US Informal sea turtle WS
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Hooking location of leatherback turtles by hook types in longline fisheries

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Introduction

- One of major concerns in longline fisheries is bycatch of sea turtles
- Various hook types are used in longline fisheries
- The impact on individuals varies depending on the hooking location or hook type

However ...

Only a few studies focused on hooking locations in the Japanese tuna hook (Huang et al. 2016)

Not well be focused on hooking location of leatherback turtle

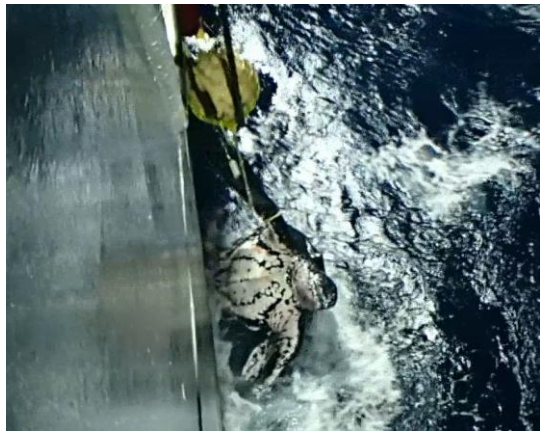
The aims for this study

Investigating the hooking location in the Japanese tuna hook

Reviewing the hooking location of leatherback turtle

Materials and methods

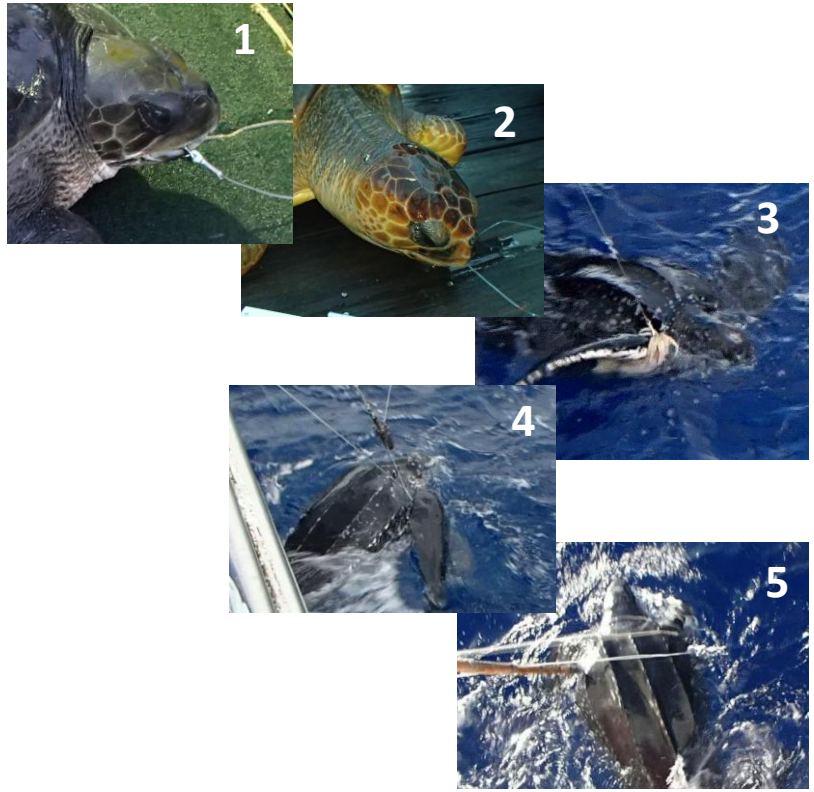
- Images and/or videos recorded by scientific observers were checked
- Species and hooking locations were identified
- Recorded in the all of oceans in 2011–2024
- Images of a total of 1,200 individuals (all species) were investigated



Materials and methods

Categorized in 5 patterns as follows;

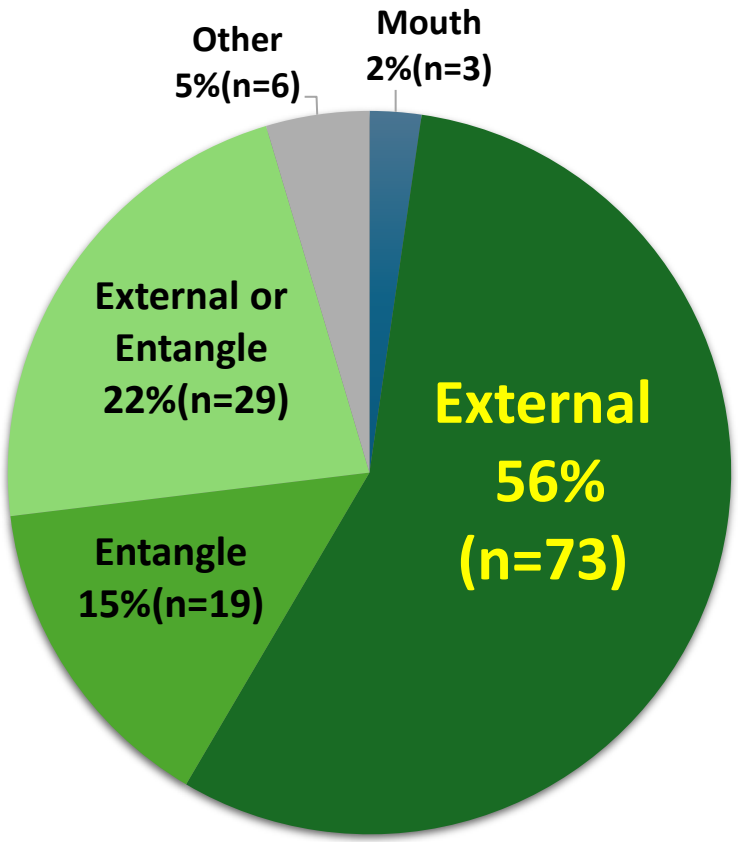
1. Mouth-hooking
2. Swallowed or hooked in mouth
3. External hooking (hook visible)
4. Entangled (tangled and not hooking)
5. Other than branch line



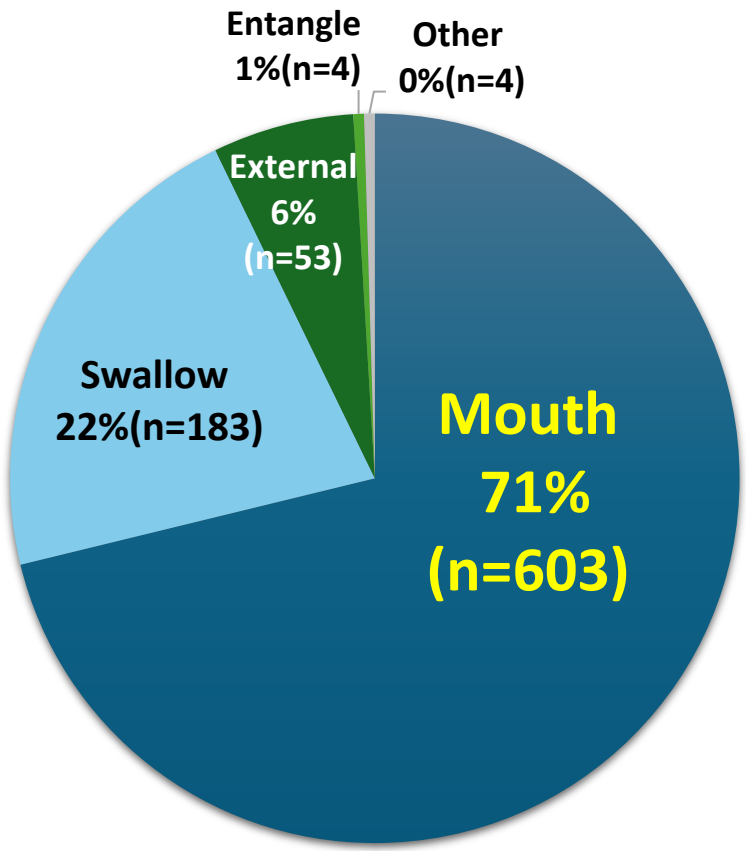
Hooking location was summarized by species

Results: Hooking location by species

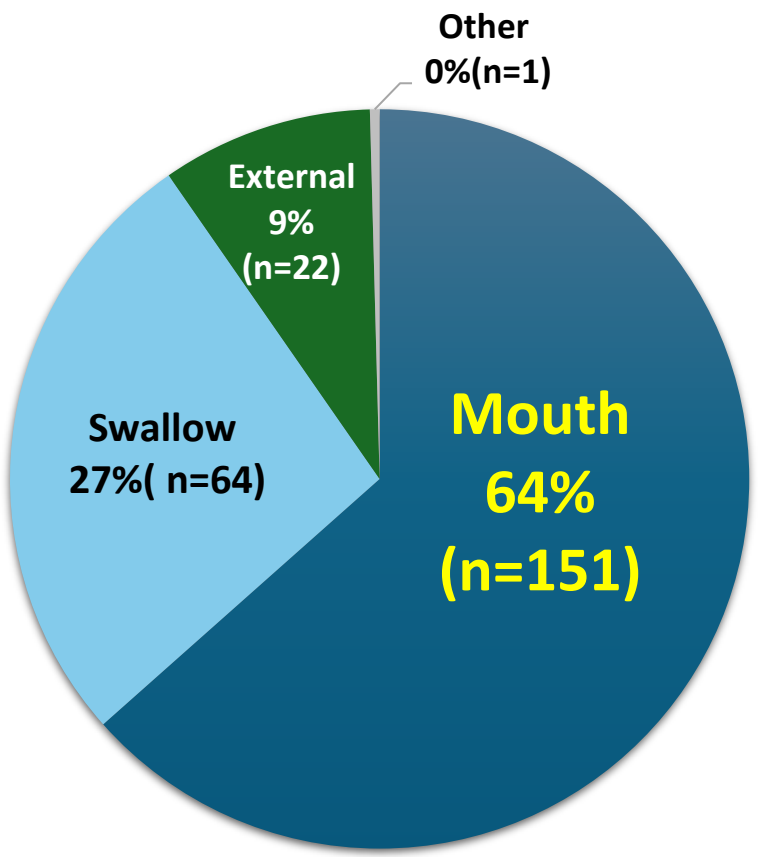
Leatherback (N=130)



Loggerhead (N=847)



Olive ridley (N=238)



External or entangled

Mouth-hooking or swallowing

Mouth-hooking was ***only 2% (3 cases)*** recorded for ***leatherback***

Results: Review of studies regarding hooking locations

J-hook vs Large circle hook

Hook type	The ratio of external or entanglement	No. of leatherback bycatch
J – non offset	74.5%	47
J – offset	70-100%	17-96
Large C – non offset	70-100%	4-137
Large C – offset	60-100%	5-70

（Coelho et al. 2015; Epperly et al. 2012; Read 2007; Sales et al. 2010; Santos et al. 2012, 2013; Stokes et al. 2012; Watson et al. 2005）

Majority of hooking location of leatherback in J-hook and large C-hook

External and entanglement

Results: Review of studies regarding hooking locations

Japanese tuna hook vs Large circle hook

No. of indiv.	Tuna	Large C
Entangled	**19**	
External	**11**	**11**
Internal	5	6
Unknown	2	1

No. Indiv.	Logger head	Olive ridley	Leather back
Tuna	1	3	14
Large C		3	15
Entang		1	18

(Huang et al. 2016)

No. of studies on tuna hook is limited but this is still **the best available information**

Majority of hooking location of leatherback in Jpn. tuna hook and large C-hook

External and entanglement

Discussions: Hooking location by species

Mouth-hooking were only 2% (3 cases) recorded for leatherback

Previous studies showed similar results in the Atlantic

（e.g. Watson et al. 2005; Epperly et al. 2012; Coelho et al. 2015; Huang et al. 2016）

Leatherbacks were bycaught by external hooking or entangled regardless hook types

Injuries by hook shape for leatherback

Large circle hook inflicts more serious injuries than the J-hook for foul hook

（Parga, M. in the 1st circle hook WS）

Using more large circle hooks can severely injure more leatherback

Bycatch mitigation measures for hardshell turtle vs. leatherback

The process and mechanism leading to bycatch may be completely different

Discussions: Bycatch rates of leatherback by hook type

J-hook vs large circle hook and shallow-set longline

The bycatch rates by hook types varied depending on the study

(Coelho et al. 2015; Foster et al. 2012; Mejuto et al. 2008)

→ Unable to conclude the effectiveness of large C-hook

Japanese tuna hook vs large circle hook and deep-set longline

Bycatch rates of the Japanese tuna hook and large C-hook are similar for leatherback

The use of relatively wider circle hooks was not associated with fewer sea turtles captured

(Huang et al. 2016)

→ **No evidence to reduce leatherback bycatch by using large C-hook instead of tuna hook**

Need more studies

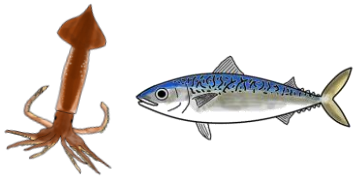
to identify what is effective components

what should be considered for the analysis

Discussions: Bycatch rates of leatherback by hook type

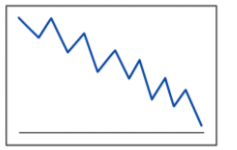
Expected reasons for difference of bycatch rates in shallow-set by study

1. Confounding effects of bait species



   Some studies show evidences of bycatch reduction by changing the bait from squid to mackerel
   However, many review studies doesn't consider to this point to avoid the no. of datasets reduction

2. Population trends may affect the results of comparisons



   Some studies compared to the bycatch rates among different years

3. There is difference in bycatch rates depends on the position of foul hook

   All the external hooking (e.g. hooking in the forelimb and carapace) are categorized in foul hook
   However, the catchability (ease of hooking) may be different by the body parts

4. Difference of hook shape even same category is affected bycatch rates

   There is various shapes excluding size even same categories of C-hook

5. The possibility of existence of effects by offsets

Too premature to evaluate the effectiveness of current mitigation measures on bycatch reduction of leatherback turtle

Conclusions

- Leatherbacks are mainly bycaught by external hooking or entanglement
- Using many large circle hook can be injured more leatherbacks
- Bycatch rate of the Japanese tuna hook is like that of large C-hook
- Changing bait type is still effective for leatherback bycatch rates reduction
- Needs more studies on the effective component of leatherback bycatch reduction

Bycatch risk analysis for three sea turtle species in the WCPO under data-limited conditions

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Key Points of Analysis

- **Purpose:**
  Estimation and visualization of bycatch risk of leatherback turtle (including loggerhead turtle and olive ridley)

- **Analysis data:**
  Bycatch records for leatherbacks, loggerheads, and olive ridleys
  The Japanese longline scientific observer program during 2011-2019
  Environmental data (sst, O_2, chlorophyll a)

- **Challenges:** Data poor (sparse and coarse) due to small number of bycatch of leatherback turtle

Key Points of Analysis

- **Problems:**

  Zero inflation

  Almost no leatherback bycatch records

  Different bycatch rates for the three species in shallow and deep sets

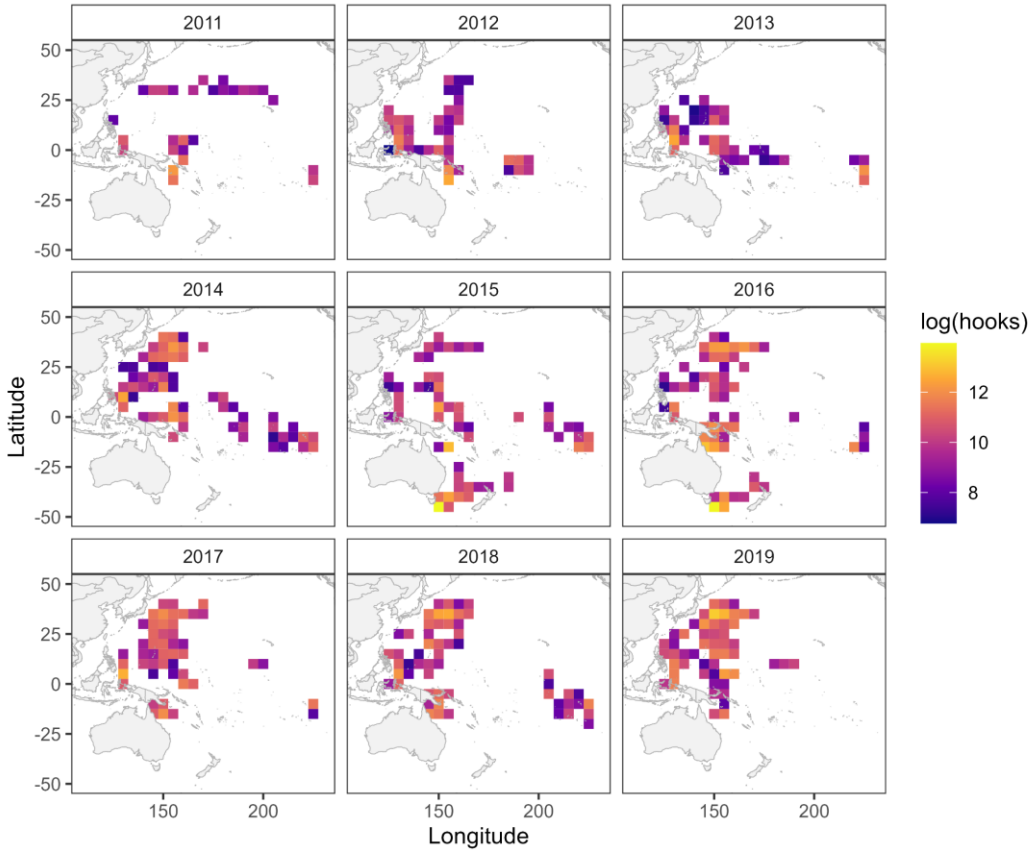
- **Solutions:**

  Aggregate data to a 5°x5° grid for minimum usability

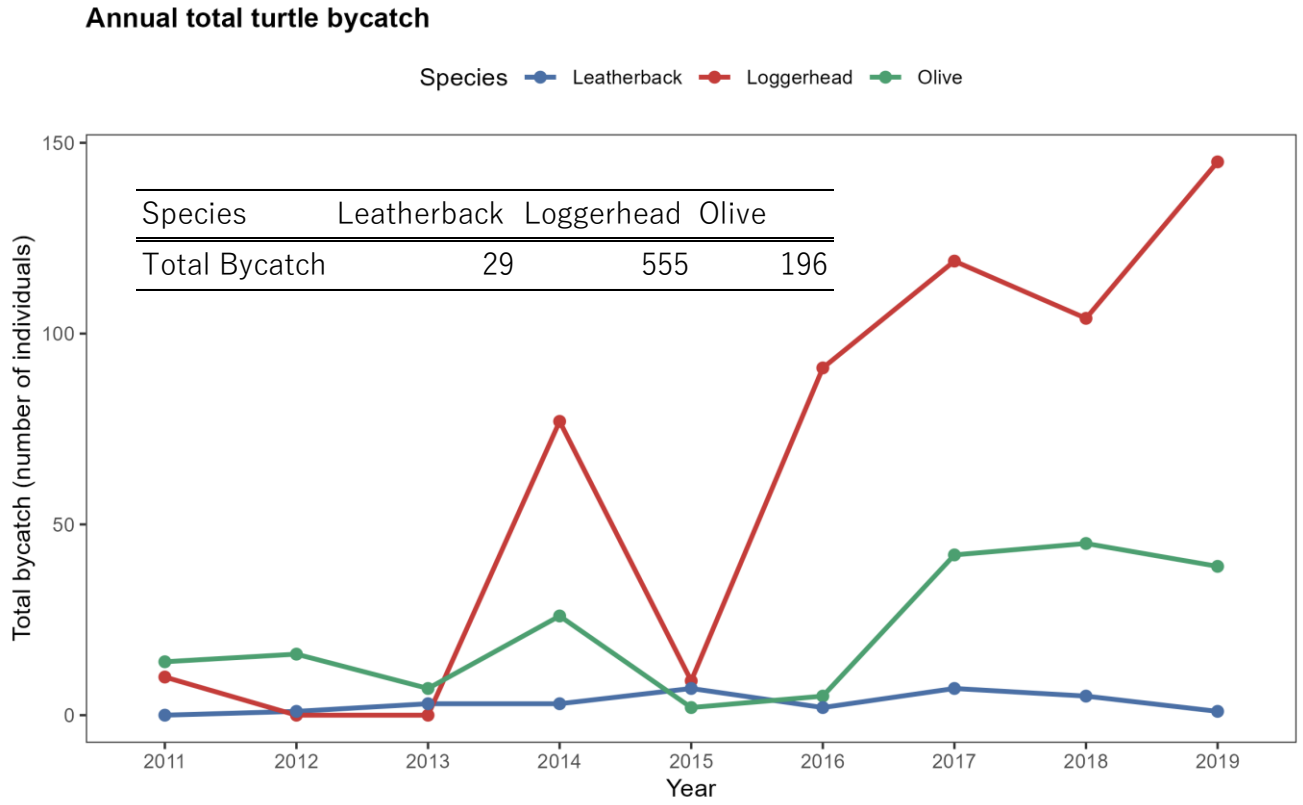
  Address zero inflation using a zero-inflated negative binomial model

  Attempt spatiotemporal smoothing estimation through information borrowing by assigning species-common variance as a basis function

Longline Bycatch Data



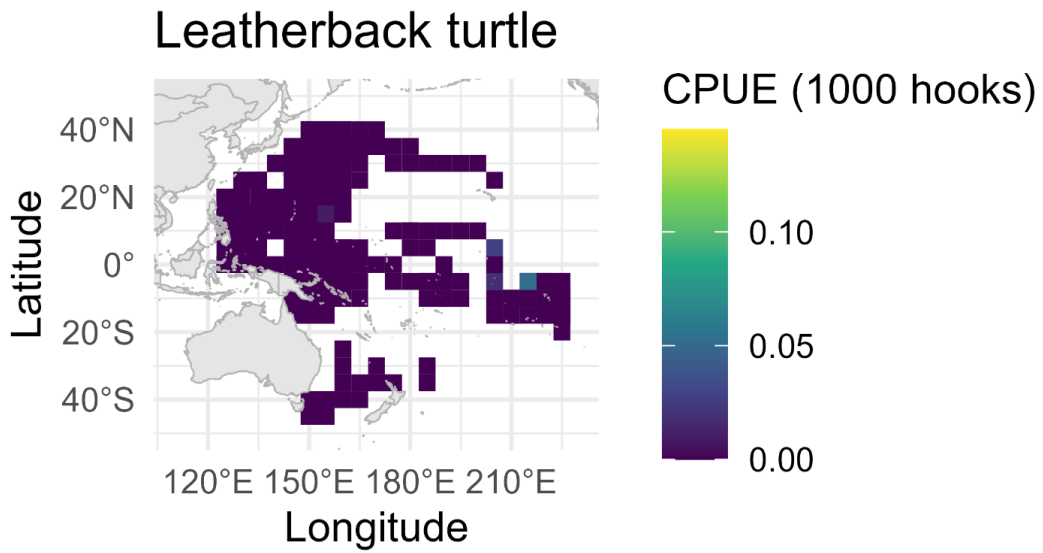
Distributional maps of No. of hooks observed by year

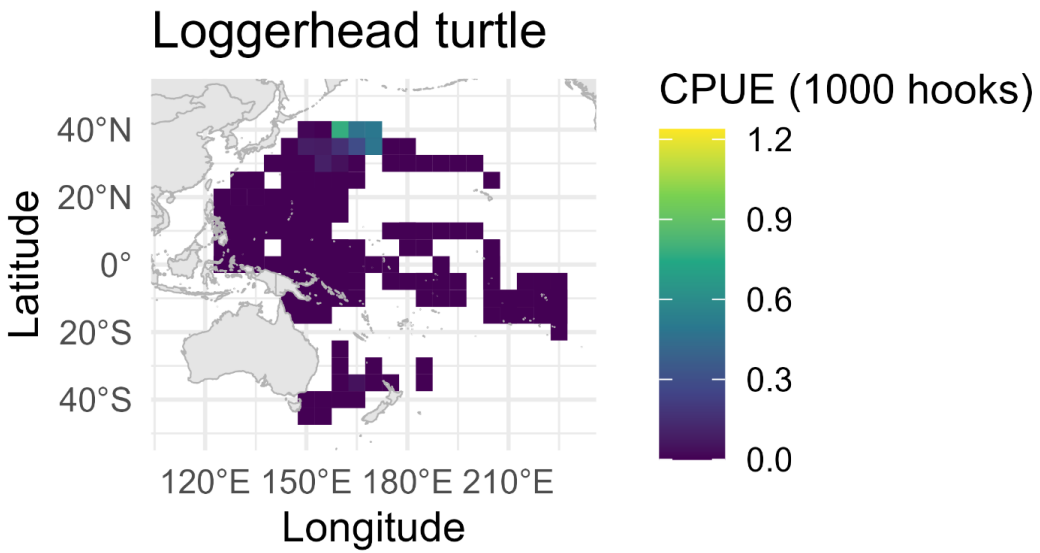


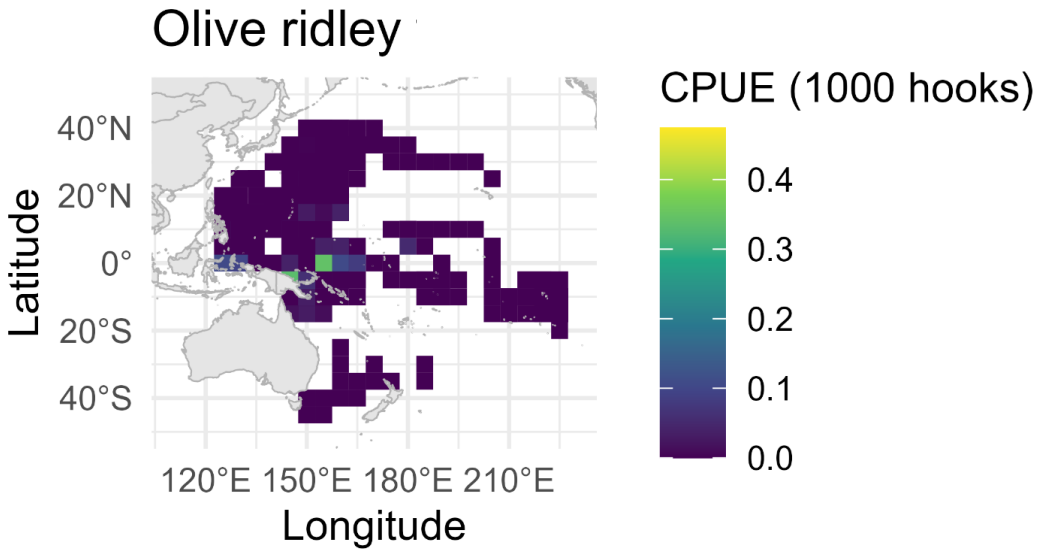
Species	Leatherback	Loggerhead	Olive
Total Bycatch	29	555	196

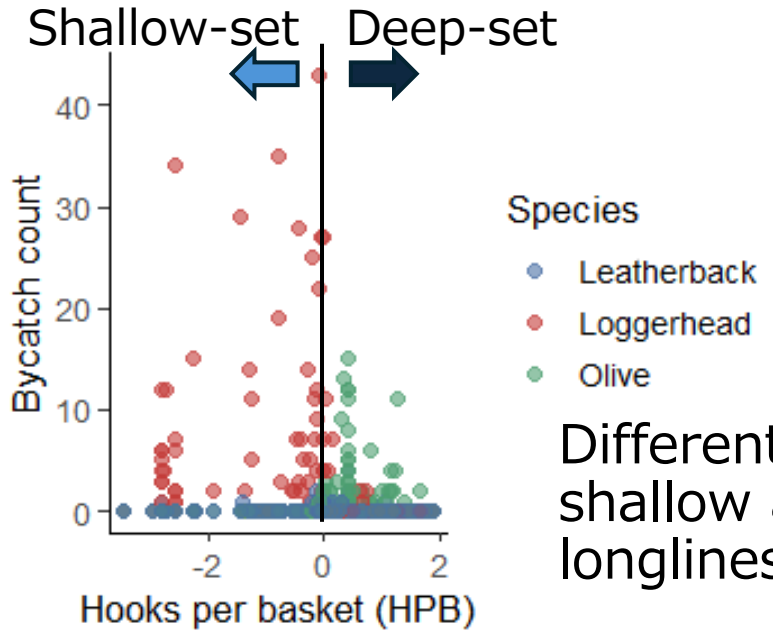
Yearly trends of No. of bycatch by species

Bycatch rate (CPUE)



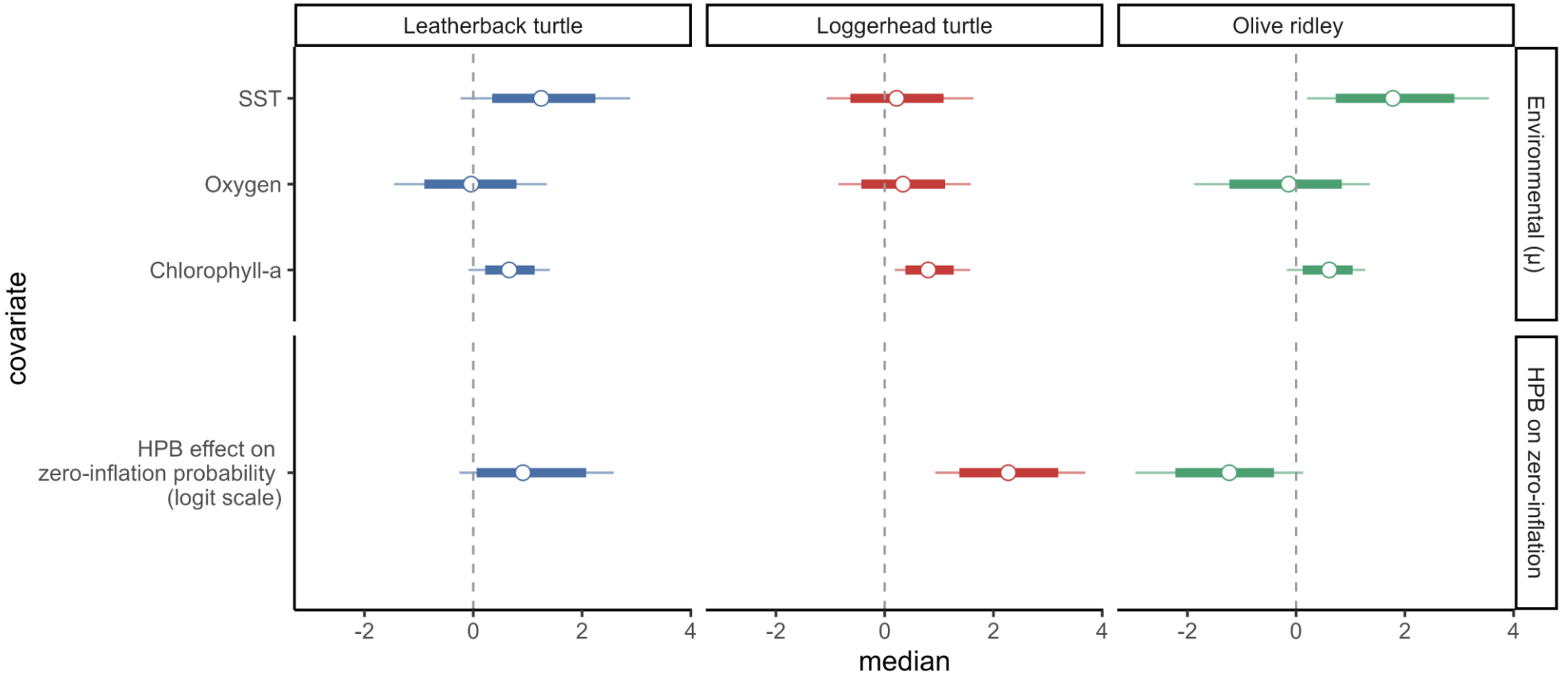


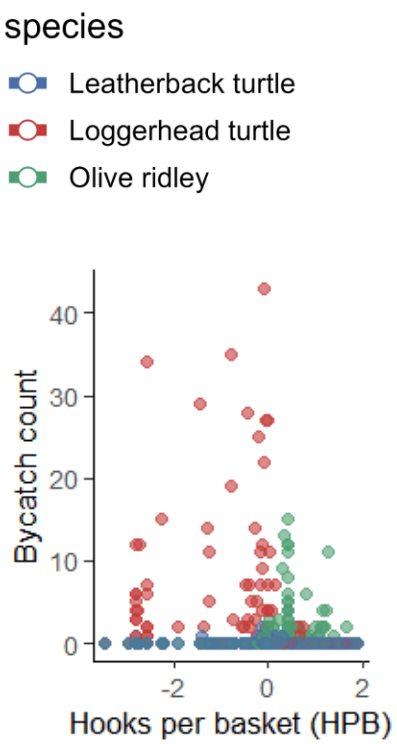




Different bycatch rates in shallow and deep-set longlines by species

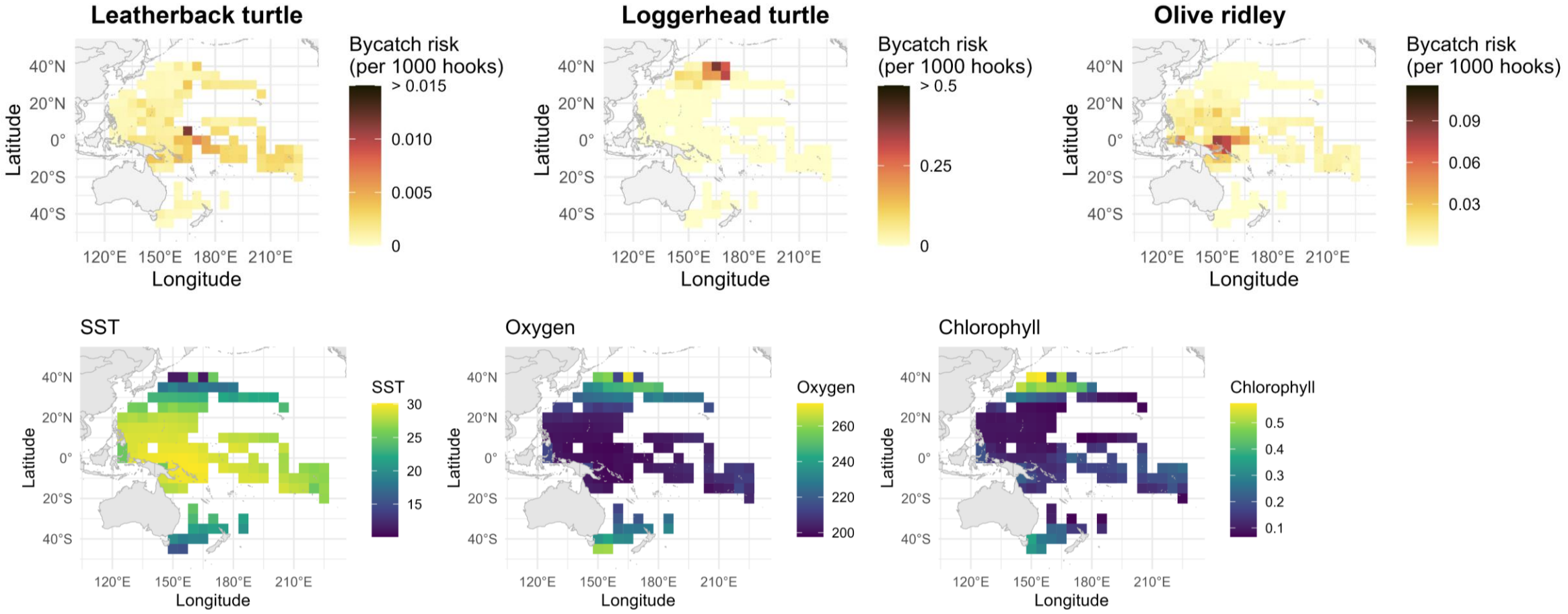
The impact of the environmental parameters on bycatch numbers (median with 95 & 80%CI)





Leatherback & Loggerhead: shallow set
Olive ridley: deep set

Bycatch risk based on estimated relative density



In areas relatively rich in food sources (≒ High Chl.)

Leatherback turtles and olive ridleys are bycaught in warm waters

Conclusions

Gear depth differentiation

Leatherback & Loggerhead → shallow-set longlines

Olive ridley → deep-set longlines

Environmental drivers

High chlorophyll-a (≒ nutrient including jellyfish rich)

→ increased bycatch risks for all species

Warm SST → higher risk for leatherback & Olive ridley

Risk magnitude

Leatherback is the lowest encounter rates and overall risk, and higher risk in tropical than temperate waters

Management implications

- **Overall bycatch risk of leatherback is very low level**
- **Spatially concentrated in tropical waters**

◆Spatially heterogeneous risk and low overall interaction rates

→Expanding mitigation measures to all deep-set longline fisheries may not reduce leatherback bycatch

◆Bycatch risk of leatherback is low and spatially limited in tropical waters

→Implementation of measures focusing on relatively high-risk tropical waters (e.g., certain EEZs) may be more cost-effective

Summary

Methodological contributions

- ◆Developed a **multi-species bycatch model** robust to sparse data
- ◆Considering **false negatives** via HBF in the observation process
- ◆Enables estimation of environmental effects on bycatch risk
- ◆Scalable framework for integrating multinational datasets

Broader Implication

- ◆ Provides a framework for improved **Pacific leatherback risk assessment**
- ◆ Supports future **cross-national data integration**

This report is still preliminary

We would like to discuss continuously in SC22


Thank you for your attention