailfish availability in regions immediately to the East of the wind driven Tehuantepec upwelling region



Sources NOAA

Ehrhardt ongoing research

Average seasonal Tehuano wind events effects on average seasonal Sailfish raised in sport fisheries in Guatemala

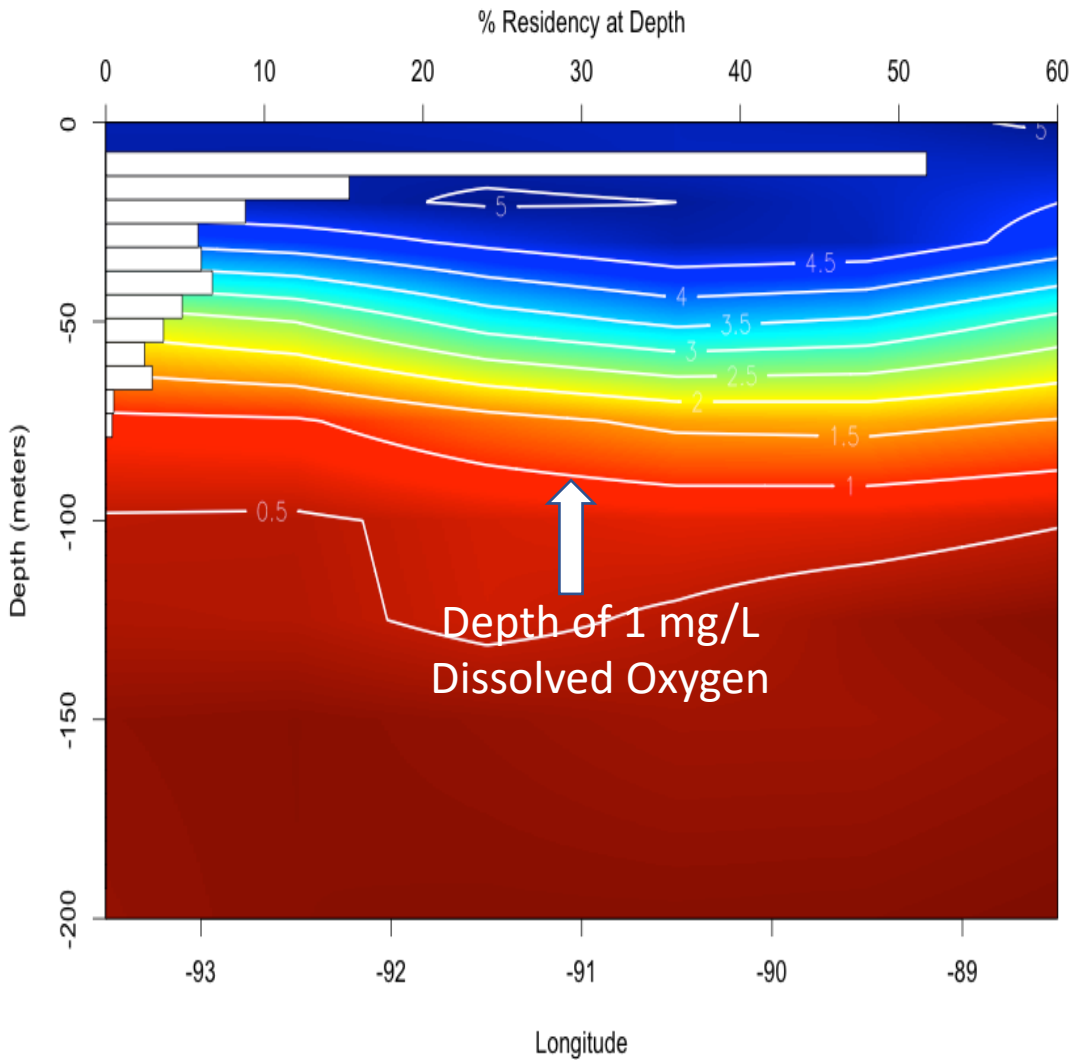


Sources NOAA

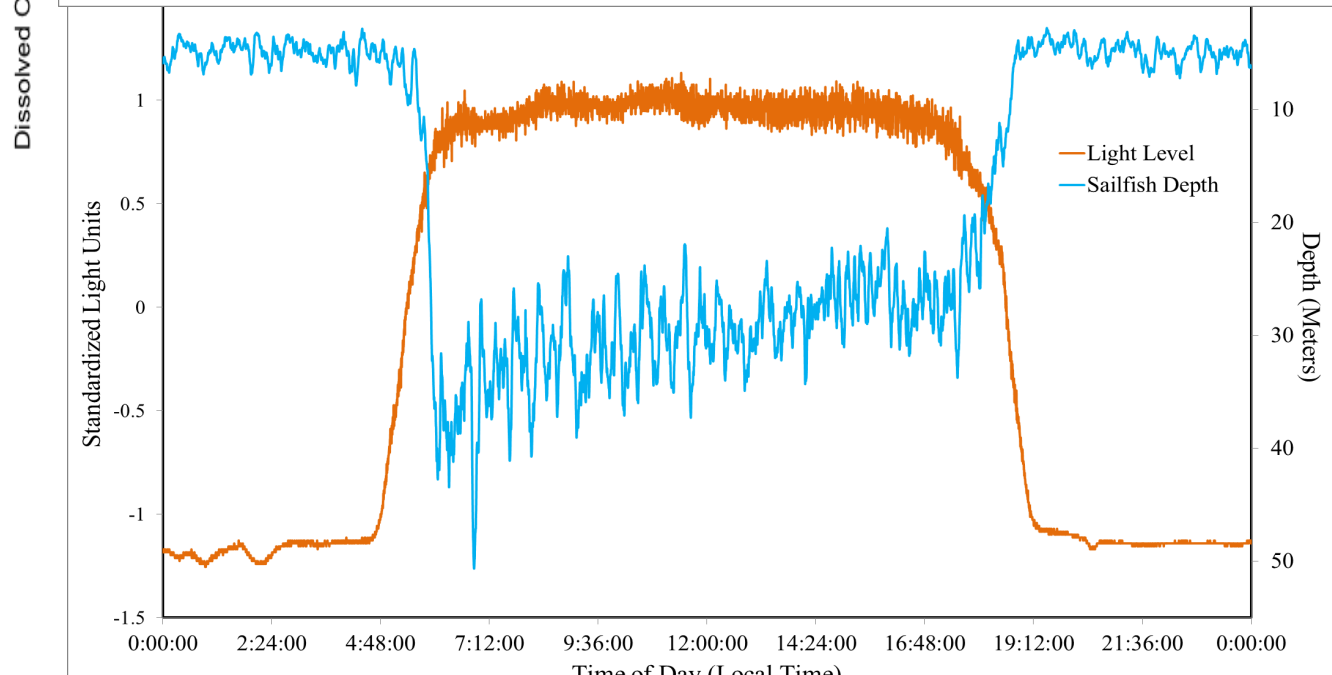
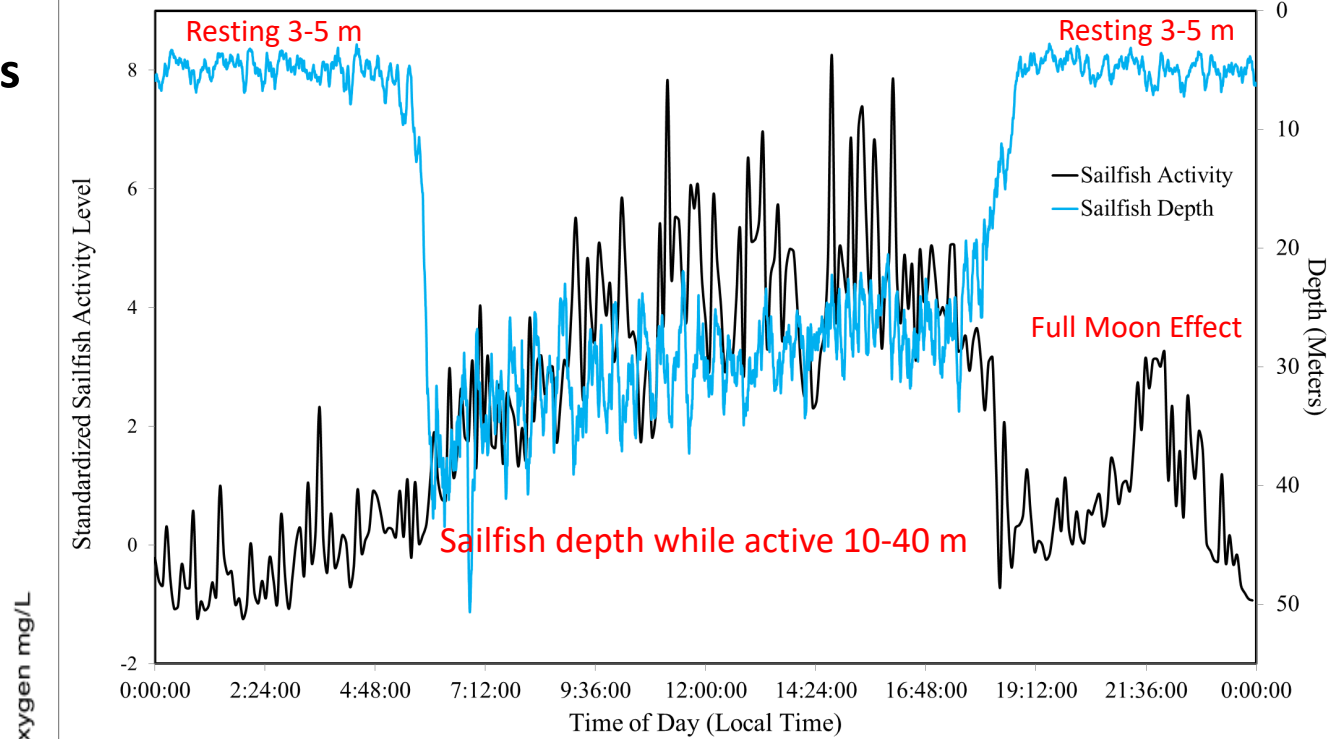
Ehrhardt ongoing research

Guatemala Sailfish vertical distribution and migrations

Dissolved Oxygen and Sailfish Residency with Depth from Transect off Guatemala, 13N

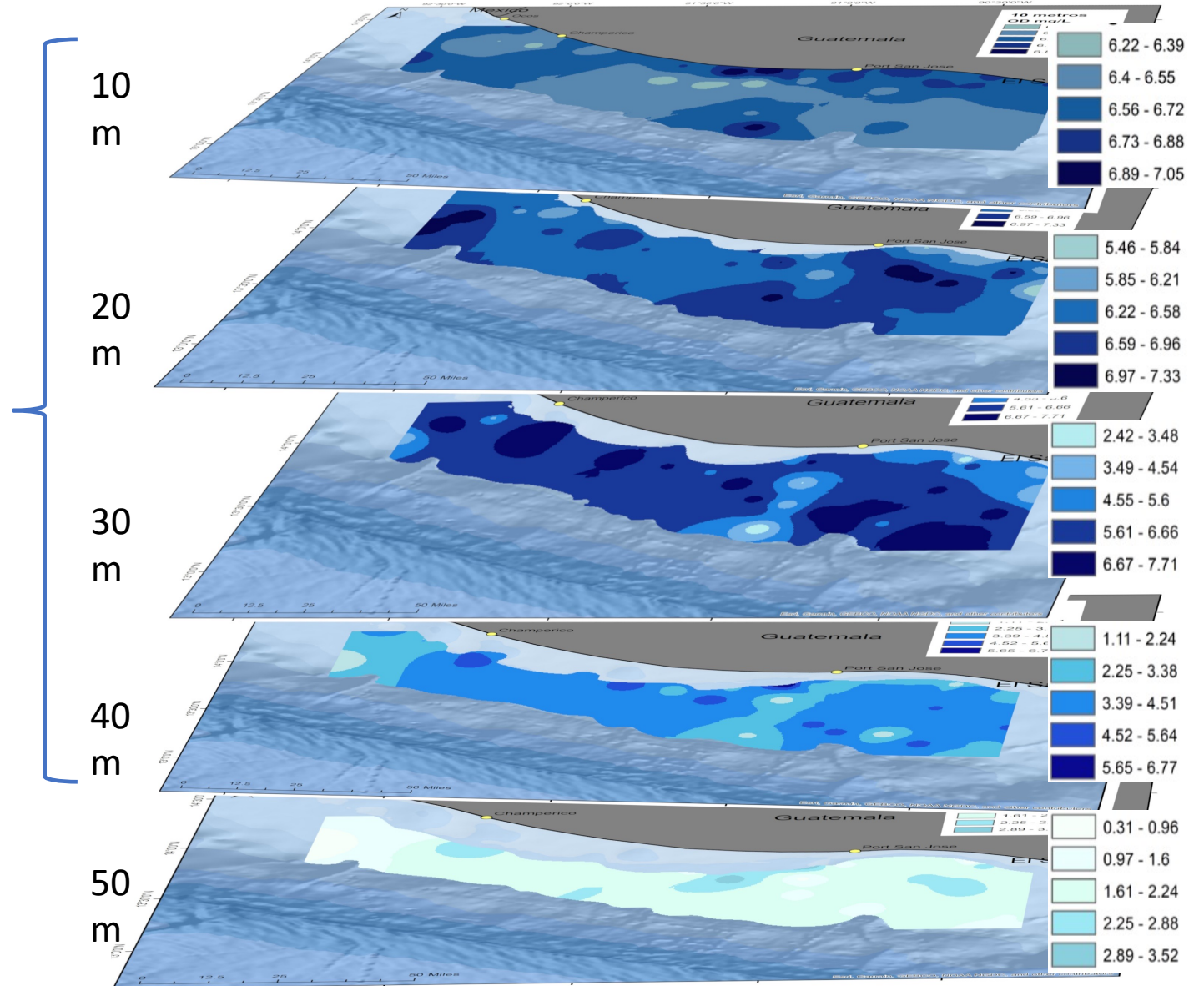


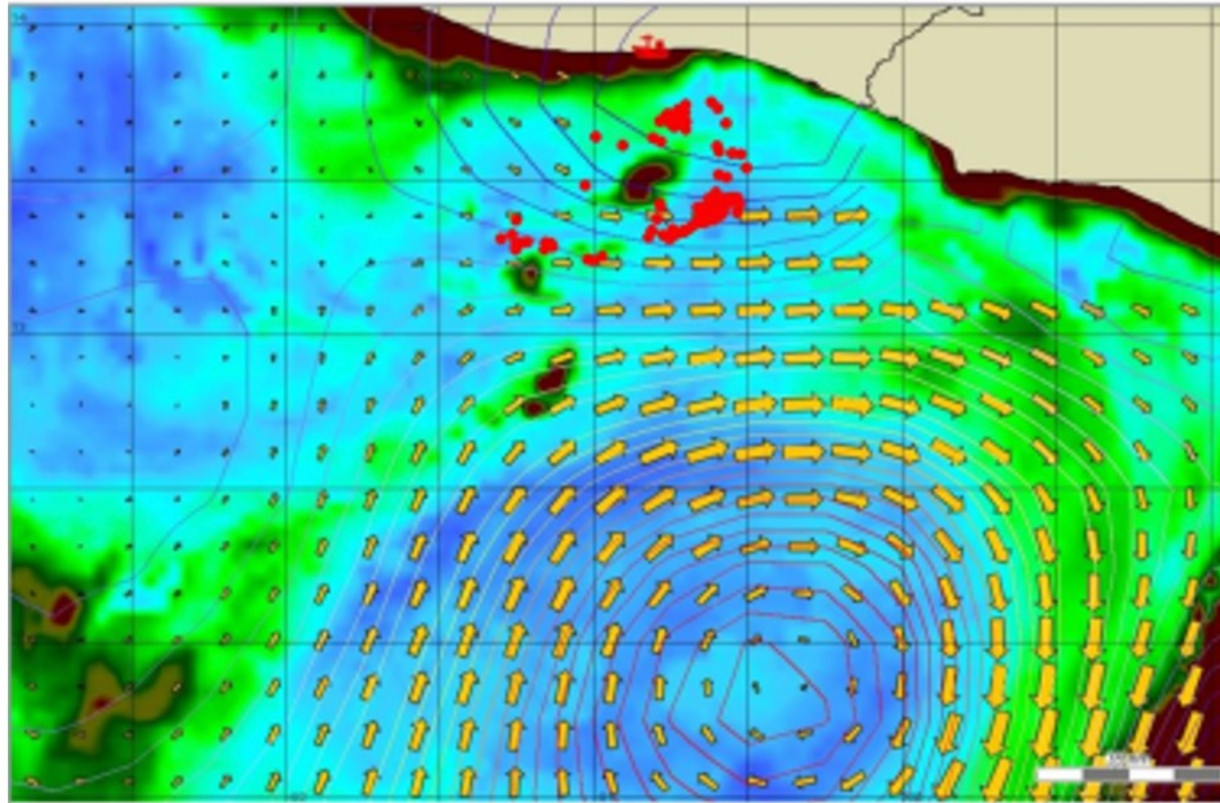
Source B. Pohlot UM PhD Dissertation
Pohlot and Ehrhardt (2017)



DO₂ spatial depth distribution off Guatemala

Preferred residence range of active satellite tagged Sailfish



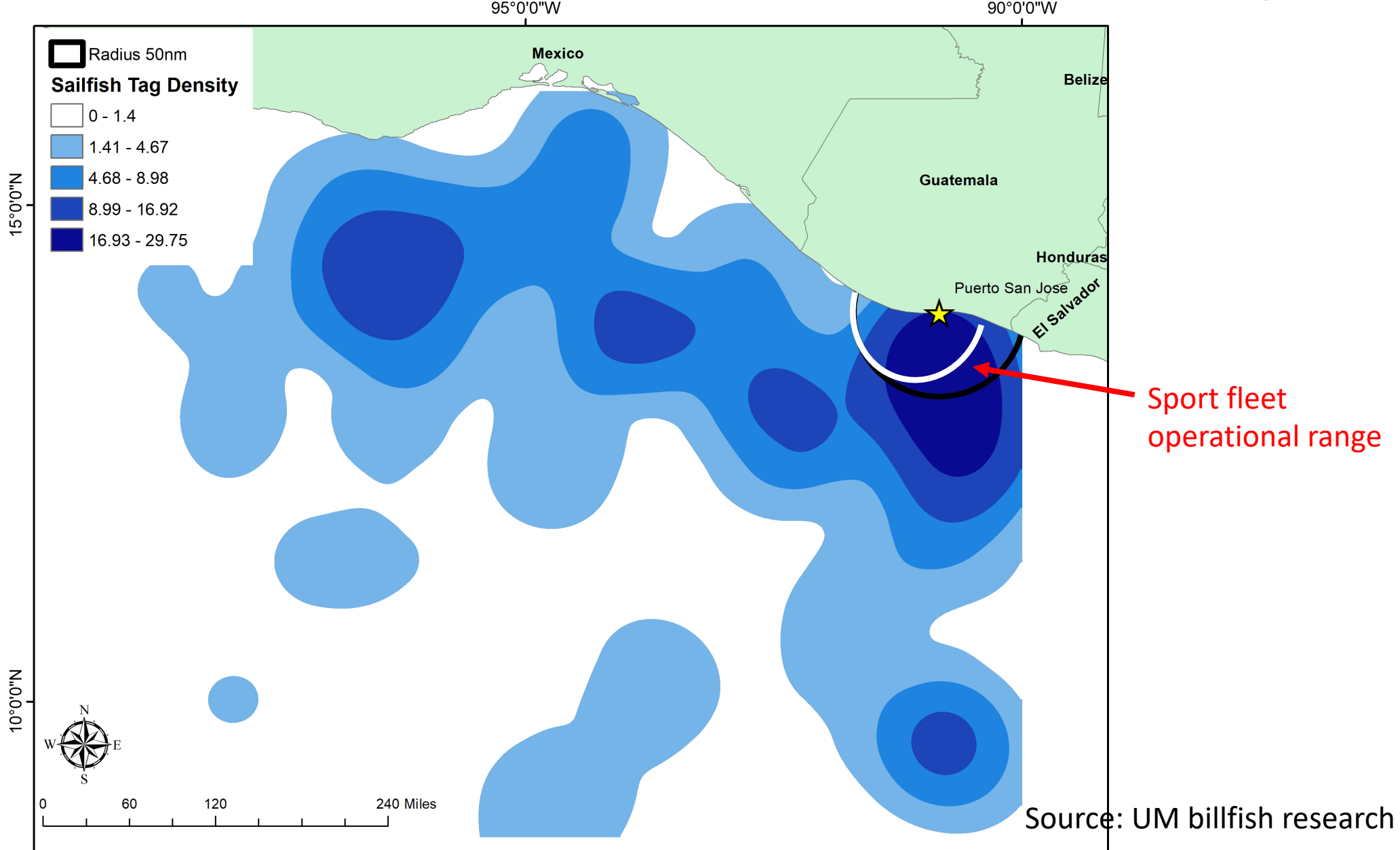


Source: UM PhD Dissertation
M. Fitchett

Identifying billfish hotspots relative to oceanographic features is important to understanding behavior. Such feature include water color (chlorophyll concentration) and current patterns.

Spatial distribution of sailfish tagged during 2018

Guatemala Celebrity Fishing Tournament and sport fleet operational range

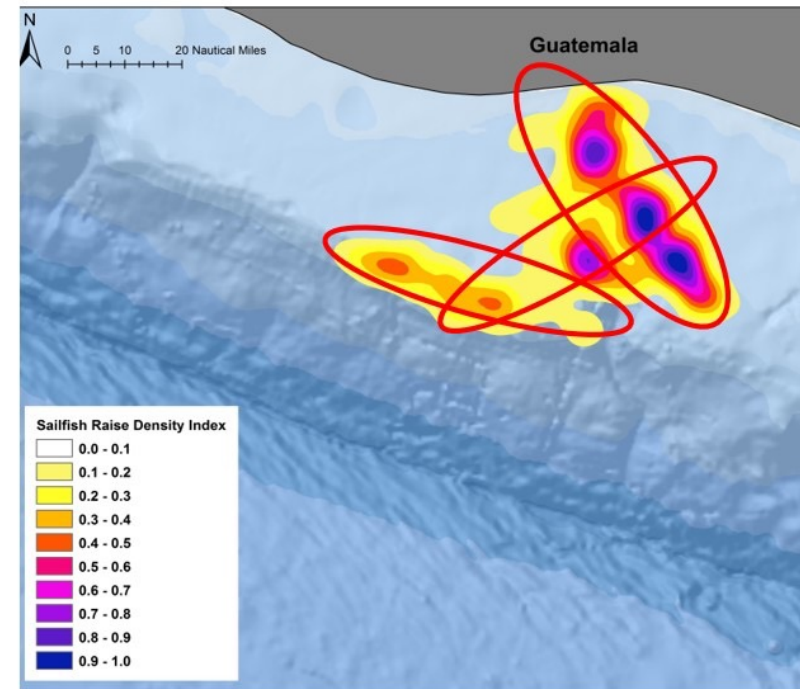
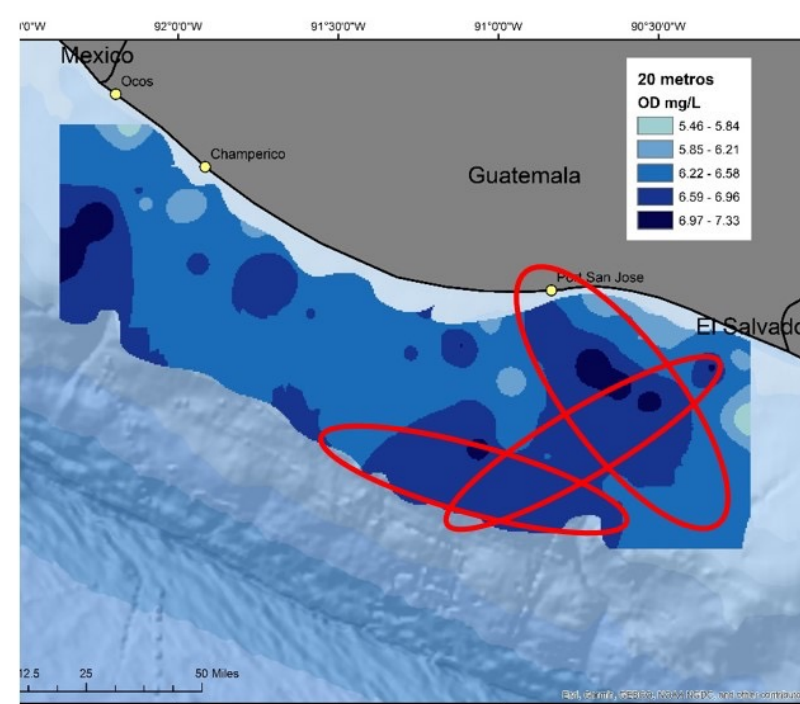


Distribution of maximum levels of dissolved oxygen at 20 meters depth

Recreational fishing concentrates in areas of increased DO_2 that attract Sailfish prey species creating hyper stable Sailfish catch rates.

Environmentally generated seasonal ecological trap

Distribution of catch rates in recreational fishing



The Message

Scientific research has been successful at defining behavioral dynamics of the seasonal availability and catchability of sailfish off the coast of Guatemala.

The results indicate a hyperstability of seasonal Sailfish catch rates

Increased seasonal vulnerability of sailfish to exploitation during periods of increased habitat compression dictates the need for strategic fishery regulations to protect the species at those times.

The Sailfish Conservation Commission in Guatemala is the first effort addressing the needs to strategically protect a valuable recreational fish species to coastal communities; however, research on core billfish scientific matters will be required and absence of research institutions dealing with such needs represents a major obstacle for billfish conservation.



This research would not have been possible without the sustained funding support by Tim Choate to the University of Miami and CABA

THANK YOU

Drs. Fitchett, Ehrhardt and Pohlot returning to port after tagging Sailfish off Guatemala