

# Out of sight, out of notebook

Seabird bycatch loss in pelagic longline  
fisheries

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Can Zhou, Nigel Brothers, Joan Browder, Yan Jiao



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# Seabird bycatch loss rate variability in pelagic longline fisheries

Can Zhou<sup>a,\*</sup>, Nigel Brothers<sup>b</sup>, Joan Browder<sup>c</sup>, Yan Jiao<sup>a</sup>

<sup>a</sup> Department of Fish and Wildlife Conservation, Virginia Polytechnic Institute and State University, Virginia 24060, USA

<sup>b</sup> Marine Ecology and Technology Consultant, Wonga Beach, Queensland 4873, Australia

<sup>c</sup> National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, FL 33176, USA



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State-space models  
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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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INFO

ABSTRACT



assessments.

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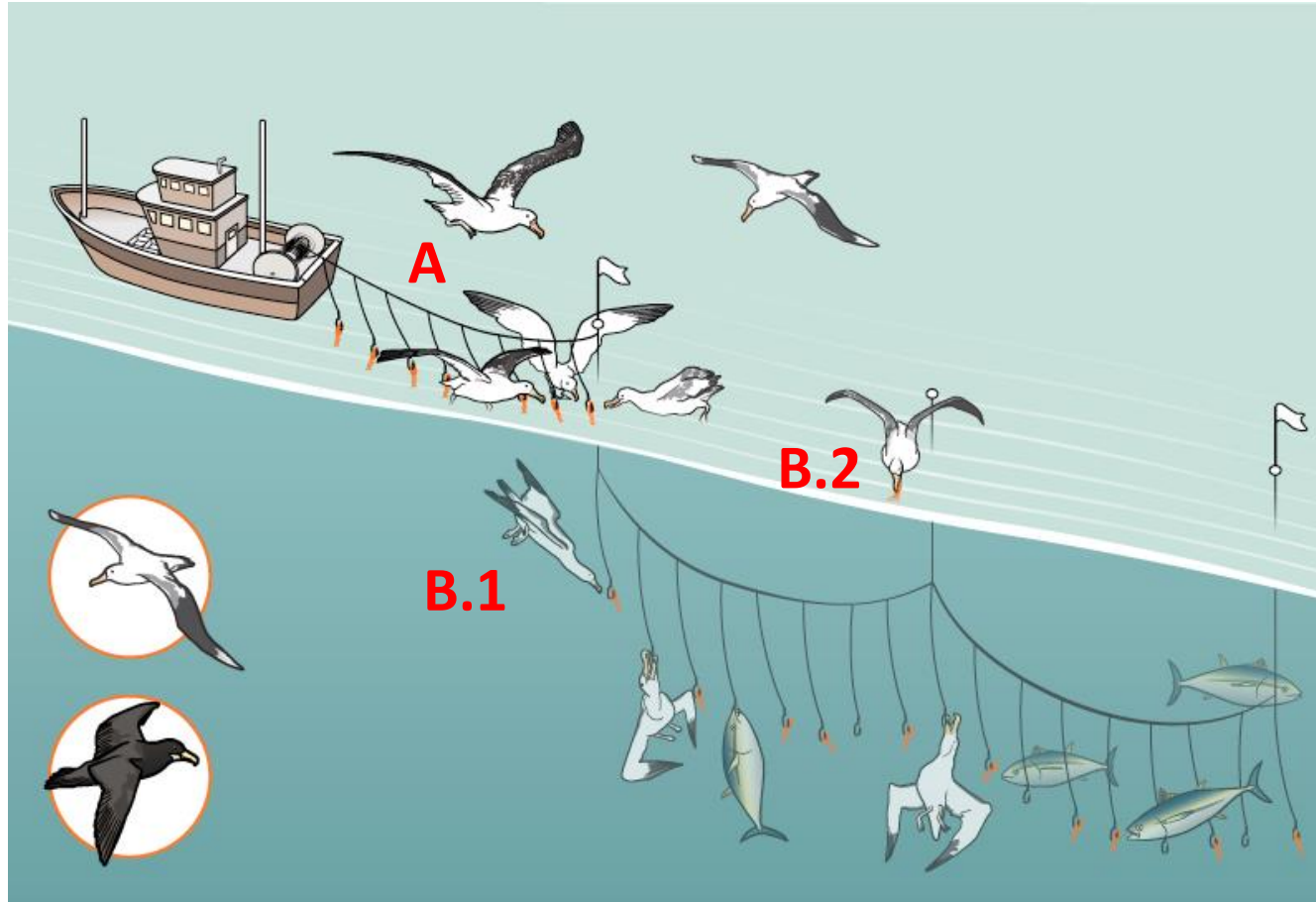
# Fisheries bycatch: a major threat to seabirds

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

[1] Anderson et al. 2011. Global seabird bycatch in longline fisheries. ESR 14, 91-106.

[2] Pott and Wiedenfeld, 2017. Information gaps limit our understanding of seabird bycatch in global fisheries. BIOC 210, 192-204.

# How seabirds are caught?



A. Surface feeders

B. Divers

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





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Line setting

Soaking

Hauling

Both from N. Brothers

# Before this study

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## Haul-only bycatch monitoring is insufficient

- Only records any catch/bycatch remaining on the hook
- Majority of the interactions occur at line setting <sup>[3,4]</sup>
- ~ 50% of the observed captures not retrieved <sup>[5]</sup>

[3] 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.

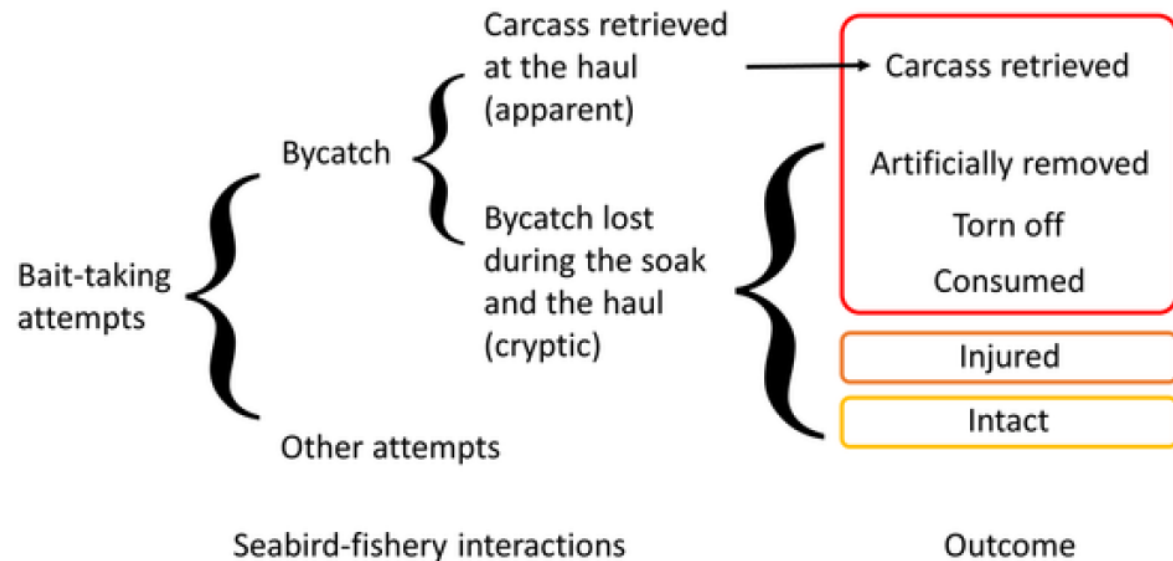
[4] Zhou et al. 2019. How much do we know about seabird bycatch in pelagic longline fisheries? A simulation study on the potential bias caused by the usually unobserved portion of seabird bycatch. *PONE*, 14(8), e0220797.

[5] 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 <sup>[4]</sup>





# Which factors affect bycatch loss?

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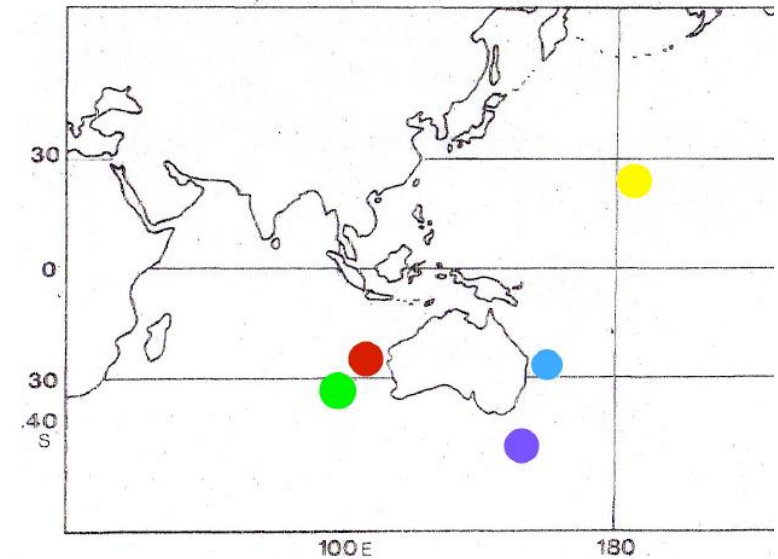
- Physical oceanic condition
- Competition (bycatch risk score)
- Species identity
- Foraging behavior (diving, scavenging)
- Fishing region

# Data

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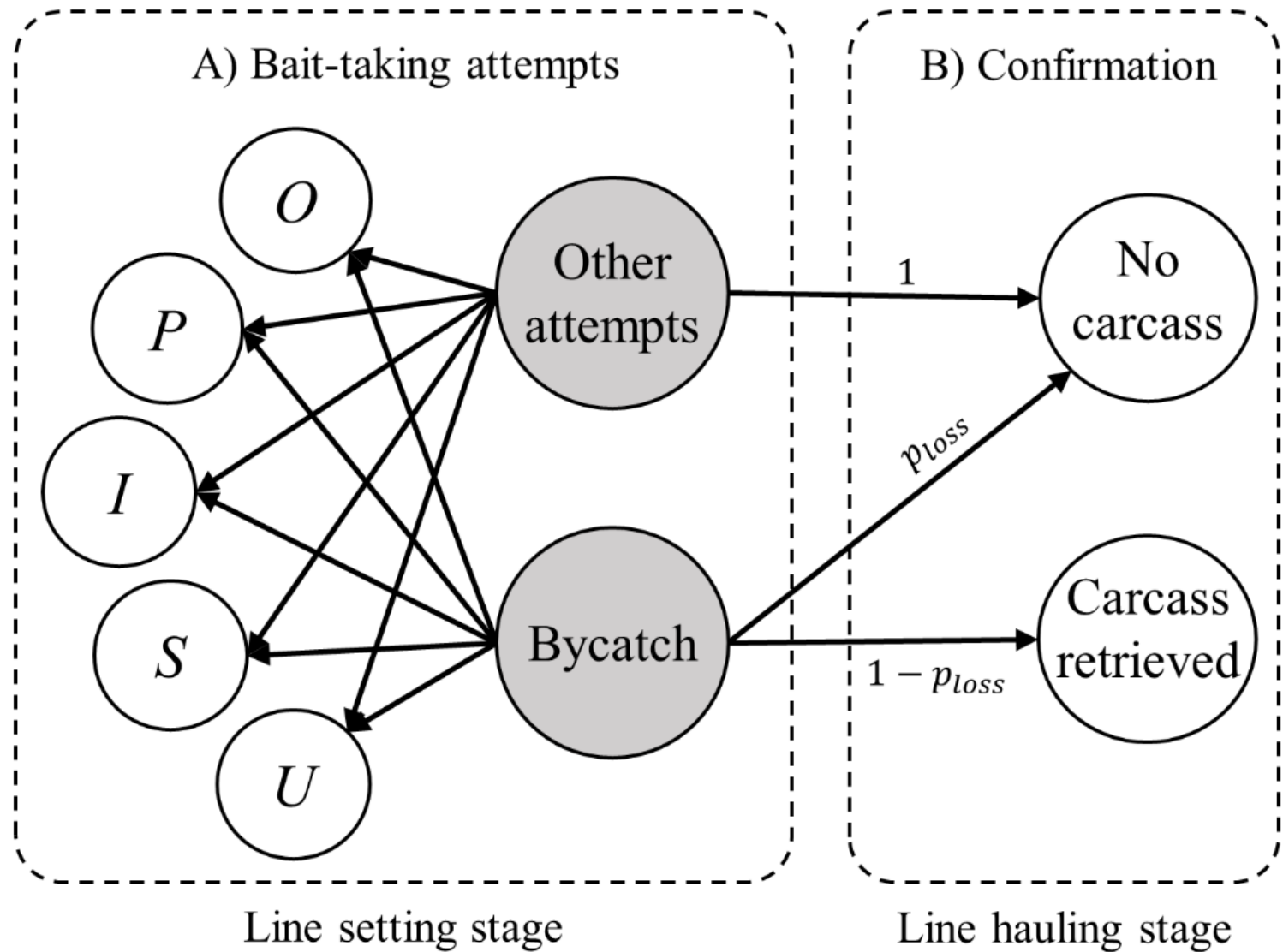
Seabird bait-taking attempt and confirmation observations data in pelagic longline fisheries

- 11 fishing vessels
- 15-year period
- 4 geographical regions
- 5,969 observed seabird interactions
- 522,077 baited hooks



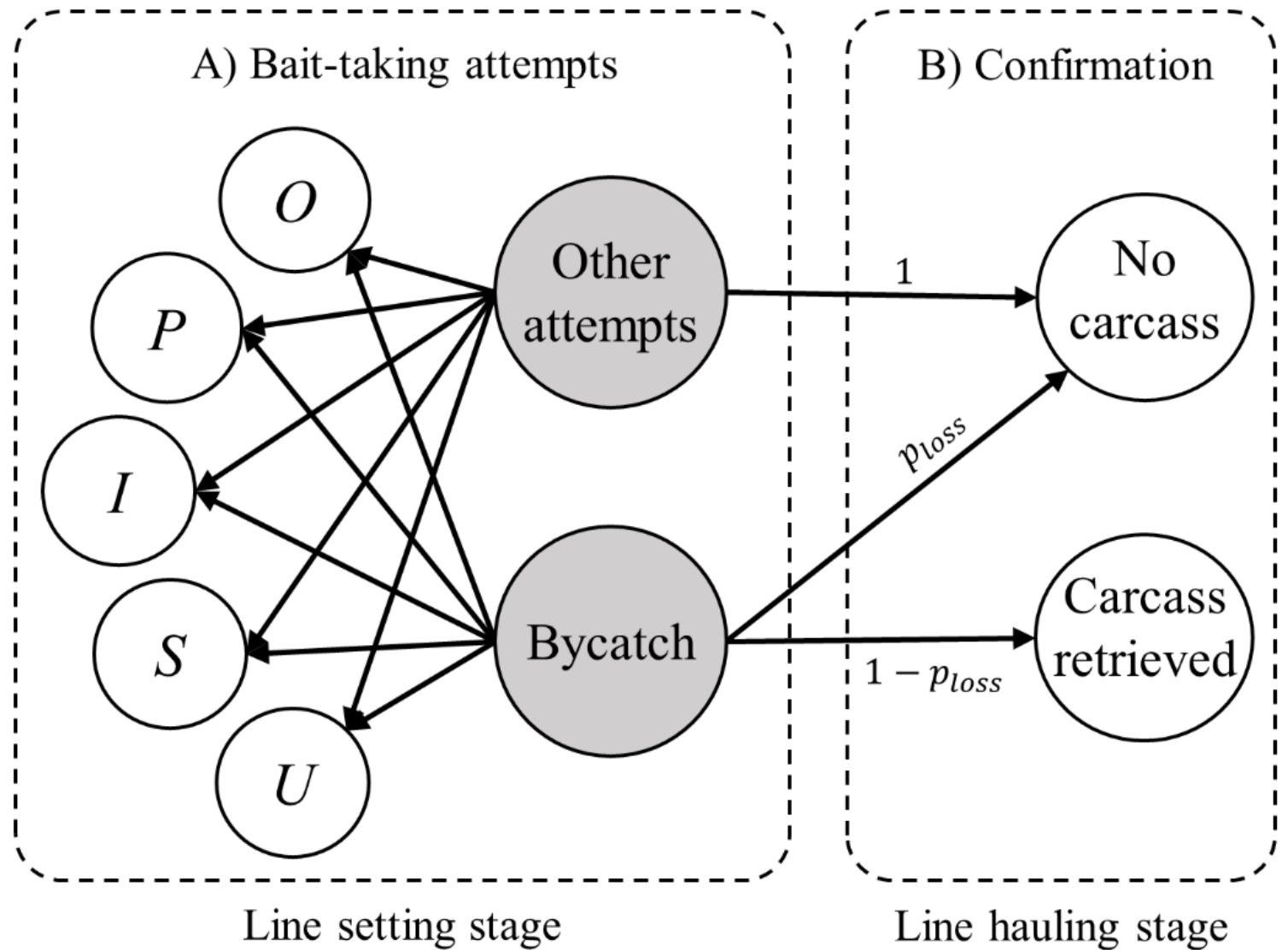


# Observation protocol & model



# Observation protocol & model

But why??





# Observation uncertainty

This is you now



From Leo Tamini / BirdLife International



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

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## 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

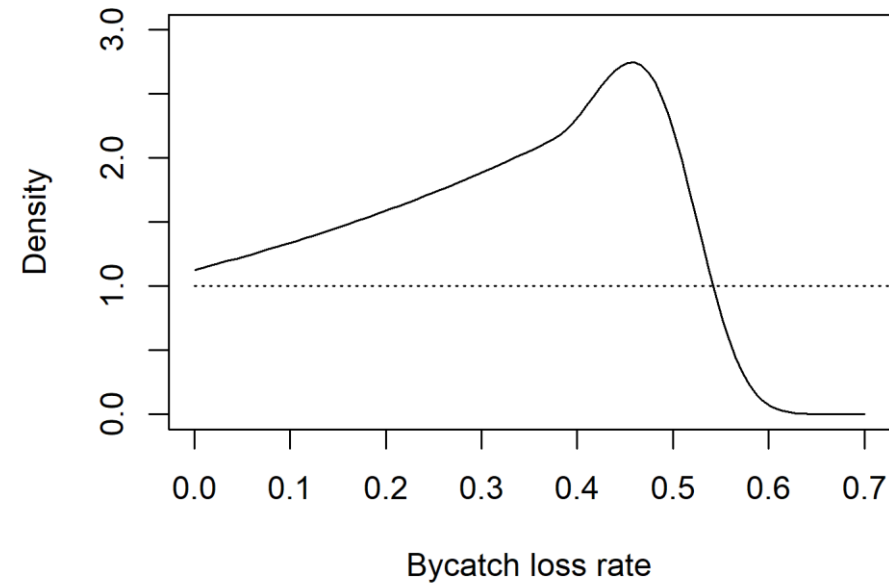
Probability of classifying a bycatch event as one of the following types	d<150
O	77.10%
P	12.27%
I	7.53%
U	0.65%
S	2.45%

Unpublished results

# Average seabird loss rate

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- Peaks around 43%
- Median **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.*



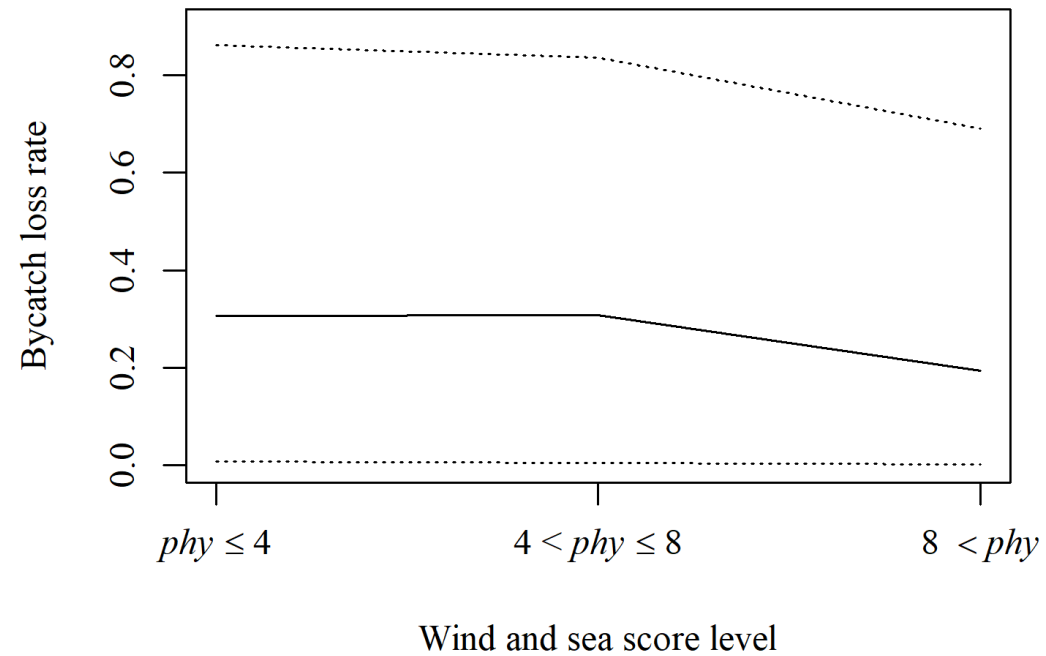
# Influencing Factors

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

# Physical environment

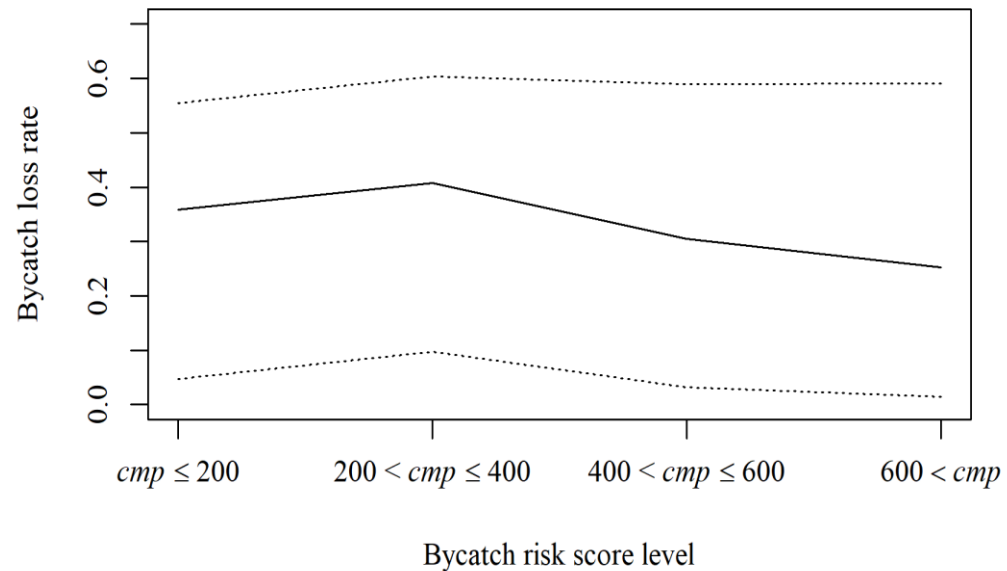
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**Figure 5** Median (solid line) and 95% credible interval (dotted lines) of the posterior estimate of the bycatch loss rate at calm, intermediate, rough conditions

# Biological environment

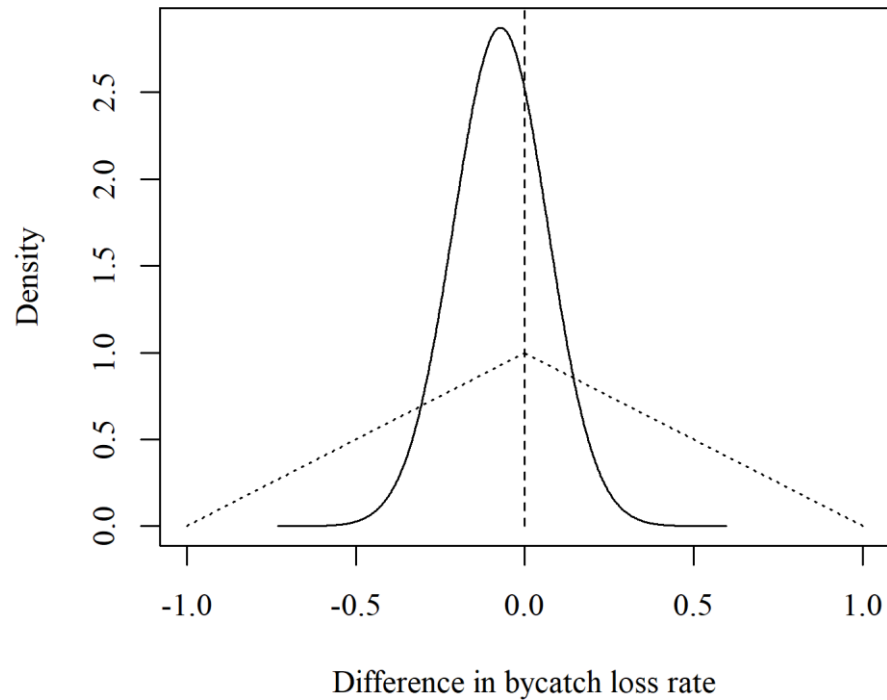
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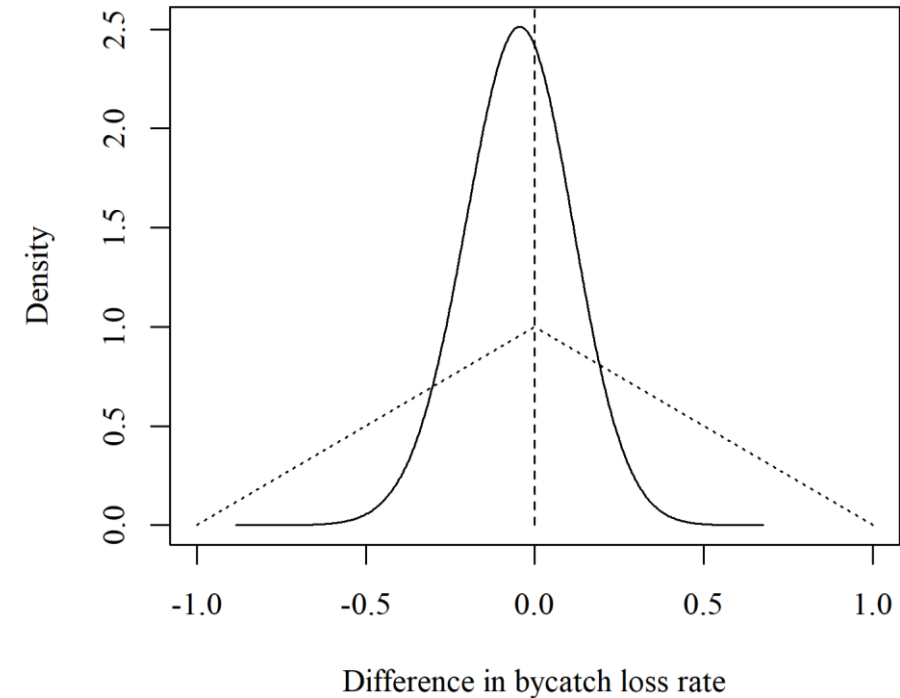
**Figure 6** Median (solid line) and 95% credible interval (dotted lines) of the posterior estimate of the bycatch loss rate at different levels of bycatch risk score



# 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

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

# Influencing Factors

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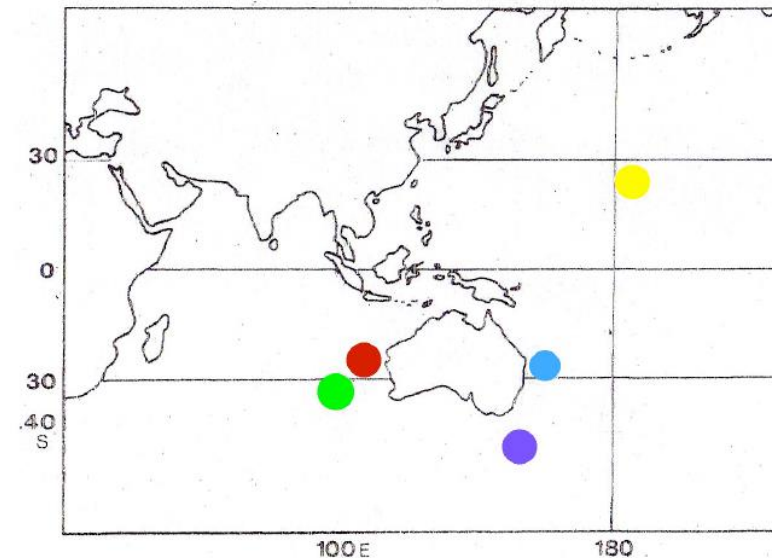
- ~~Physical environment (oceanic condition)~~
- ~~Biological environment (bycatch risk score)~~
- Species identity
- ~~Foraging behavior (diving, scavenging)~~
- ~~Fishing region~~ ?

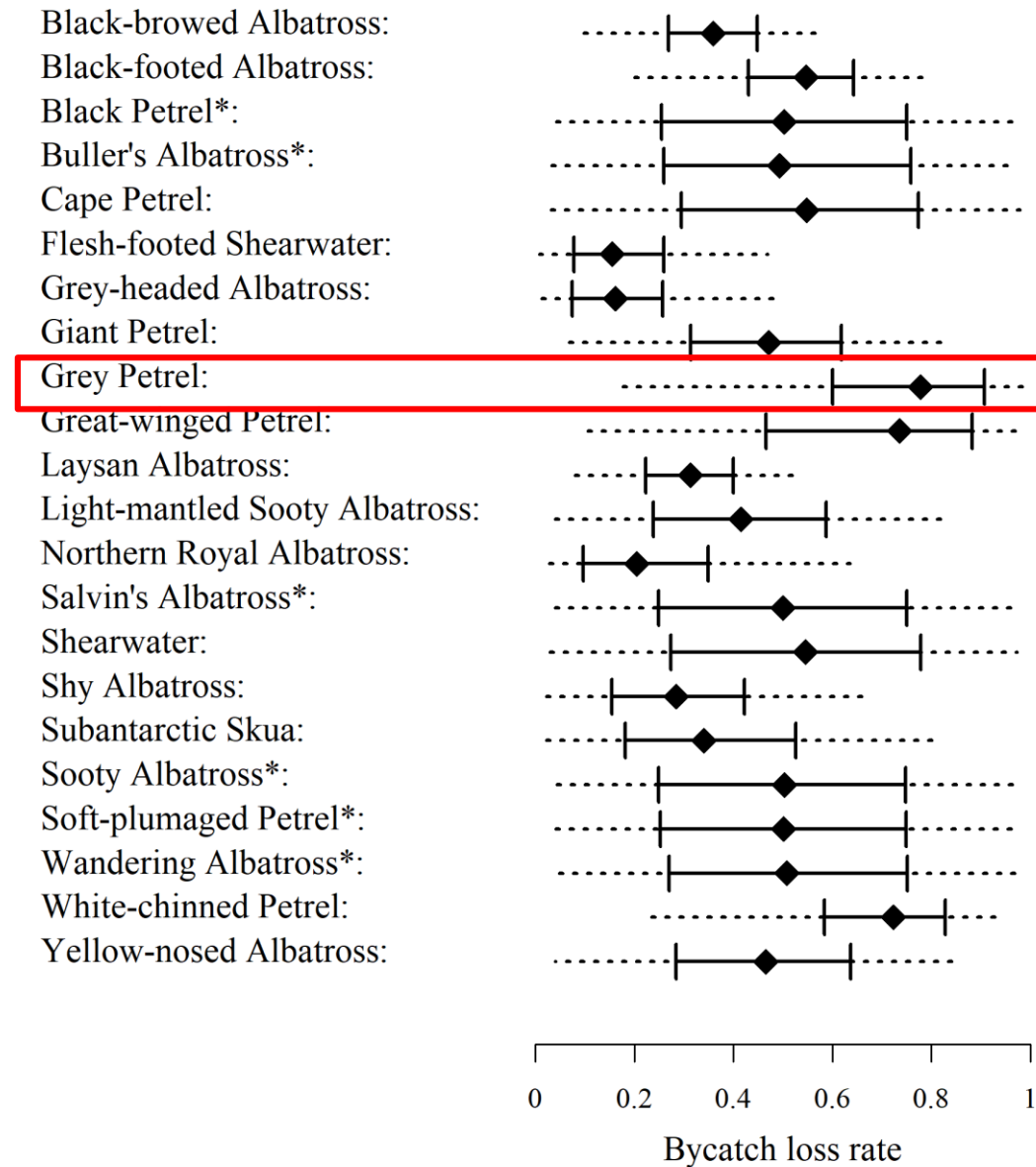


# Influencing Factors

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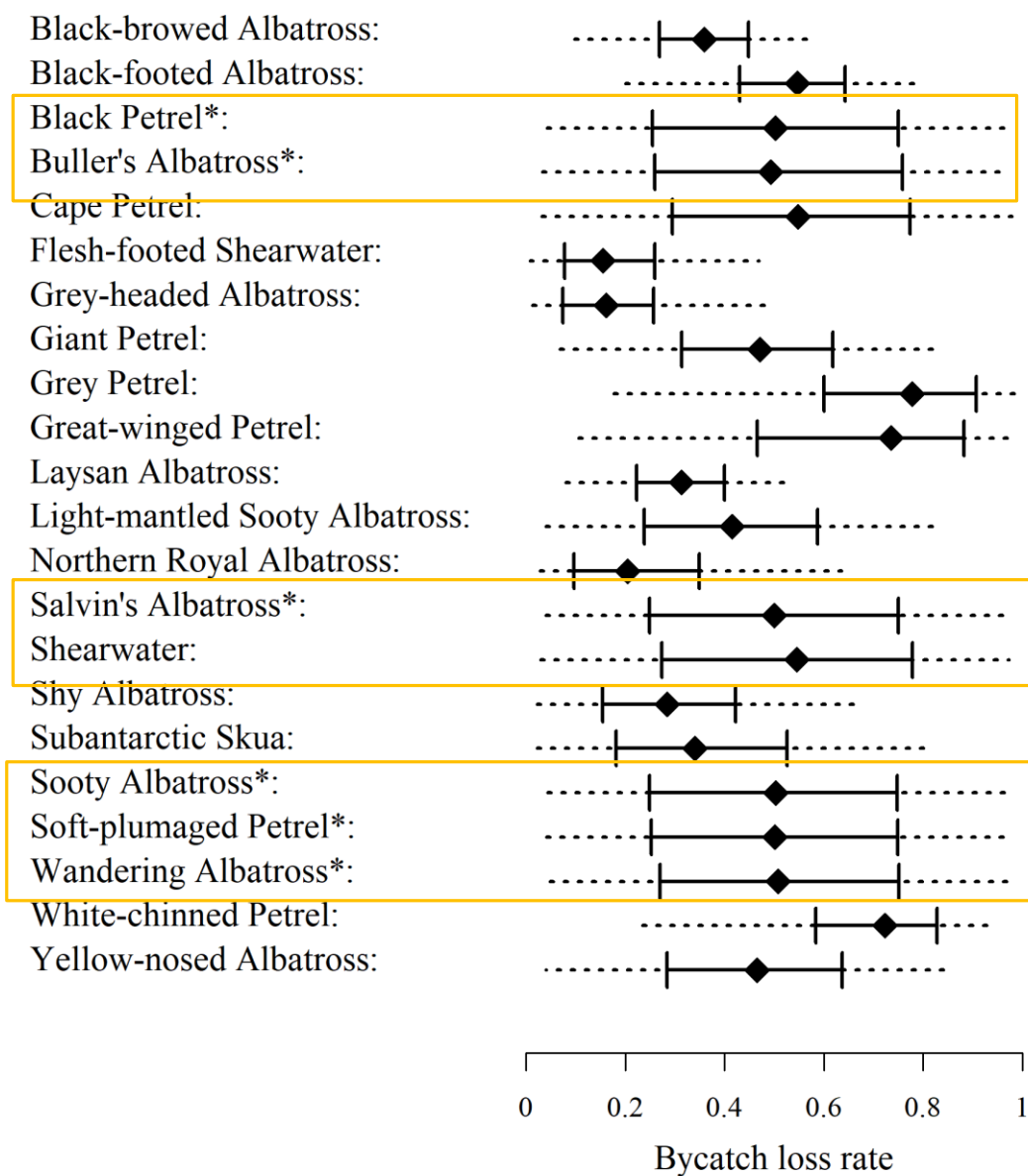
- ~~Physical environment (oceanic condition)~~
- ~~Biological environment (bycatch risk score)~~
- Species identity
- ~~Foraging behavior (diving, scavenging)~~
- ~~Fishing region ?~~





78%

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



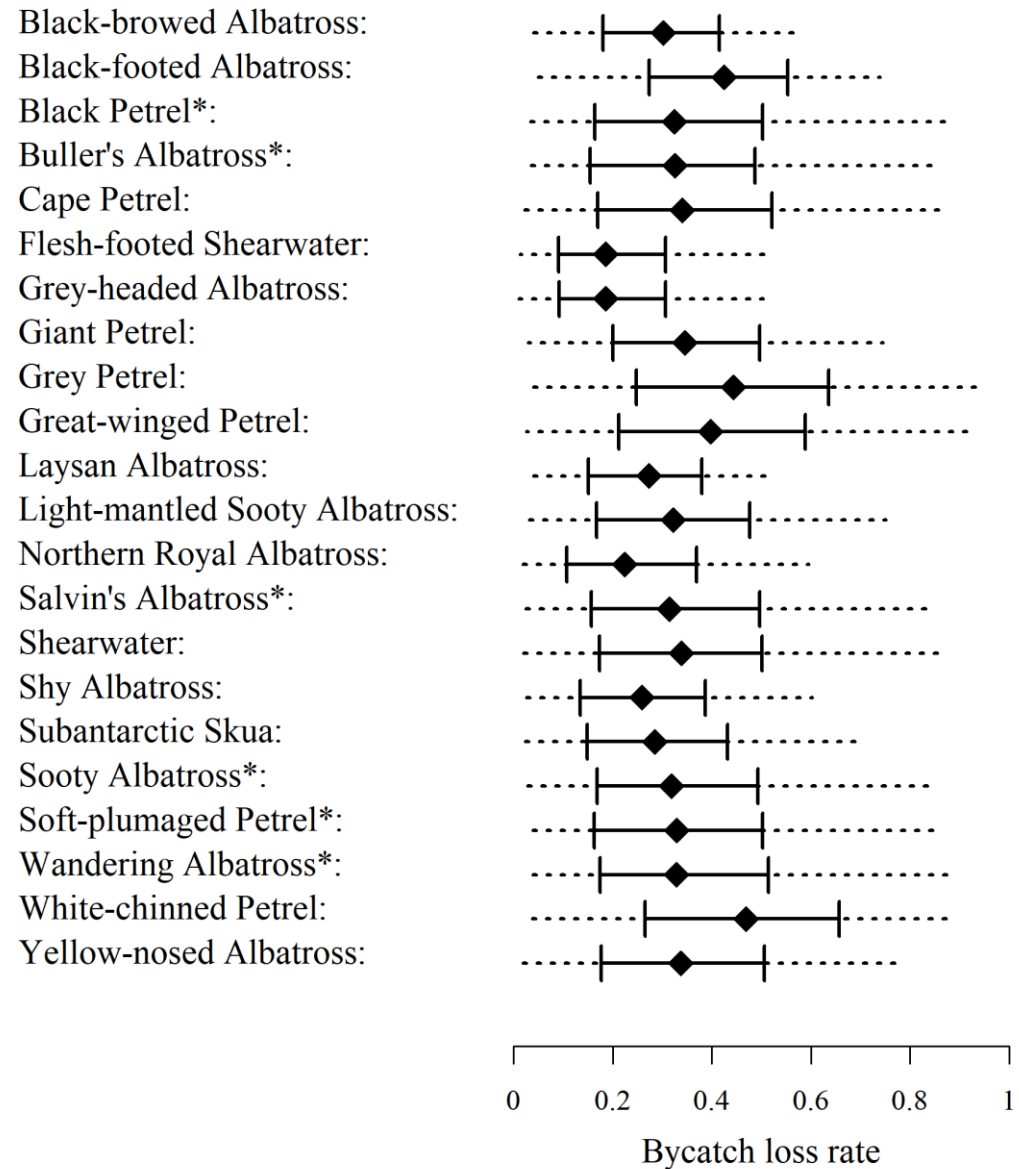
Insufficient info

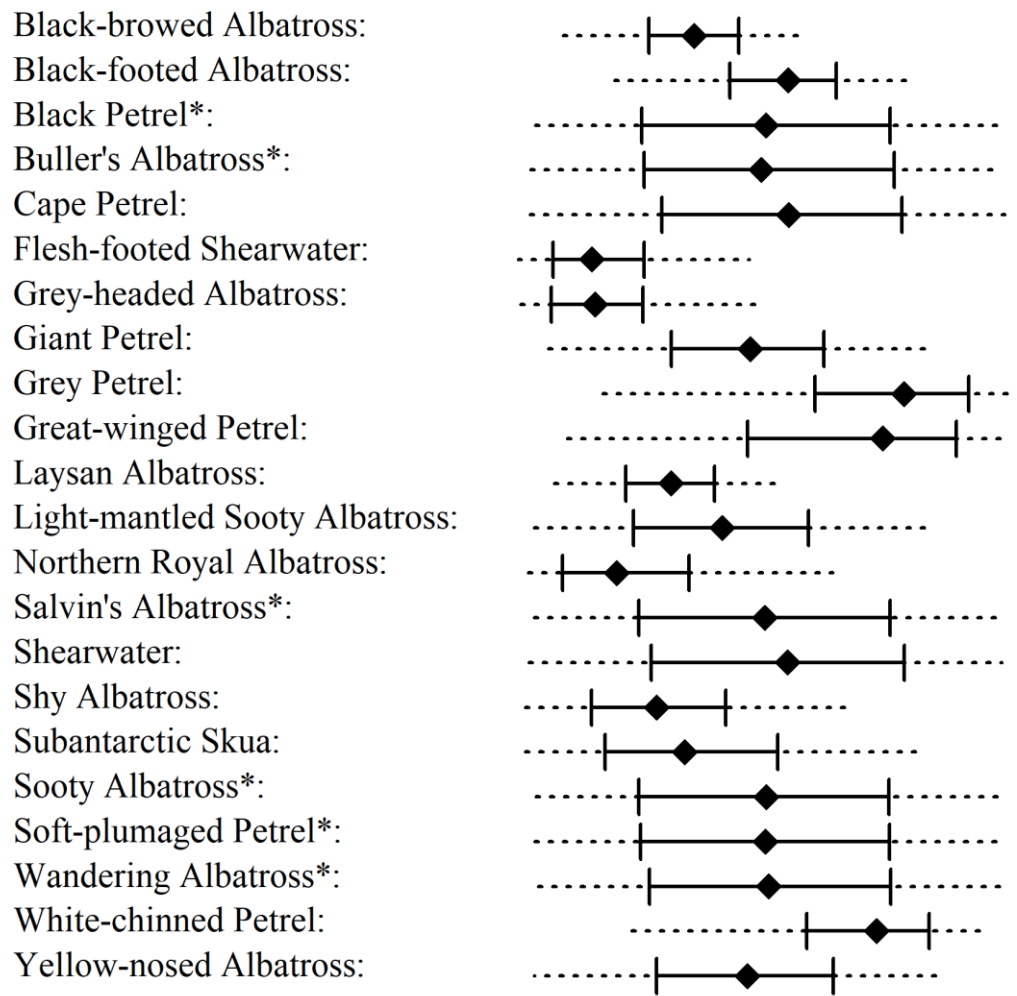
**Figure 4** Bycatch loss rates of common seabird species (groups) in pelagic longline fisheries.



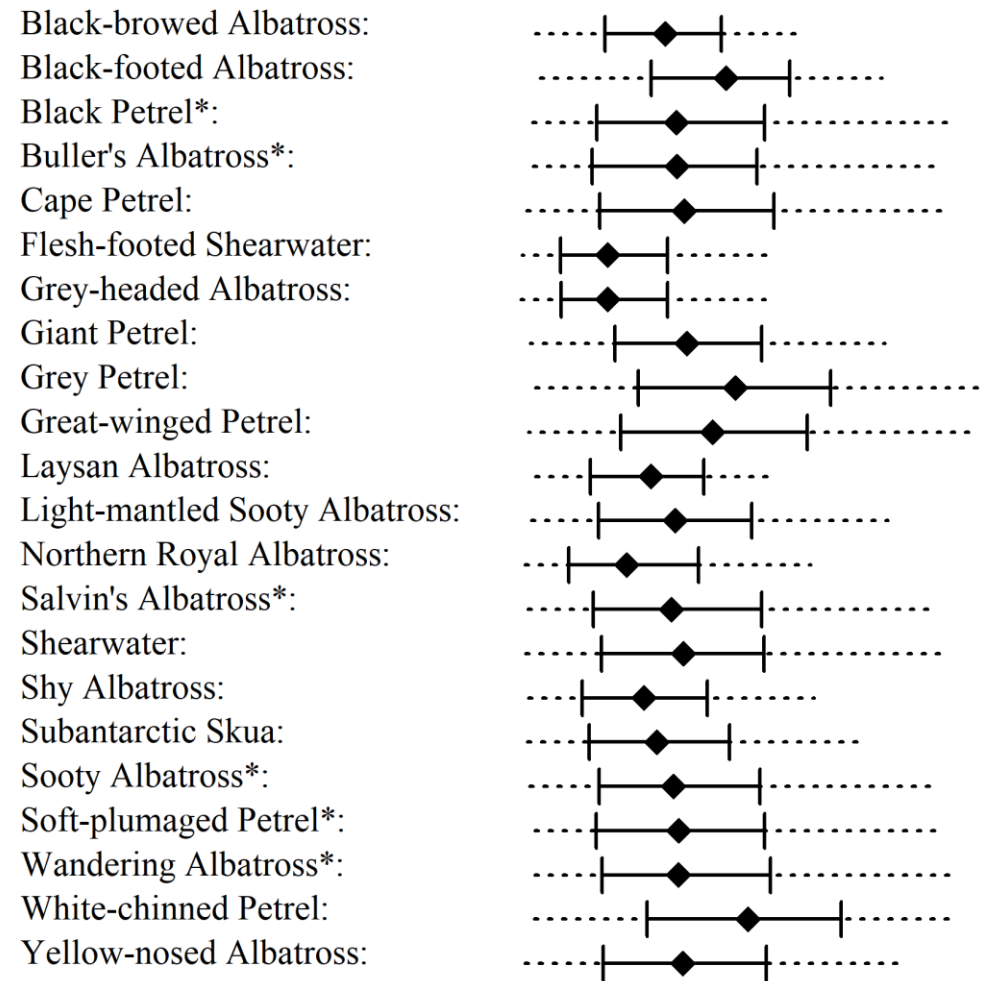
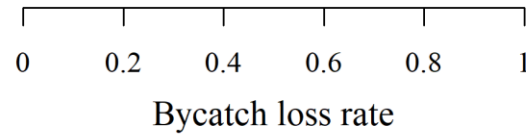
# Estimates from the hierarchical model

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

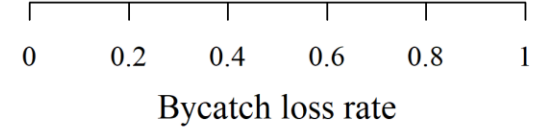




## Species-specific



## Hierarchical



# Recommendations

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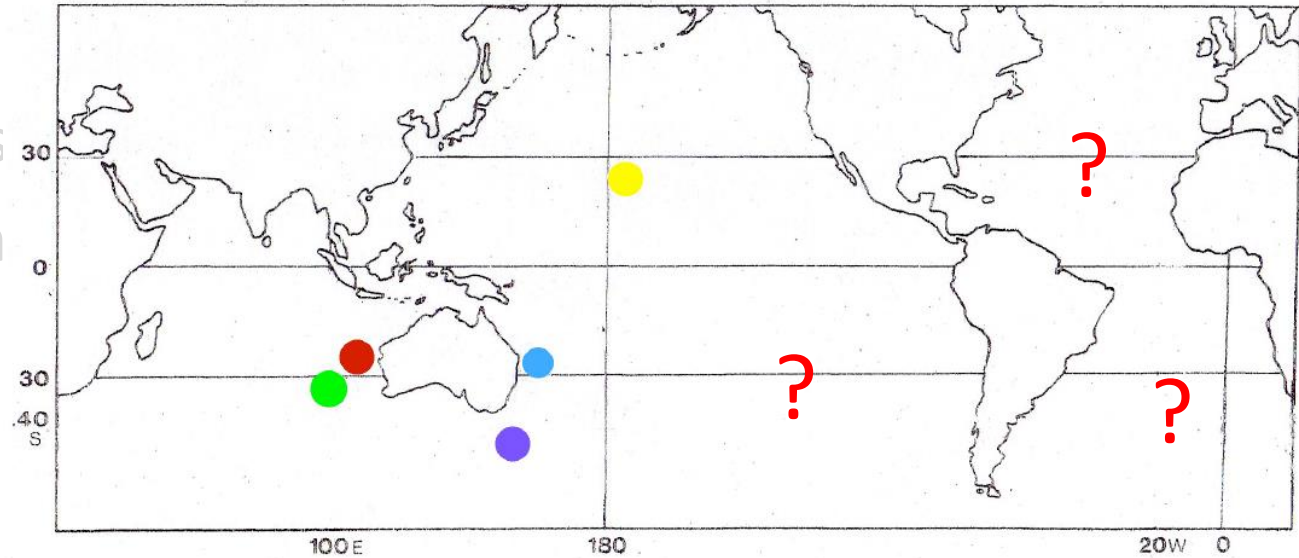
At minimum

- 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



# Acknowledgements

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Nigel Brothers for long term dedication

Eric Gilman for valuable inputs

Funders, management agencies, vessel owners, and crew involved in facilitating the original study



**Thanks for joining us!**



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**Questions?**

