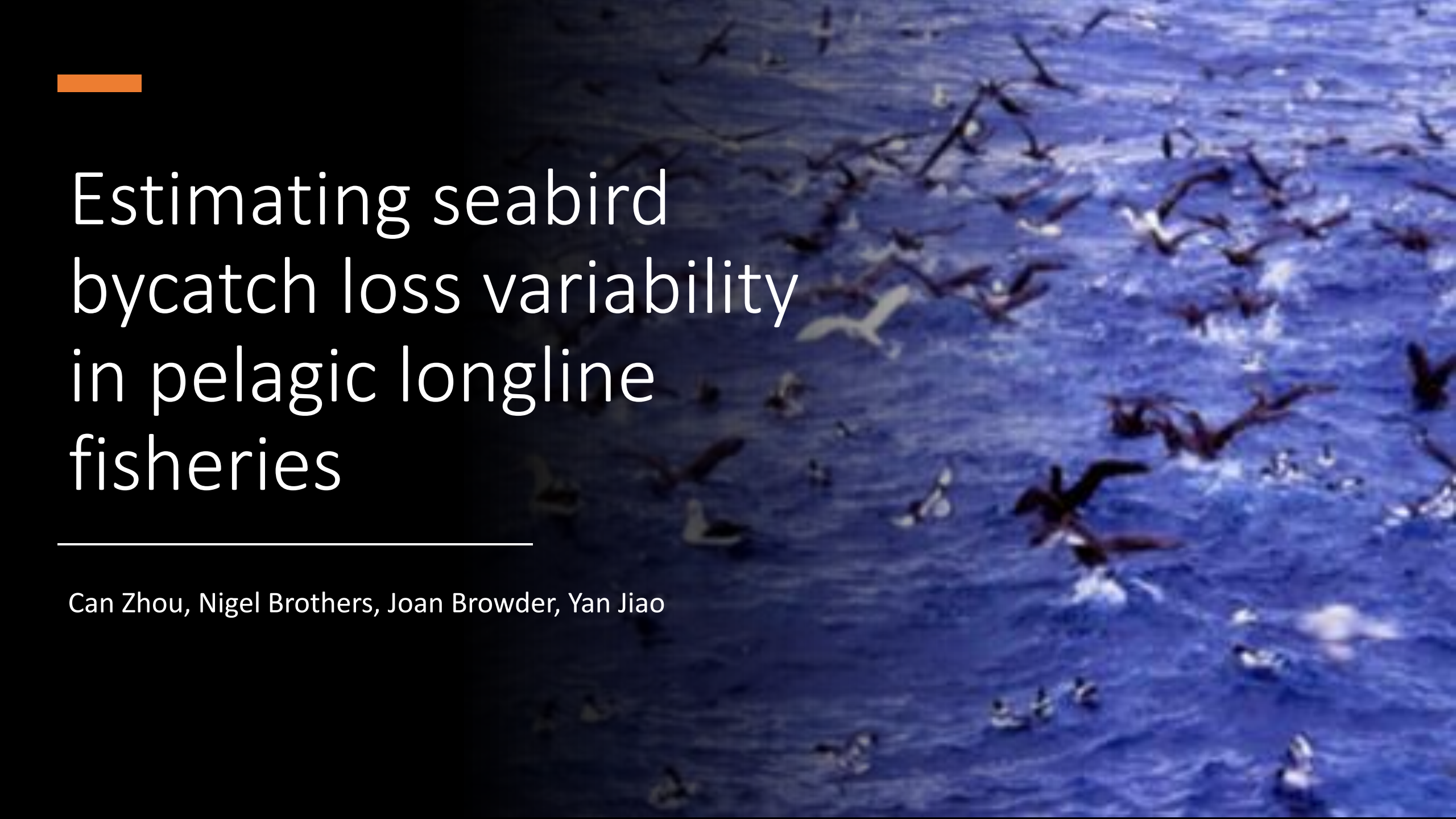
Estimating seabird bycatch loss variability in pelagic longline fisheries

Can Zhou, Nigel Brothers, Joan Browder, Yan Jiao



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Seabird bycatch loss rate variability in pelagic longline fisheries

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ARTICLE INFO

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Cryptic bycatch

ABSTRACT

The incidental mortality of seabirds from fisheries ranks as the greatest threat impacting seabirds globally. However, its impact on seabird populations may have been substantially underestimated due to lost, undetected bycatch. To estimate the full extent of the bycatch problem, knowledge about the magnitude and variability of lost bycatch is necessary. Based on a long-term dataset, this study aims to facilitate the loss-corrected bycatch estimates for pelagic longline fisheries that do not have a concurrent bycatch loss observation component. We analyze information from all types of fishery interactions of seabirds to improve the estimate of bycatch loss rate and also reveal its variability. Specifically, we analyze how environmental and ecological factors affect seabird bycatch loss rate using Bayesian state-space models. Results show strong species effects in the bycatch loss rate. Inclement weather and strong competition among seabird species also affect bycatch loss rate. Estimates of the species-specific bycatch loss rate indicate that, for some species, the loss can well exceed the average loss rate, suggesting that seabird bycatch loss cannot be further ignored in assessing the fishery impact on seabird populations. To gauge the full scale of seabird bycatch, it is critical to account for this lost bycatch in bycatch assessments, at minimum, using an average loss rate with the ultimate goal of species-specific loss-corrected assessments.

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BIOLOGICAL CONSERVATION

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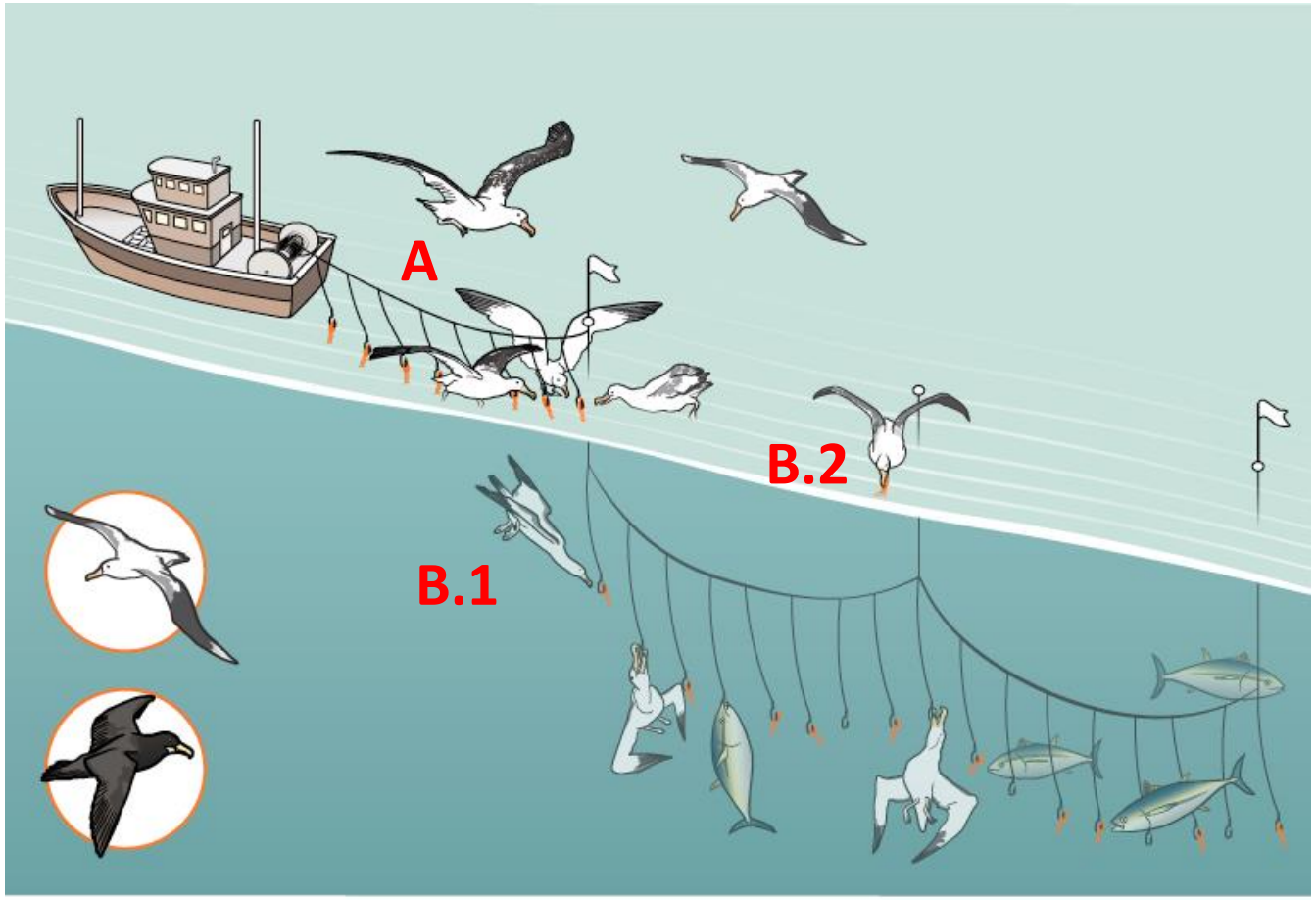
Fisheries bycatch: a major threat to seabirds

- At least 160,000 annually [1]
- Top factor by impact [2]
- Threatens 17 albatross species
- Impacting 127 species [3]

[1] Anderson et al. 2011. Global seabird bycatch in longline fisheries. ESR 14, 91-106.
[2] Dias, M.P., Martin, R., Pearmain, E.J., Burfield, I.J., Small, C., Phillips, R.A., Yates, O., Lascelles, B., Borboroglu, P.G. and Croxall, J.P., 2019. Threats to seabirds: a global assessment.BIOC, *237*, pp.525-537.
[3] Pott and Wiedenfeld, 2017. Information gaps limit our understanding of seabird bycatch in global fisheries. BIOC 210, 192-204.

How seabirds are caught?



By **Emily Eng and Whitney Pipkin**
SMITHSONIANMAG.COM
AUGUST 22, 2016

A. Surface feeders

B. Divers

. . .

Line setting

Soaking

Hauling

Both from N. Brothers

Before this study

Haul-only bycatch monitoring is insufficient

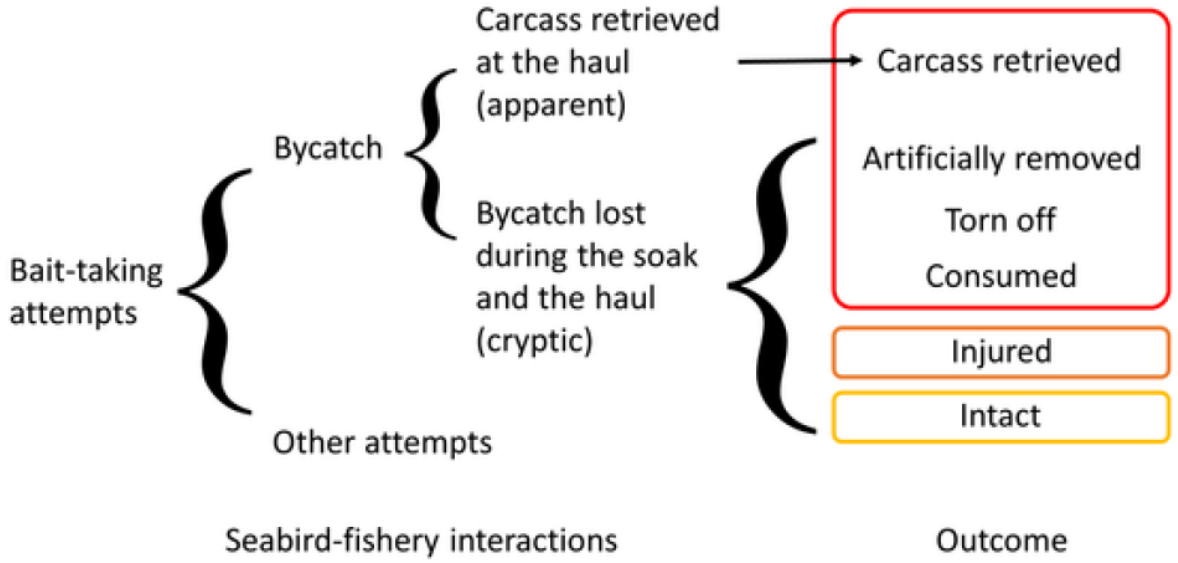
- Only records any catch/bycatch remaining on the hook
- Majority of the interactions occur at line setting [4,5]
- ~ 50% of the observed captures not retrieved [6]

[4] Brothers et al. 1999. The influence of environmental variables and mitigation measures on seabird catch rates in the Japanese tuna longline fishery within the Australian Fishing Zone, 1991–1995. BIOC 88, 85-101.
[5] Zhou et al. 2019. How much do we know about seabird bycatch in pelagic longline fisheries? A simulation study on the potential bias caused by the usually unobserved portion of seabird bycatch. *PONE*, *14*(8), e0220797.
[6] Brothers et al. 2010. Seabird bycatch in pelagic longline fisheries is grossly underestimated when using only haul data. PONE 5, e12491.

What's missing?

How to adjust haul-only bycatch estimates?

- OK to multiply by 2?
- Integrated modeling [5]



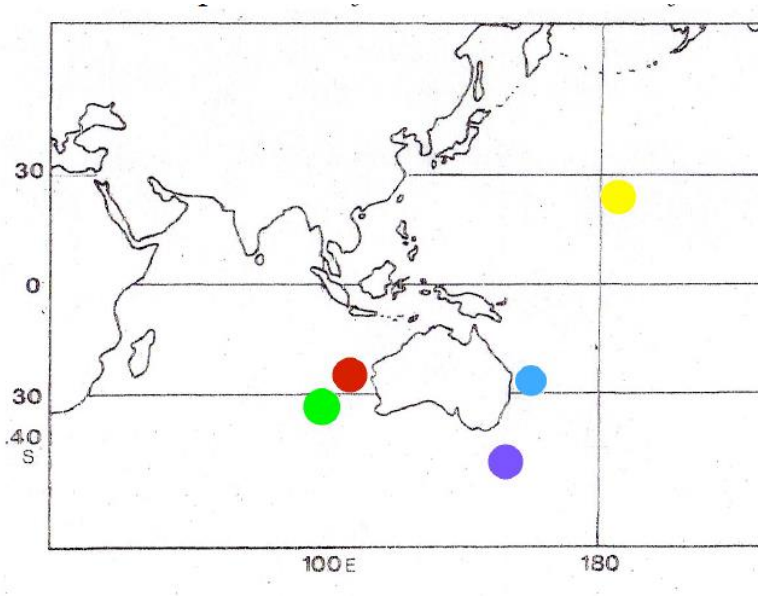
Which factors affect bycatch loss?

- Physical oceanic condition
- Competition (bycatch risk score)
- Species identity
- Foraging behavior (diving, scavenging)
- Fishing region

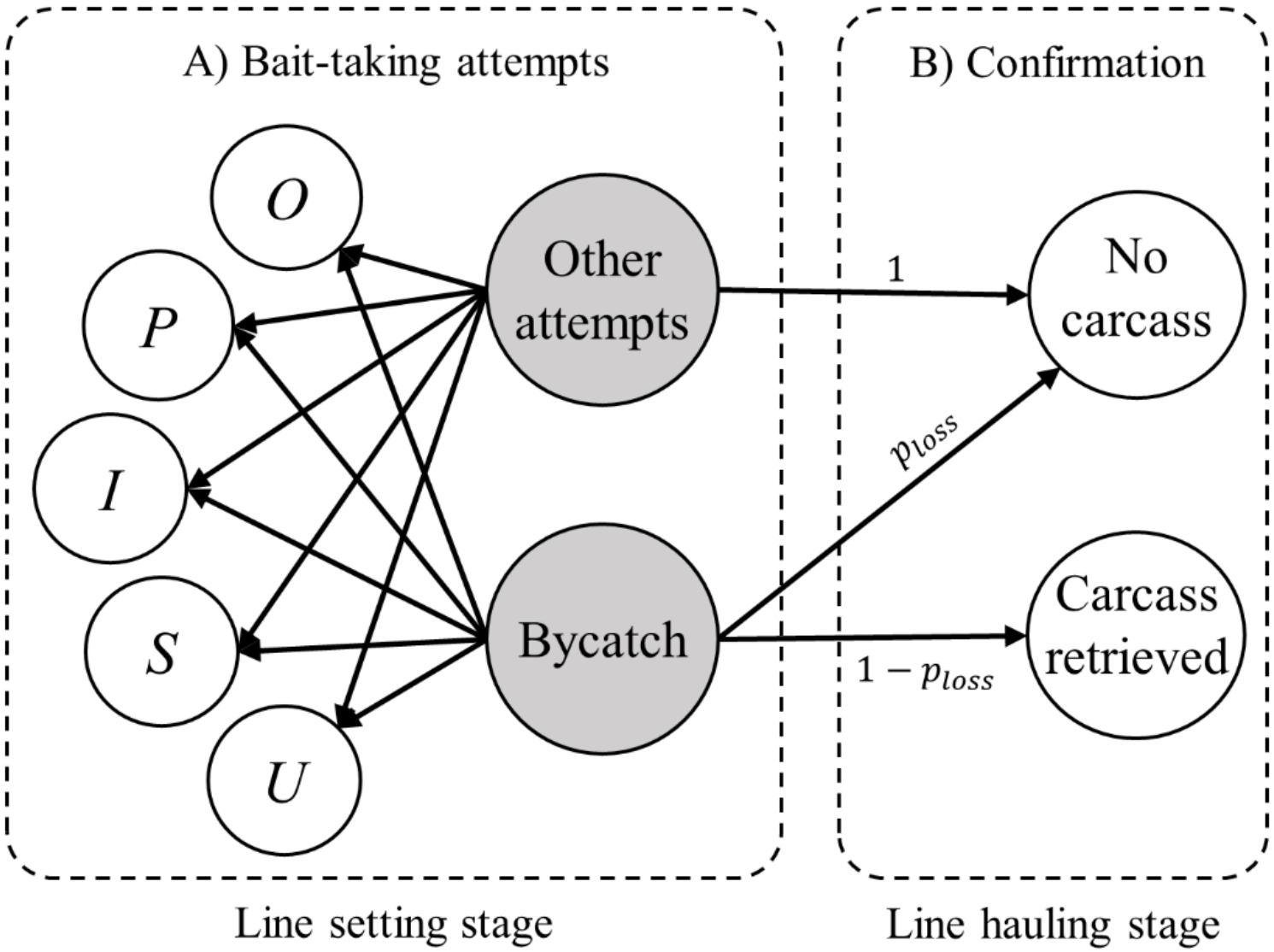
Data

Seabird bait-taking attempt and confirmation observations data in pelagic longline fisheries

- 11 fishing vessels
- 15-year period
- 4 geographical regions
- 5,969 observed seabird interactions
- 726,626 baited hooks

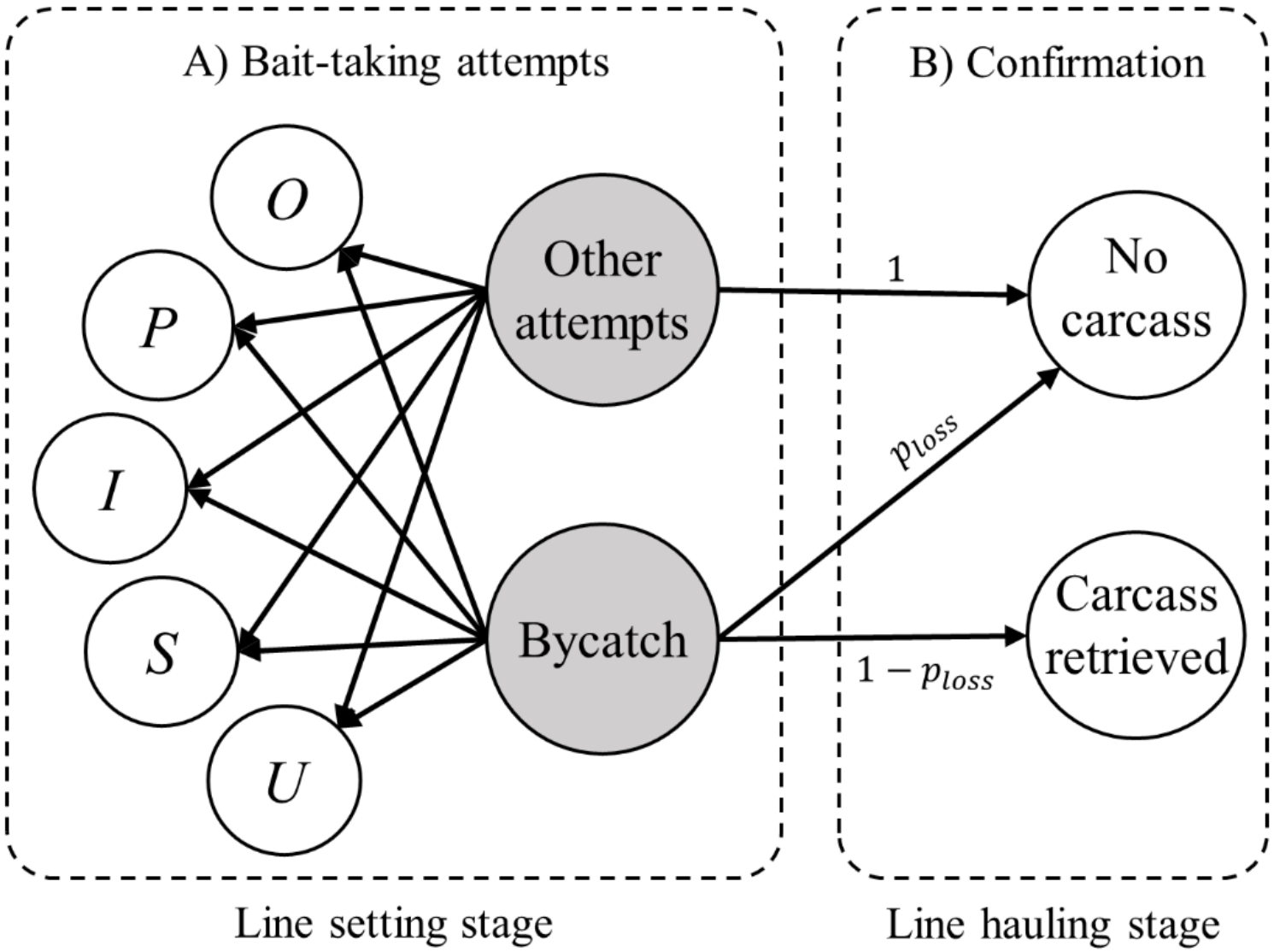


Observation protocol & model



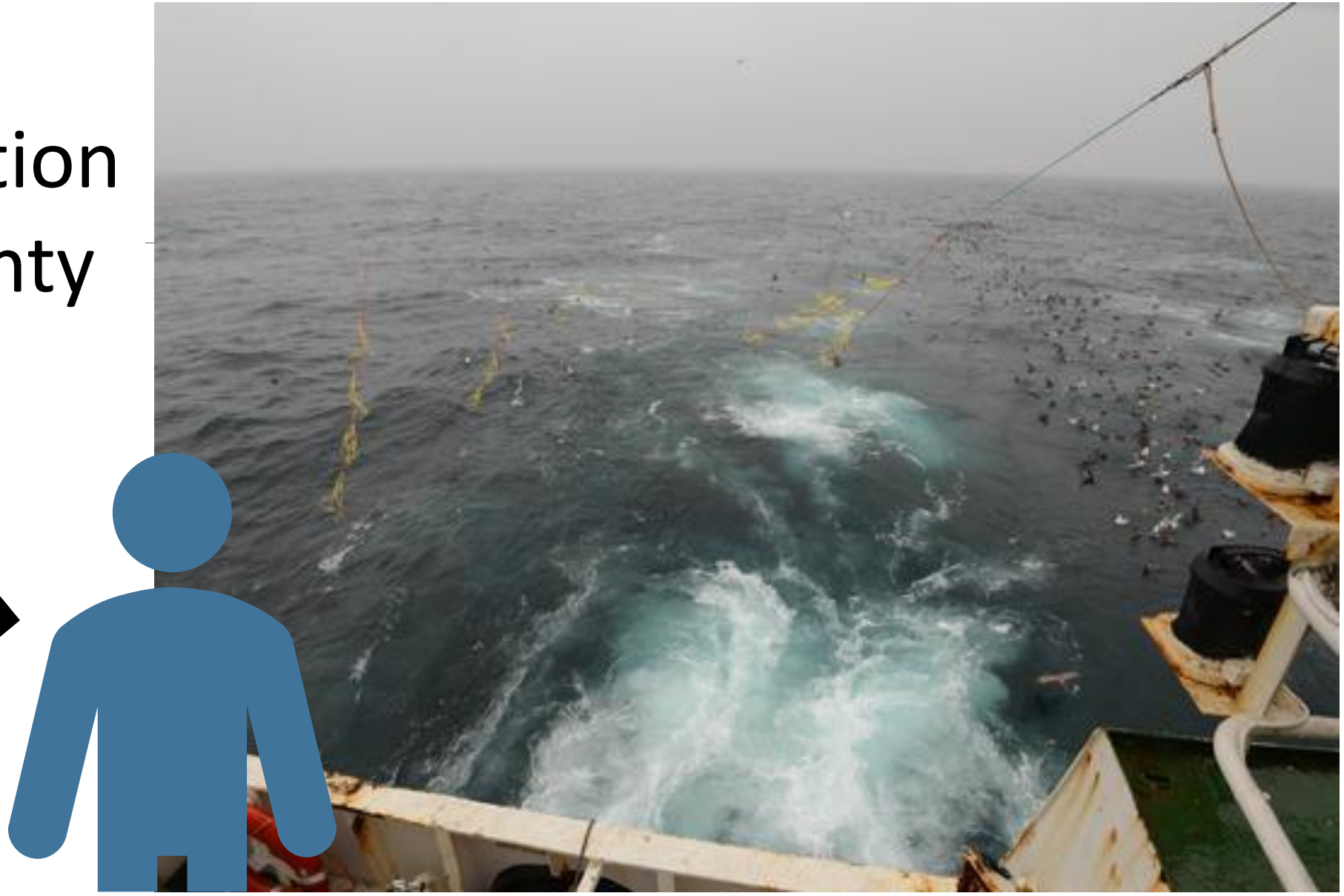
Observation protocol & model

But why??



Observation uncertainty

This is you now



From Yuri Artukhin / WWF

From F Peppes / BirdLife Albatross Task Force

From the Fish Project / Oregon Institute of Marine Biology

From ACAP

Table 1 Number of bait-taking interactions by the extent of confirmation of outcome and whether or not carcass was retrieved

Bait-taking attempts	Carcass retrieved	
	No	Yes
Observed caught (O)	90	85
Possibly caught (P)	65	14
Indeterminate (I)	238	13
Successful (S)	1152	2
Unsuccessful (U)	1331	0

Both from N Brothers

Observation uncertainty

Other attempts

Probability of classifying a other attempts as one of the following types	Median
O	1.82%
P	2.07%
I	8.43%
U	47.02%
S	40.66%

Bycatch event

Probability of classifying a bycatch event as one of the following types	d<150
O	77.10%
P	12.27%
I	7.53%
U	0.65%
S	2.45%

Unpublished results

Average seabird loss rate

- Peaks around 43%
- Mean 31%
- 95% CI (2%, 54%)

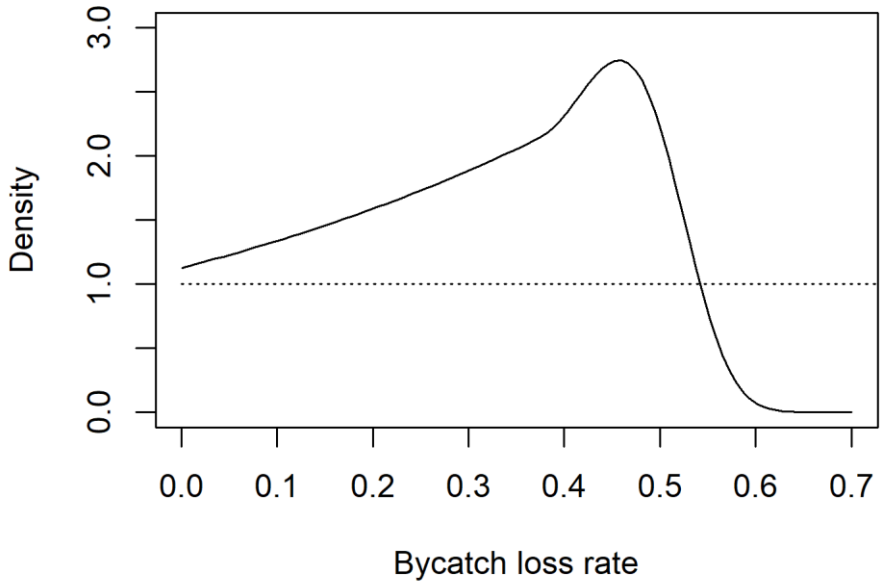


Figure 3 Prior (dotted line) and posterior estimate (solid curve) of the average bycatch loss rate based on model H0.

Influencing Factors

- Physical environment (oceanic condition)
- Biological environment (bycatch risk score)
- Species identity
- Foraging behavior (diving, scavenging)
- Fishing region

Physical environment

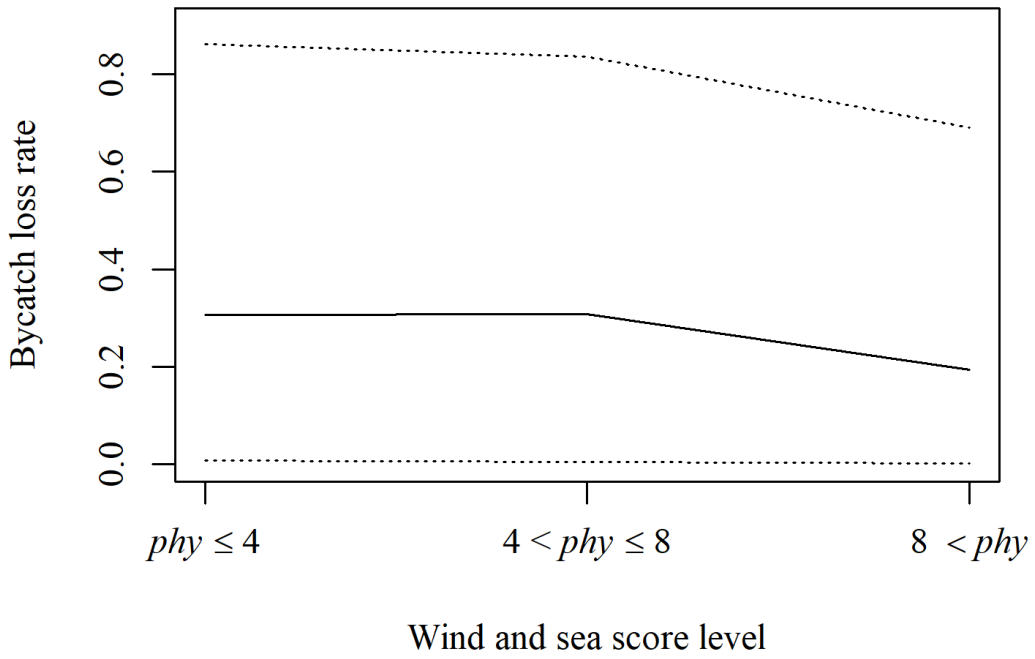


Figure 5 Median (solid line) and 95% credible interval (dotted lines) of the posterior estimate of the bycatch loss rate at calm, intermediate, rough conditions

Biological environment

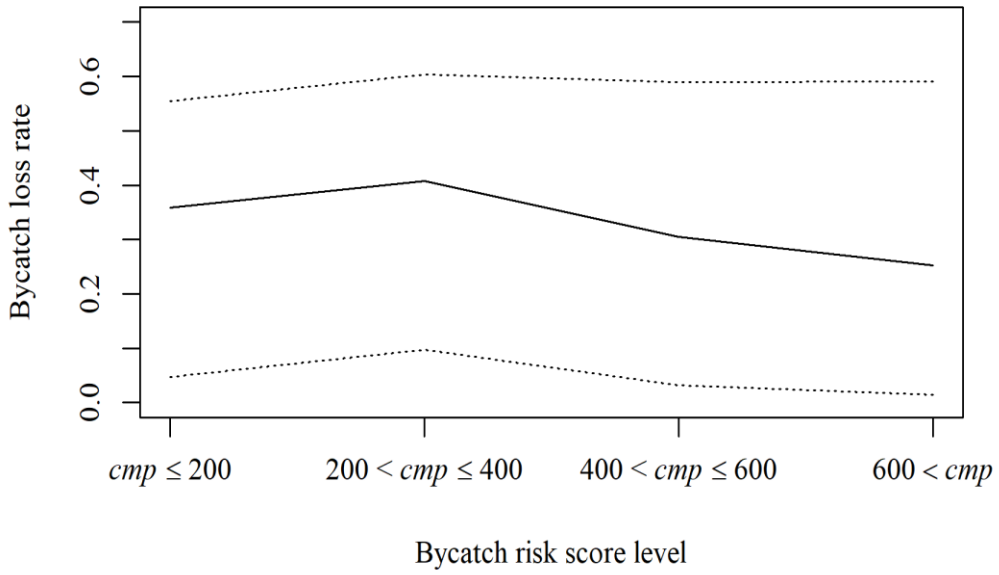


Figure 6 Median (solid line) and 95% credible interval (dotted lines) of the posterior estimate of the bycatch loss rate at different levels of bycatch risk score

Foraging behavior

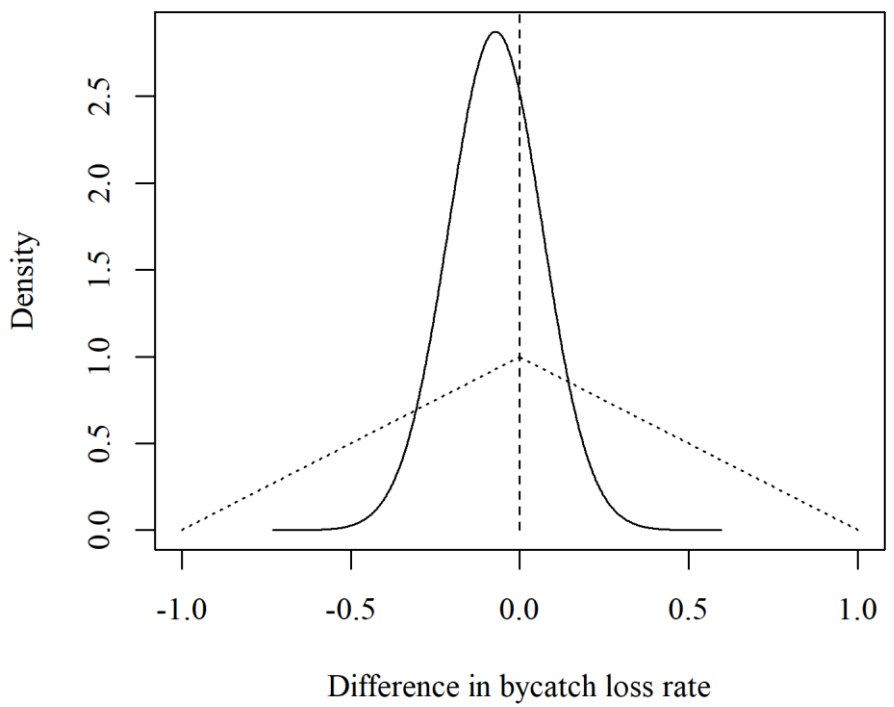


Figure 7 Prior (dotted line) and posterior (solid curve) of the difference in bycatch loss rate between divers and non-divers

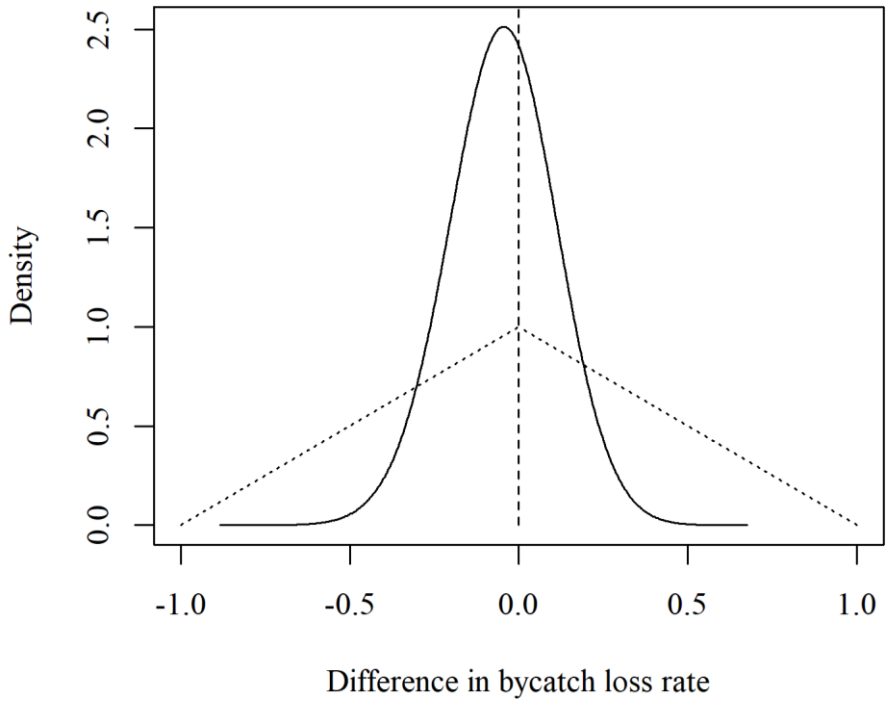


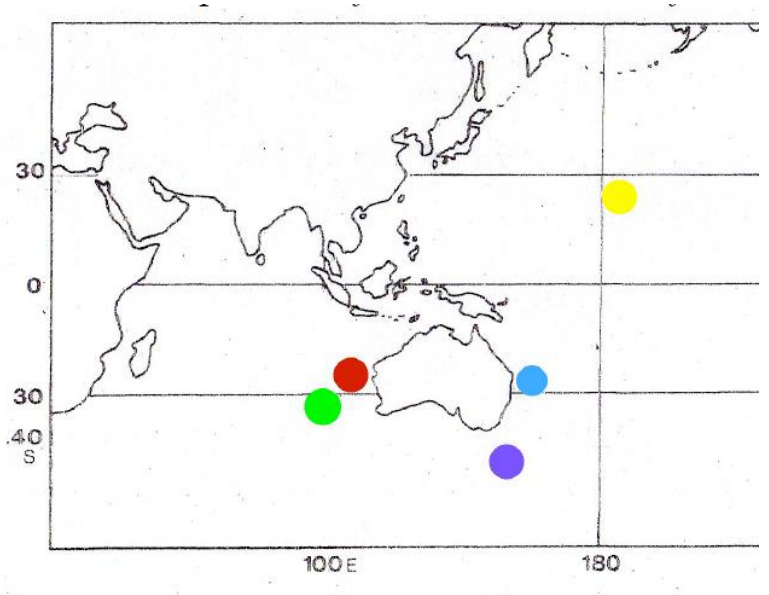
Figure 8 Prior (dotted line) and posterior (solid curve) of the difference in bycatch loss rate between scavengers and non-scavengers

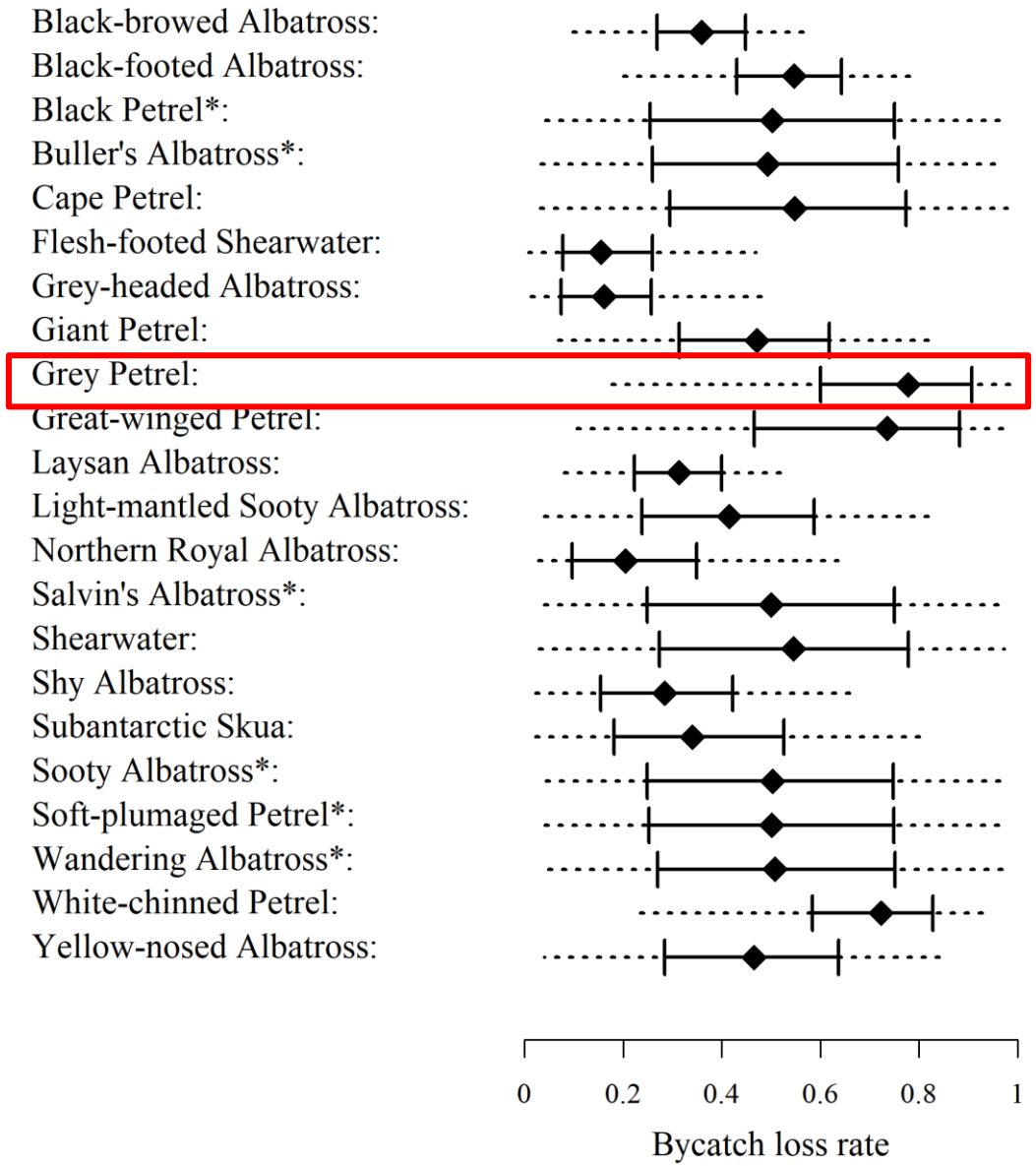
Model selection results

Hypotheses	Covariates	Delta DIC
H0	-	8.6
H1	~~Fishing region~~	9.5
H2	~~Physical condition~~	8.9
H3	~~Bycatch risk score~~	11.1
H4	Species-specific effect	0
H5	Hierarchical species effect	2.5
H4e1	~~Diver or not~~	9.5
H4e2	~~Scavenger or not~~	10.1

Influencing Factors

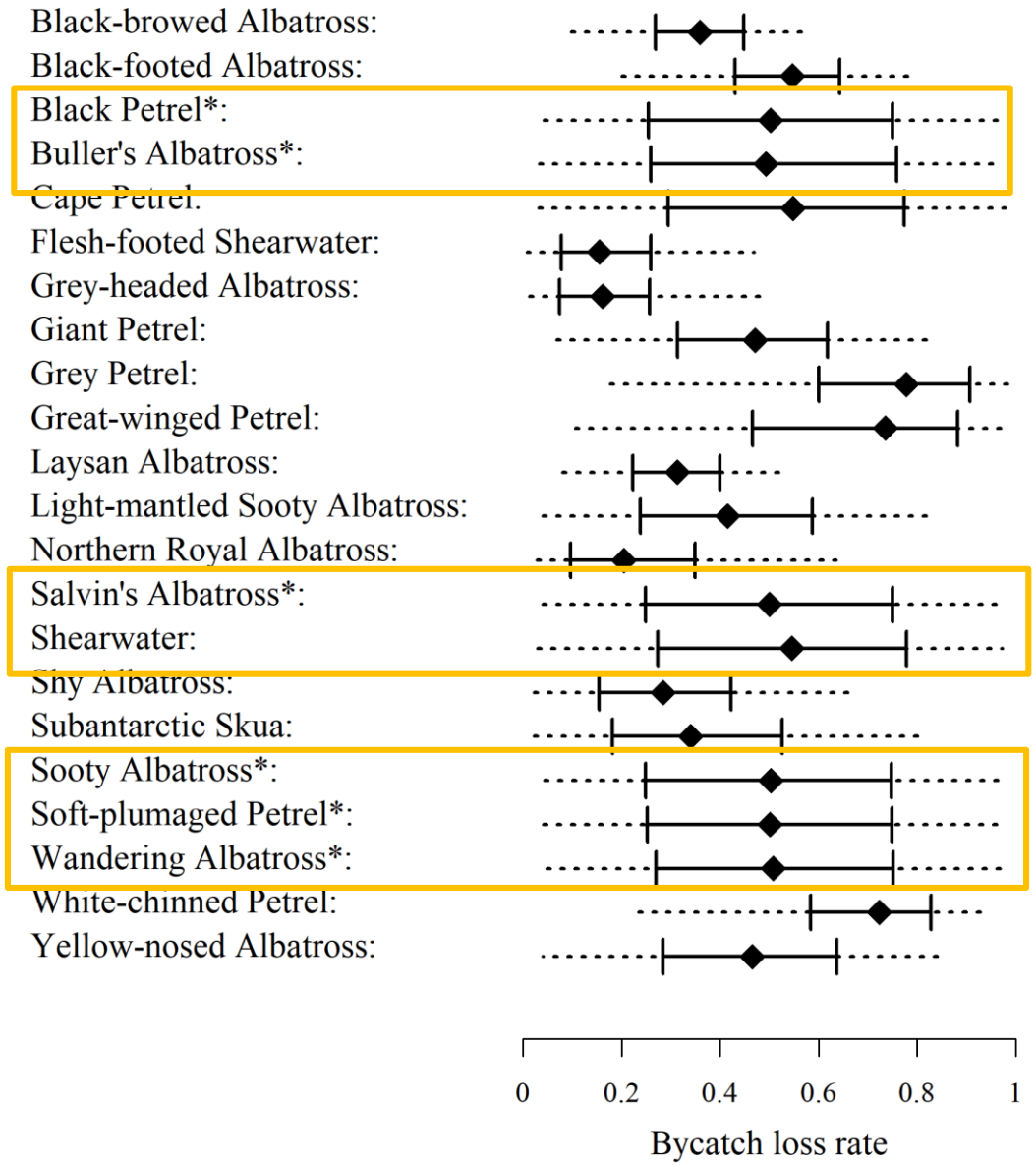
- ~~Physical environment (oceanic condition)~~
- ~~Biological environment (bycatch risk score)~~
- Species identity
- ~~Foraging behavior (diving, scavenging)~~
- ~~Fishing region~~





78%

Figure 4 Bycatch loss rates of common seabird species (groups) in pelagic longline fisheries.

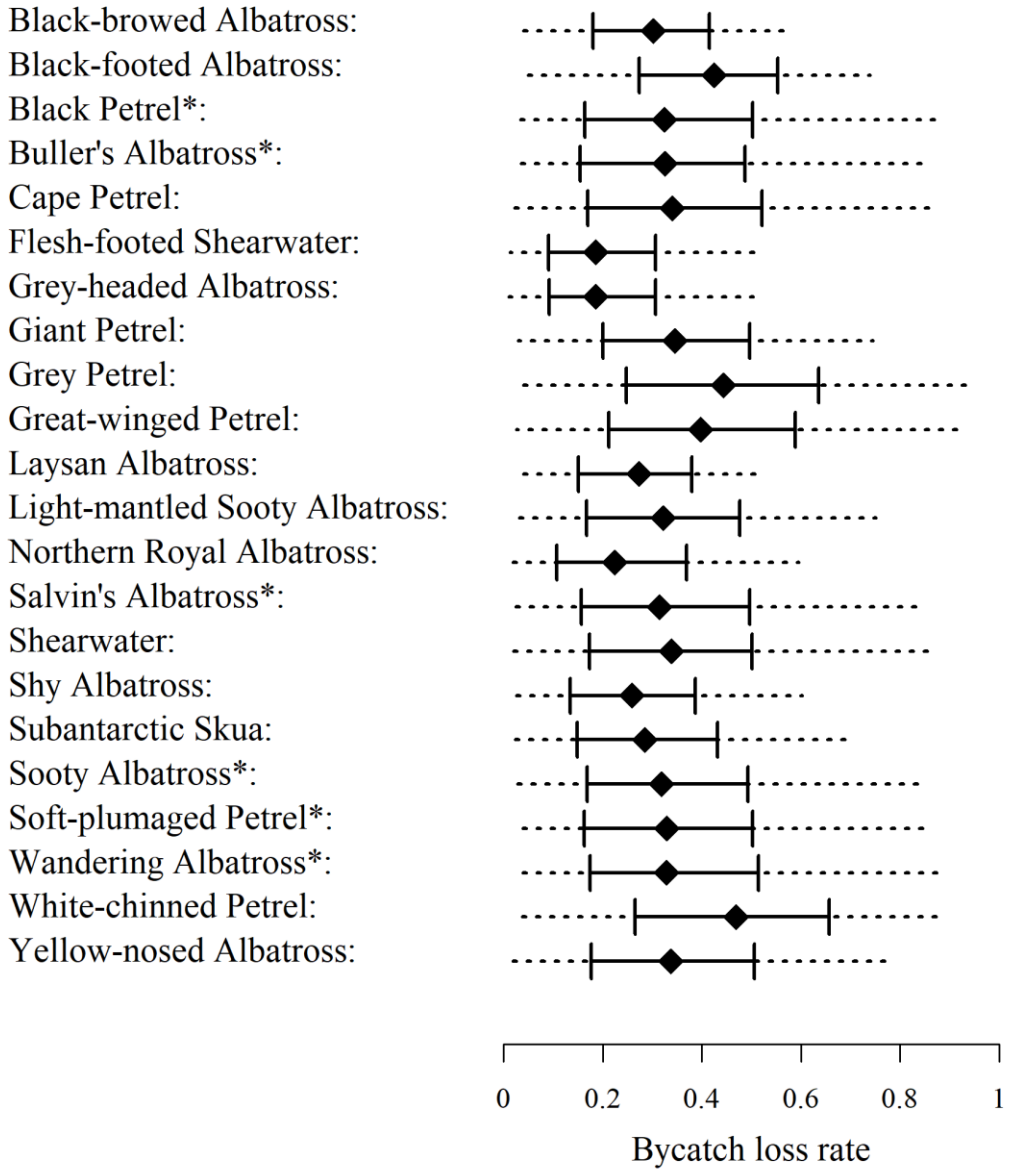


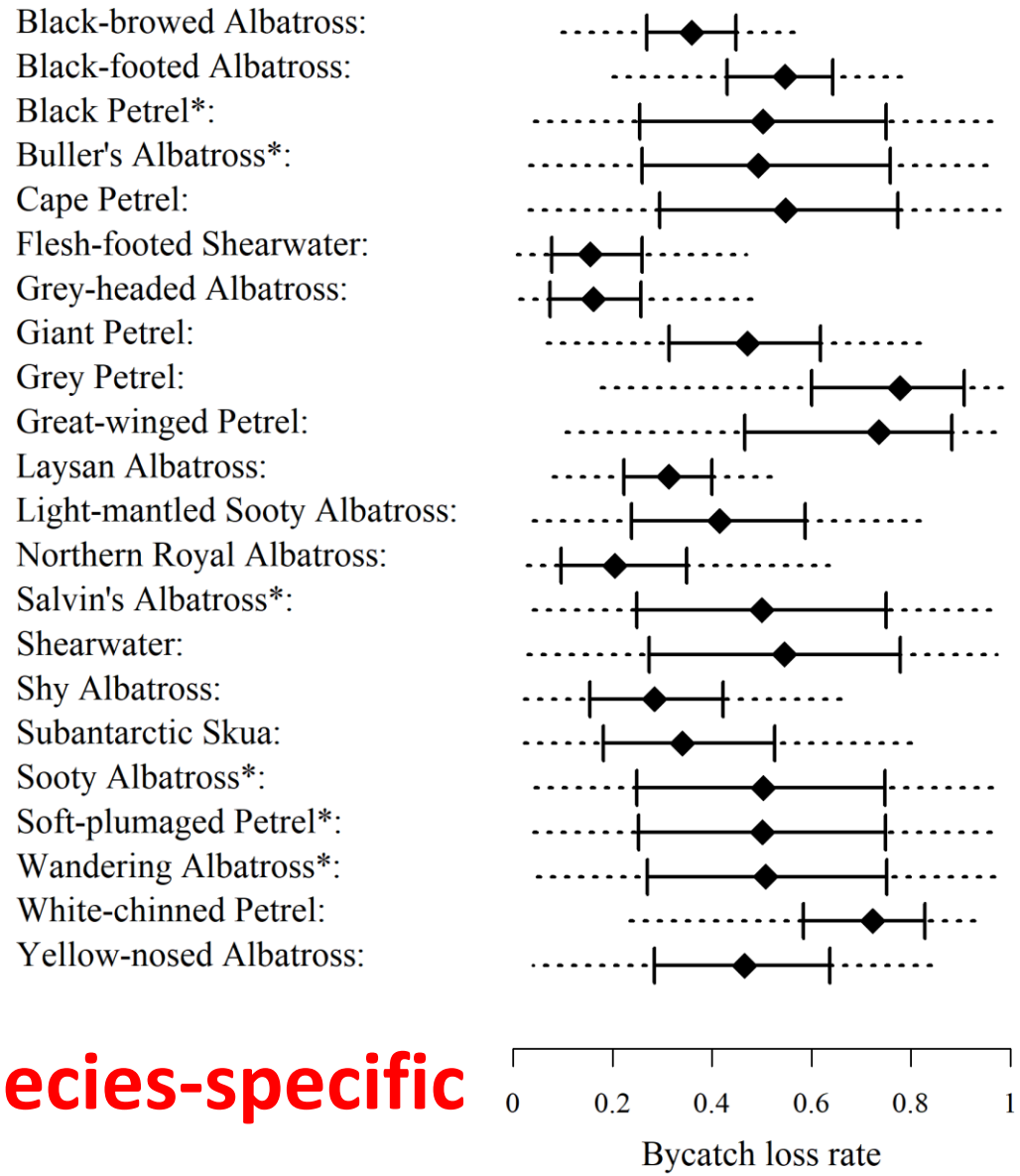
Insufficient info

Figure 4 Bycatch loss rates of common seabird species (groups) in pelagic longline fisheries.

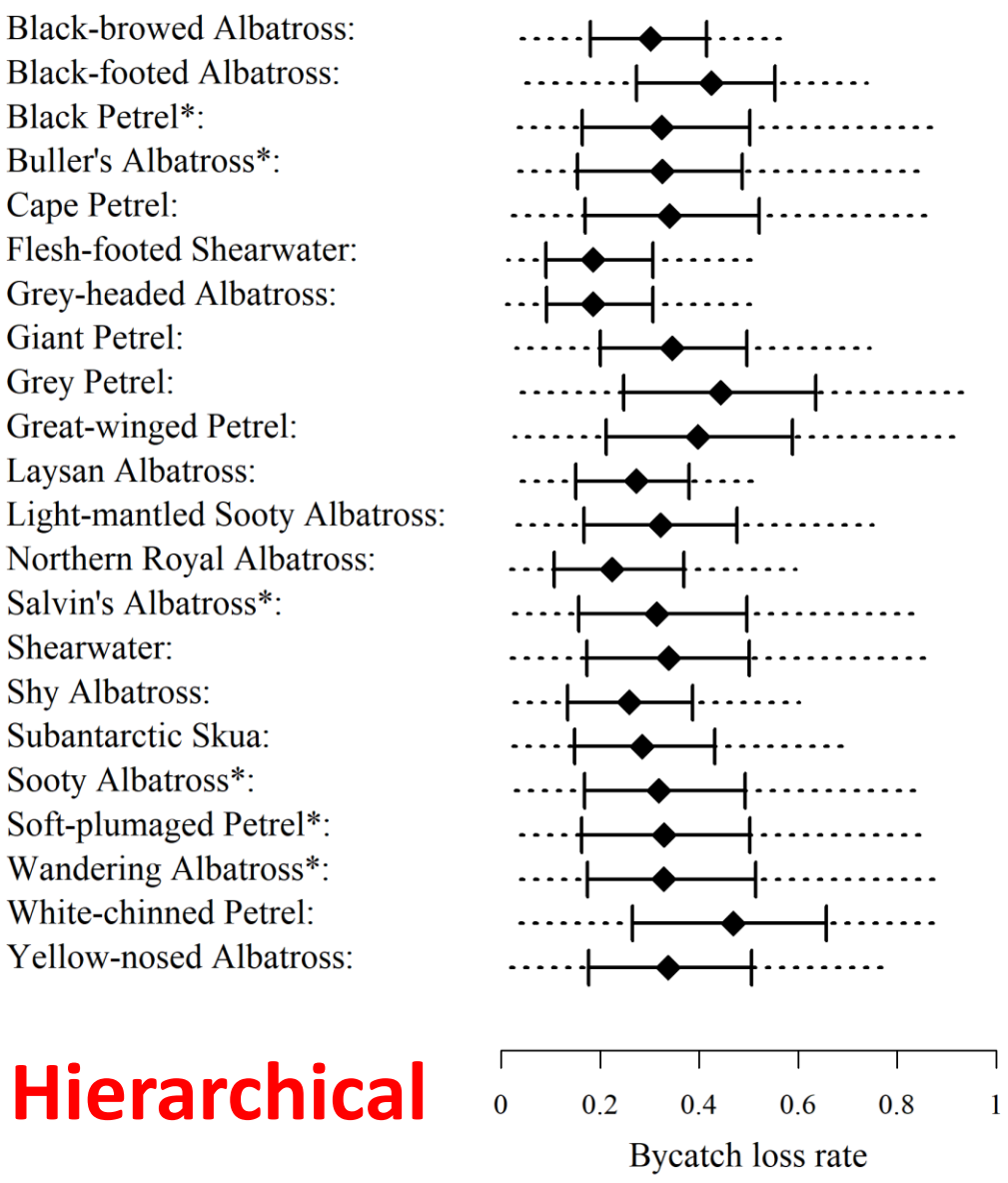
Estimates from the hierarchical model

Effects of a hierarchical structure:
Estimates pulled towards their mean
Smoother, less pronounced





Species-specific



Hierarchical

Recommendations

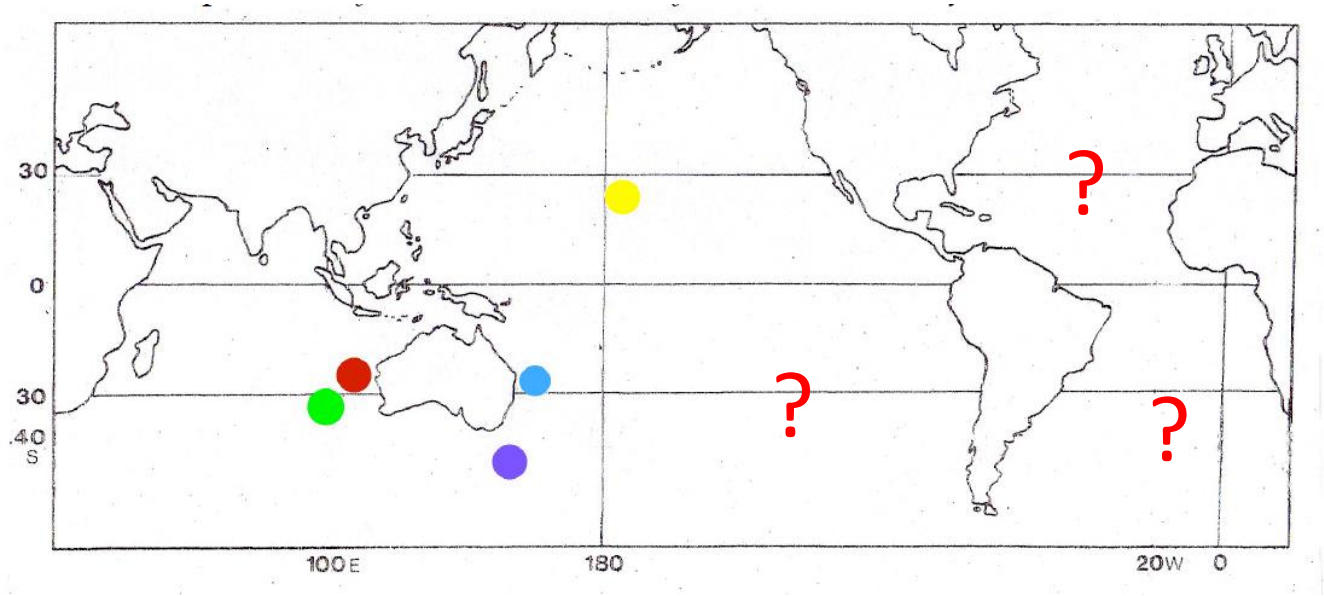
At minimum

- Use the average loss rate
- Gauge the approximate scale of the total bycatch

Recommendations

At minimum

- Use the average loss
- Gauge the approxim



- Preferred approach
  - Species-specific loss-corrected assessments
  - Conduct independent observations

What's next?

RESEARCH ARTICLE

How much do we know about seabird bycatch in pelagic longline fisheries? A simulation study on the potential bias caused by the usually unobserved portion of seabird bycatch

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Thanks for joining!