

# A statistical and spatial analysis of chemical contaminants in Cocos Lagoon, Guam

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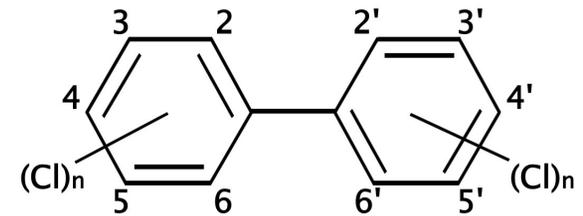
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# Background

- Cocos Lagoon is located on the southwestern corner of Guam, a U.S. island territory in Micronesia
- US Coast Guard operated had a LORAN navigation site on Cocos Island inside the Lagoon from 1944 to 1963
- Hazardous materials, including polychlorinated biphenyls (PCBs), were disposed of on land and in nearshore ocean exposing surrounding waters, sediment, fish species and also humans to these and other chemicals
- Local residents consume the fish as part of their regular diet, therefore there is concern about the health risks associated with consuming fish contaminated with PCBs



# Background: PCBs



- PCBs belong to a family of man-made organic chemicals known as chlorinated hydrocarbons
- Transformers and capacitors containing PCBs on Cocos Island were buried or dumped in the ocean, exposing the sediment and biota throughout Cocos Lagoon to these chemical contaminants
- PCBs are extremely persistent in the environment causing bioaccumulation by fish species
- PCBs biomagnification the PCBs in people who have ingest these fish
- PCBs can cause a variety of adverse health effects:
  - immune system suppression
  - reproductive system impacts (including birth defects)
  - cancer (EPA, 1996)

# Previous Research

- In 2014, the US Coast Guard have indicated the presence of chemical contaminants, particularly PCBs, on and in the area adjacent to Cocos Island
- In May 2015, NOAA's National Centers for Coastal Ocean Science (NCCOS) scientists, and local NOAA Coral Reef Conservation Program (CRCP) and sampled sediments and fish throughout Cocos Lagoon
- Samples collected were analyzed for approximately 190 chemical contaminants, including 82 PCB congeners



# Objectives

This study used the data generated from the NOAA sampling in Cocos Lagoon to:

- Conduct statistical analyses of PCBs in sediments from 25 aquatic sites, along with 27 fish tissue samples from 16 sites of these 25 sites
- Develop charts and tables displaying the results of the analyses to be incorporated into future NOAA reports and manuscripts
- Assess the human health risks associated with the chemical contaminants present

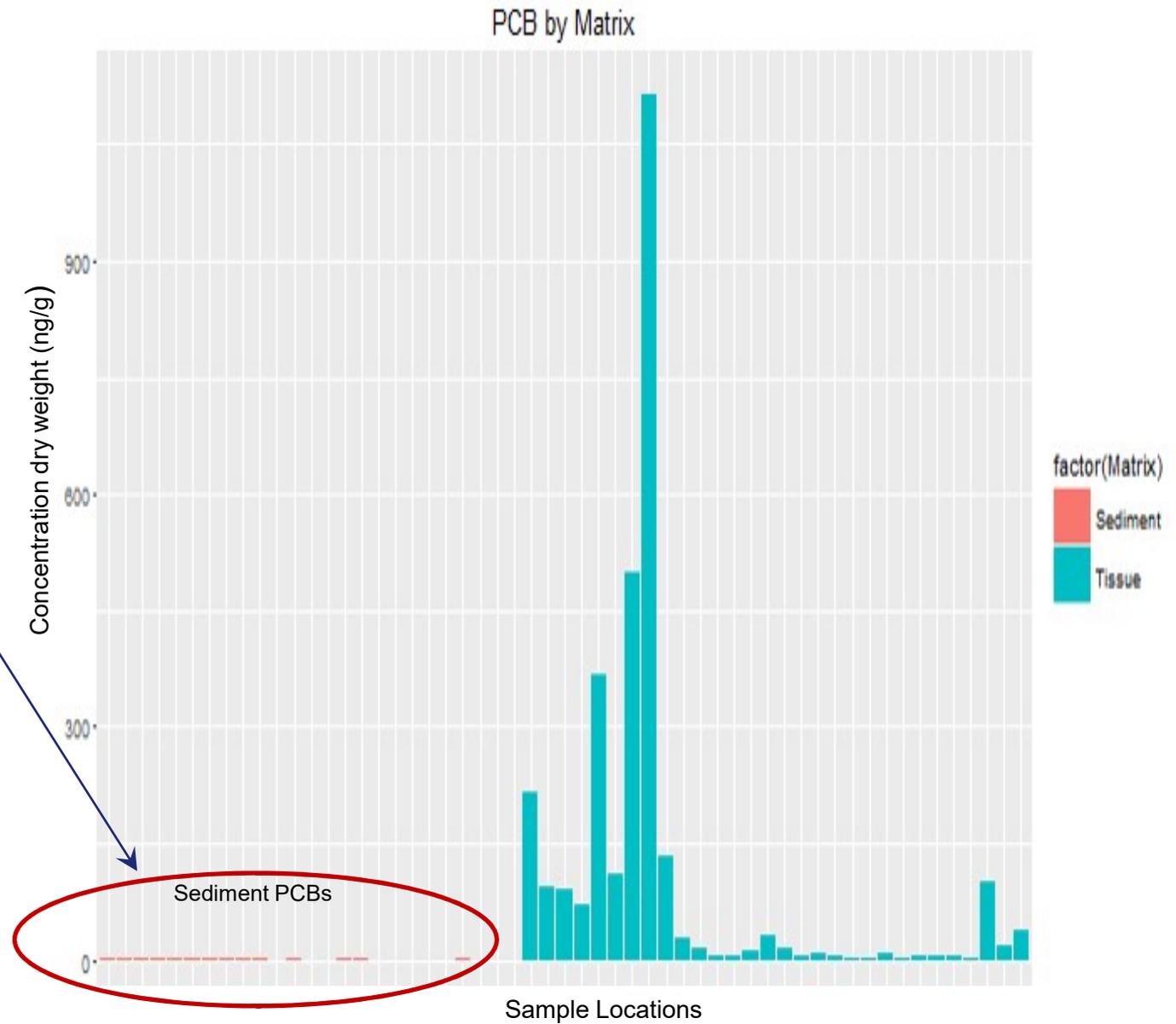
# Methodology

- ArcGIS: used to display the concentrations of PCBs in relation to EPA screening values
- Statistical Analysis Tools such as JMP (SAS product) and R to perform Non-parametric Wilcoxon test

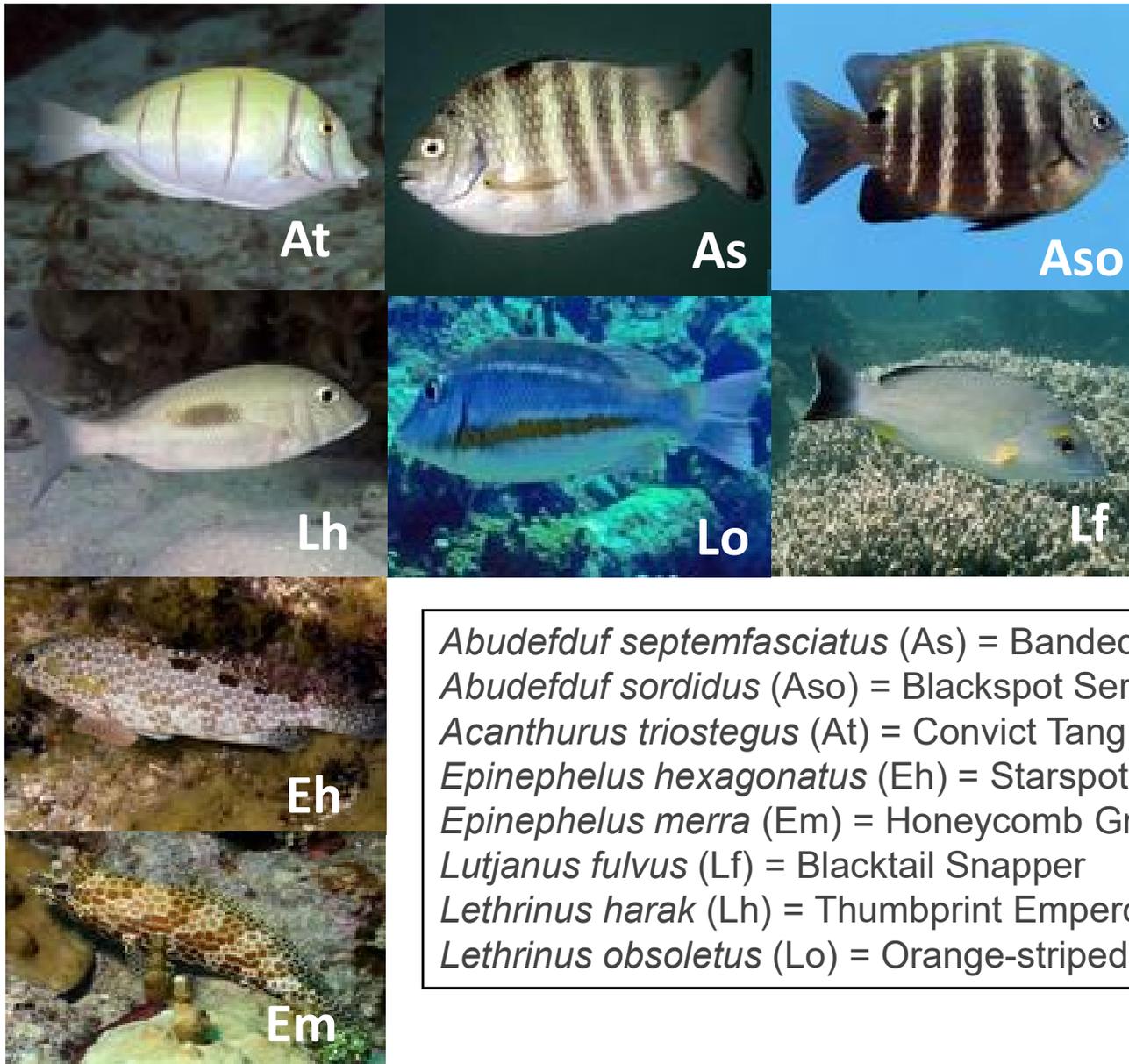


# Results

- PCBs in sediments were much lower, than in the fish samples ( $\leq 1.20$  ng/g)

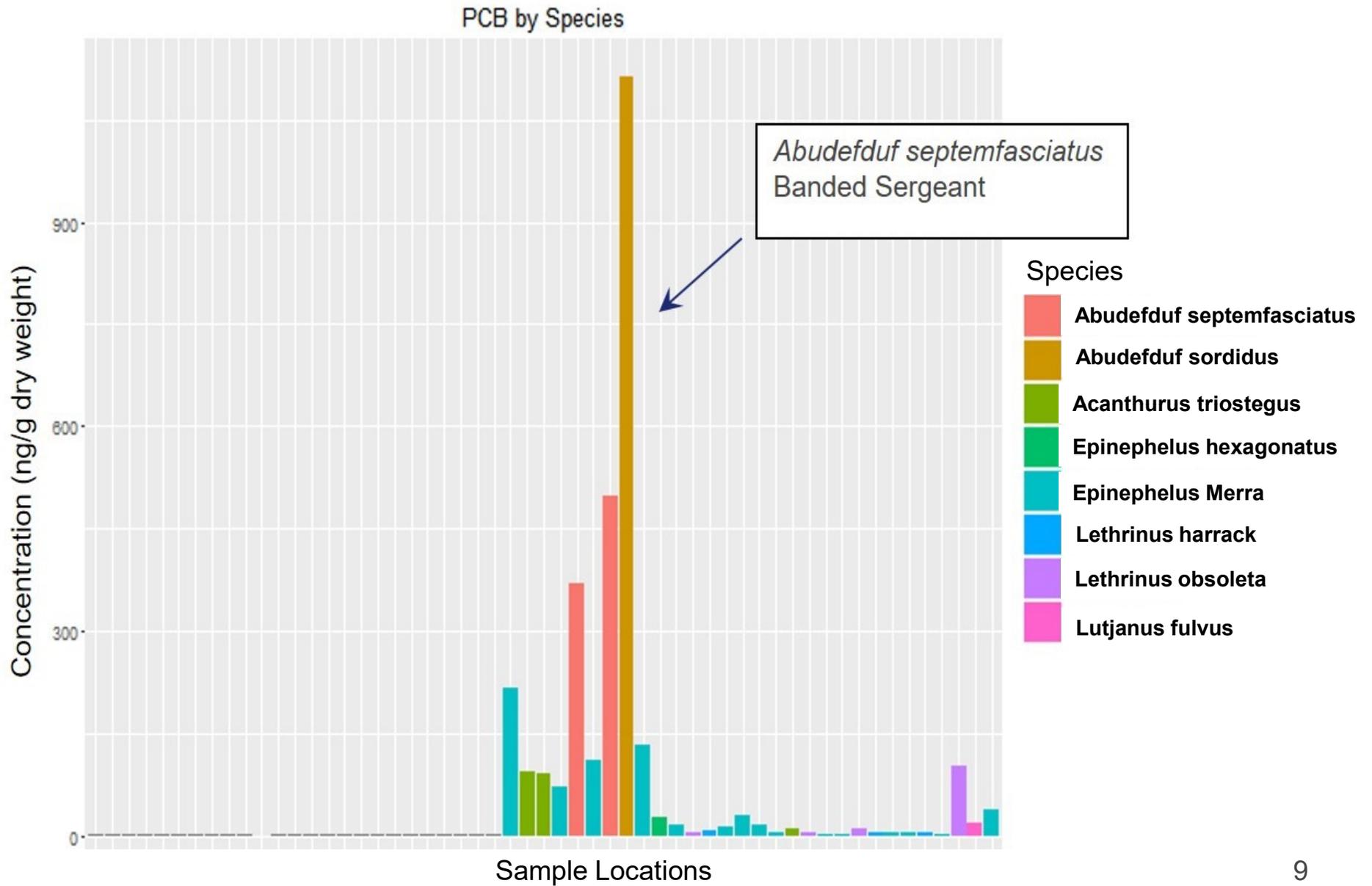


# Results: Fish Species Analyzed



*Abudefduf septemfasciatus* (As) = Banded Sergeant  
*Abudefduf sordidus* (Aso) = Blackspot Sergeant  
*Acanthurus triostegus* (At) = Convict Tang  
*Epinephelus hexagonatus* (Eh) = Starspotted Grouper  
*Epinephelus merra* (Em) = Honeycomb Grouper  
*Lutjanus fulvus* (Lf) = Blacktail Snapper  
*Lethrinus harak* (Lh) = Thumbprint Emperor  
*Lethrinus obsoletus* (Lo) = Orange-striped Emperor

# PCBs Results by Fish Species



# Results: EPA Screening Values

- Screening values (SV) have been developed by the USEPA to define the risk resulting from the consumption of fish by subsistence and recreational fishers
- SVs (concentration values in fish tissues) have been developed for both recreational fishers and subsistence fishers for total PCBs
- Subsistence fisher screening values are lower than recreational fishers, as subsistence fishers consume fish at a higher rate, perhaps on a daily basis
- Exceedance of these SVs should be taken as an indication that more intensive site-specific studies are needed

EPA screening value of PCBs for subsistence fishers = 2.45 ng/g (ppb)

EPA screening value of PCBs for recreational fishers = 20 ng/g (ppb)

Species

As = *Abudefduf septemfasciatus*  
Aso = *Abudefduf sordidus*  
At = *Acanthurus triostegus*  
Eh = *Epinephelus hexagonatus*  
Em = *Epinephelus merra*  
Lf = *Lutjanus fulvus*  
Lh = *Lethrinus harak*  
Lo = *Lethrinus obsoletus*

PCBs in Fish Tissue

**Red** (above EPA recreational Screening Value)

range = 20 – 338.46 ng/g ww

**Yellow** (above EPA subsistence Screening Value)

range = 2.45 – 19.99 ng/g ww

**Black** (no EPA exceedence)

range = 0.14 – 2.44 ng/g ww

p-value = < 0.0001



● Fish Collection site

# Summary

- PCBs in sediments ( $\leq 1.20$  ng/g) were much lower indicating no concern compared in the fish samples
- Concentrations of polychlorinated biphenyls (PCBs) in biota were above the EPA subsistence screening value, and even the recreational fishers screening value (SV) for some fish species around Cocos Island
- Indicates risk to humans, particularly subsistence fishers consuming fish, particularly from around Cocos Island
- Based on my results Cocos Lagoon has been shut down imposing economic and recreational losses on the adjacent communities

# Next Steps

- To better protect human health and the environment further work by the USEPA, USCG, and Guam EPA may include additional remediation of the former USCG LORAN site, and/or the monitoring of chemical contaminant concentrations in water and biota adjacent to Cocos Island
- In conjunction with recent biota testing results, the NOAA results will be used to assess the current fishing advisory area within Cocos Lagoon
- During the Fall, I will write the results of my analyses that will be included in report and submit for publication as a NOAA tech memo, and journal article.
- My future aspirations are to attend UC Davis for graduate school to pursue a Ph.D in water science

# Literature Cited

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