

MIT2023-01

# Effects of hook and bait type on commercial longline fisheries bycatch

Rachel Hickcox



**Proteus**

*Knowledge | Results | Data*

[www.proteus.co.nz](http://www.proteus.co.nz)

# Background

- Bycatch = incidental catch of non-target species
  - Line entanglement -> drowning or injury
  - Baited hook swallowed
  - Body part hooked
  - Other interactions with gear
- Seabirds and sea turtles in SLL

# Objectives

①

## Literature review longline fisheries

1. Hook, bait type on seabird + turtle bycatch rates
2. Recommendations for improved data collection

③

## Available data sources of bycatch with hook, bait type information

②

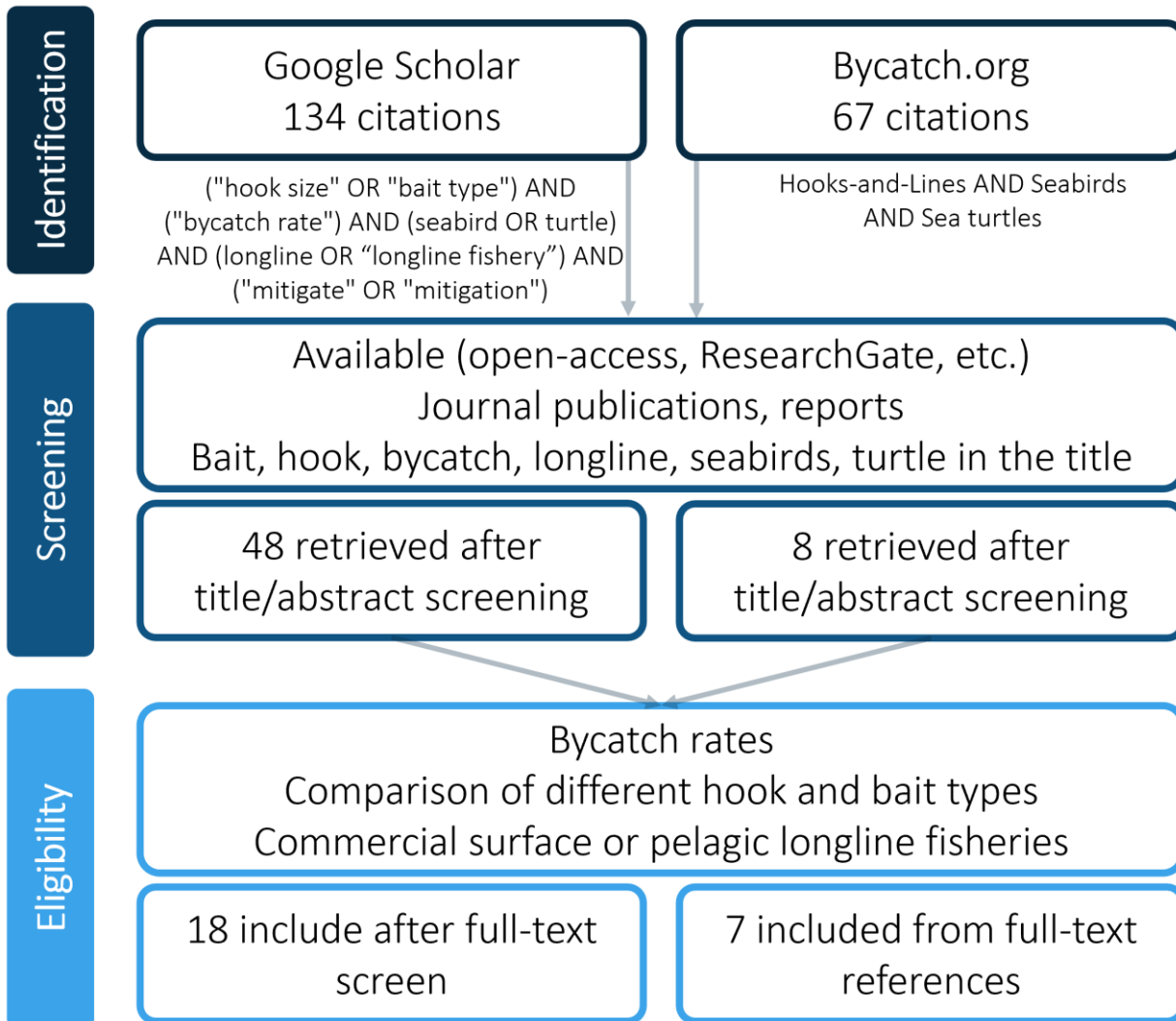
## International literature review on fisheries best practice

④

## Questionnaire for SLL operators

1. Design and summarise responses
2. Characterise current gear set-ups in SLL fisheries
3. Identify hooks, baits effective for bycatch mitigation
4. Inform protected species risk management plans

# Literature review



## 25 published and grey literature

Dyed bait	5 studies
Bait type	2 studies
Hook type	
seabirds	1 study
sea turtles	6 studies
both	1 study
Bait + hook type	
seabirds	1 study
sea turtles	8 studies
Hookpods	1 study

# Bait type



- Insufficient data
- 1 study **increased captures with mackerel vs squid**
  - Li et al. 2012
- 1 study **no significant difference**, low capture rates
  - Richards et al. 2012

# Bait type



- Insufficient data
- 1 study **increased captures with mackerel vs squid**
  - Li et al. 2012
- 1 study **no significant difference**, low capture rates
  - Richards et al. 2012



- 8/9 studies **reduced turtle captures with mackerel**
  - Báez et al. (2010); Brazner & McMillan (2008); Coelho et al. (2015); Gilman et al. (2007); Mejuto et al. (2008); Santos et al. (2012; 2013); Watson et al. (2005)
  - All in swordfish fisheries; 2 also in tuna fisheries
- 3 studies **reduced target catch rates** (not all reported)
  - Báez et al. (2010); Richards et al. (2012); Watson et al. (2005)

# Bait type - Dyed

**Dyed bait** (usually blue squid) as seabird deterrent



- 3/4 studies **dyed bait reduced seabird bycatch**
  - Cocking et al. (2008); Ochi et al. (2011); Yokota et al. (2009)
- No significant difference between dyed squid + mackerel
  - Lydon & Starr (2004)
- May reduce target species catch (tuna)
  - Ochi et al. (2011)



- Insufficient data for sea turtles
  - Swimmer et al. (2005)



Supplied by John Cleal

# Hook type

- 3 types
- Different sizes – 8/0 to 18/0
- Offset
  - $>10^\circ$  increases turtle capture (Gilman et al. 2010)



Reproduced from Gilman et al. (2010)



Circle hook 17/0. Supplied by DOC.



# Hook type



- Insufficient data
- 2 studies **18/0 circle hook reduced captures** vs 9/0 J hook
  - Watson et al. (2005); Domingo et al. (2012)
- 1 study **≥ 16/0 circle hook reduced captures** vs J hook
  - Li et al. (2012)



# Hook type



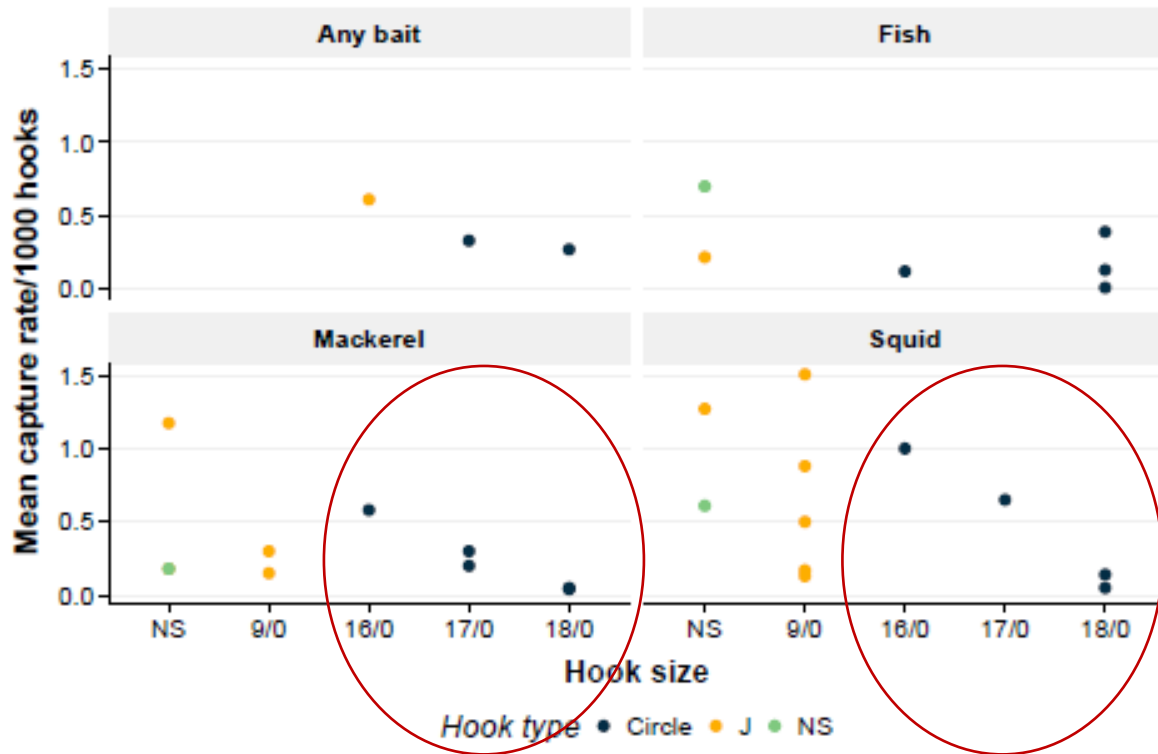
- 2 studies **18/0 circle hook reduced captures vs 9/0 J hook**
  - Gilman et al. (2007); Swimmer et al. (2017)
- 7 studies **17/0 circle hook reduced captures vs large J hook**
  - Bolten & Bjorndal (2005); Coelho et al. (2015); Lima et al. (2023); Mejuto et al. (2008); Pacheco et al. (2011); Santos et al., (2012; 2013)
- **Mixed results** based on fisheries, turtle species
  - E.g., Brazner & McMillan (2009); Domingo et al. (2012)
- **≥16/0 circle hooks more effective**
  - Read (2007); Cambiè et al. (2012); Piovano et al. (2012)
- **Non-offset and offset <10° reduced turtle captures**
  - Coelho et al. (2015)

# Hook type

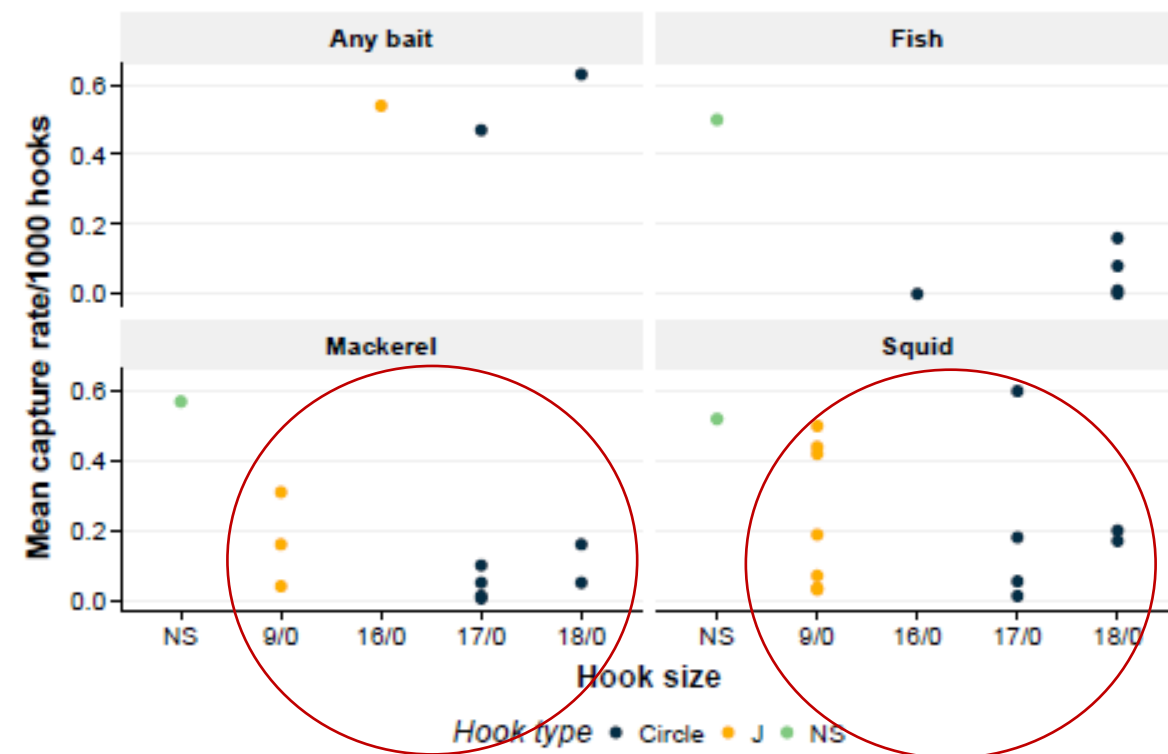
- 2 studies **decrease swordfish rates**
  - Lima et al. (2023); Piovano et al. (2012)
- 1 study **decrease tuna rates**
  - Read et al. (2007)
- 2 studies **no change or increase in target species rates**
  - Watson et al. (2005); Domingo et al. (2012)
- May also increase shark/other fish species bycatch

# Capture rates of reviewed sources

## Loggerhead turtle



## Leatherback turtle



# Objectives

①

## Literature review longline fisheries

1. Hook, bait type on seabird + turtle bycatch rates
2. Recommendations for improved data collection

③

## Available data sources of bycatch with hook, bait type information

②

## International literature review on fisheries best practice

④

## Questionnaire for SLL operators

1. Design and summarise responses
2. Characterise current gear set-ups in SLL fisheries
3. Identify hooks, baits effective for bycatch mitigation
4. Inform protected species risk management plans

# Bait type - Best practice

- **Recommends fish/mackerel bait**

- Acknowledge cost, potential target catch reduction
- In combination with other mitigation methods
- E.g., 'Guidelines to Reduce Sea Turtle Mortality in Fishing Operations' (Gilman et al., 2010); Sustainable Fisheries Partnership



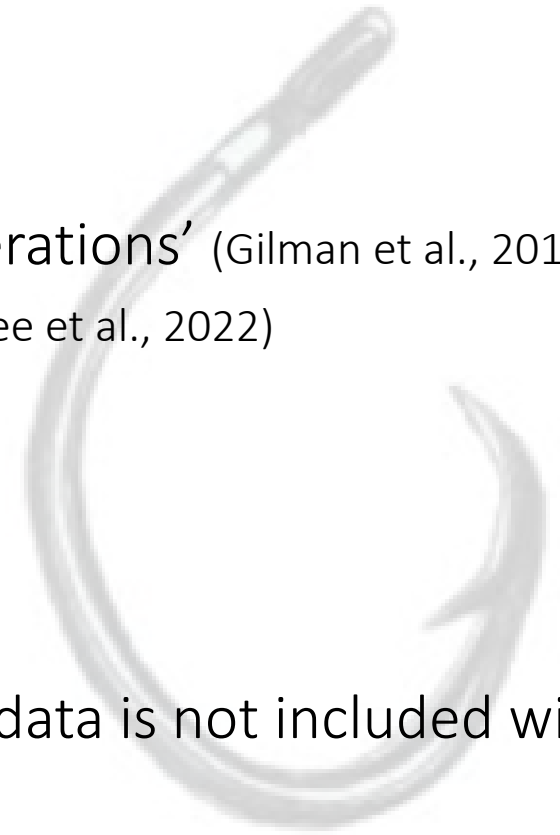
- **Dye bait blue** to reduce seabird bycatch

- If day-setting
- Increased bird attendance
- Full moon
- ACAP - not enough evidence, not recommended



# Hook type - Best practice

- **Recommends circle hooks  $\geq 17/0$** 
  - Acknowledge potential target catch reduction
  - 16/0 circle hooks currently the largest hooks used in NZ SLL
  - E.g., 'Guidelines to Reduce Sea Turtle Mortality in Fishing Operations' (Gilman et al., 2010); Western and Central Pacific Fisheries Commission (WCPFC) (Lee et al., 2022)
- **Recommends offset  $\leq 10^\circ$** 
  - Lack of reporting of offset, often unknown
  - No way to currently examine the effect of offset, considering data is not included with bycatch reporting or necropsy
  - E.g., WCPFC (Lee et al., 2022)



# Objectives

①

## Literature review longline fisheries

1. Hook, bait type on seabird + turtle bycatch rates
2. Recommendations for improved data collection

③

## Available data sources of bycatch with hook, bait type information

②

## International literature review on fisheries best practice

④

## Questionnaire for SLL operators

1. Design and summarise responses
2. Characterise current gear set-ups in SLL fisheries
3. Identify hooks, baits effective for bycatch mitigation
4. Inform protected species risk management plans



# Data sources

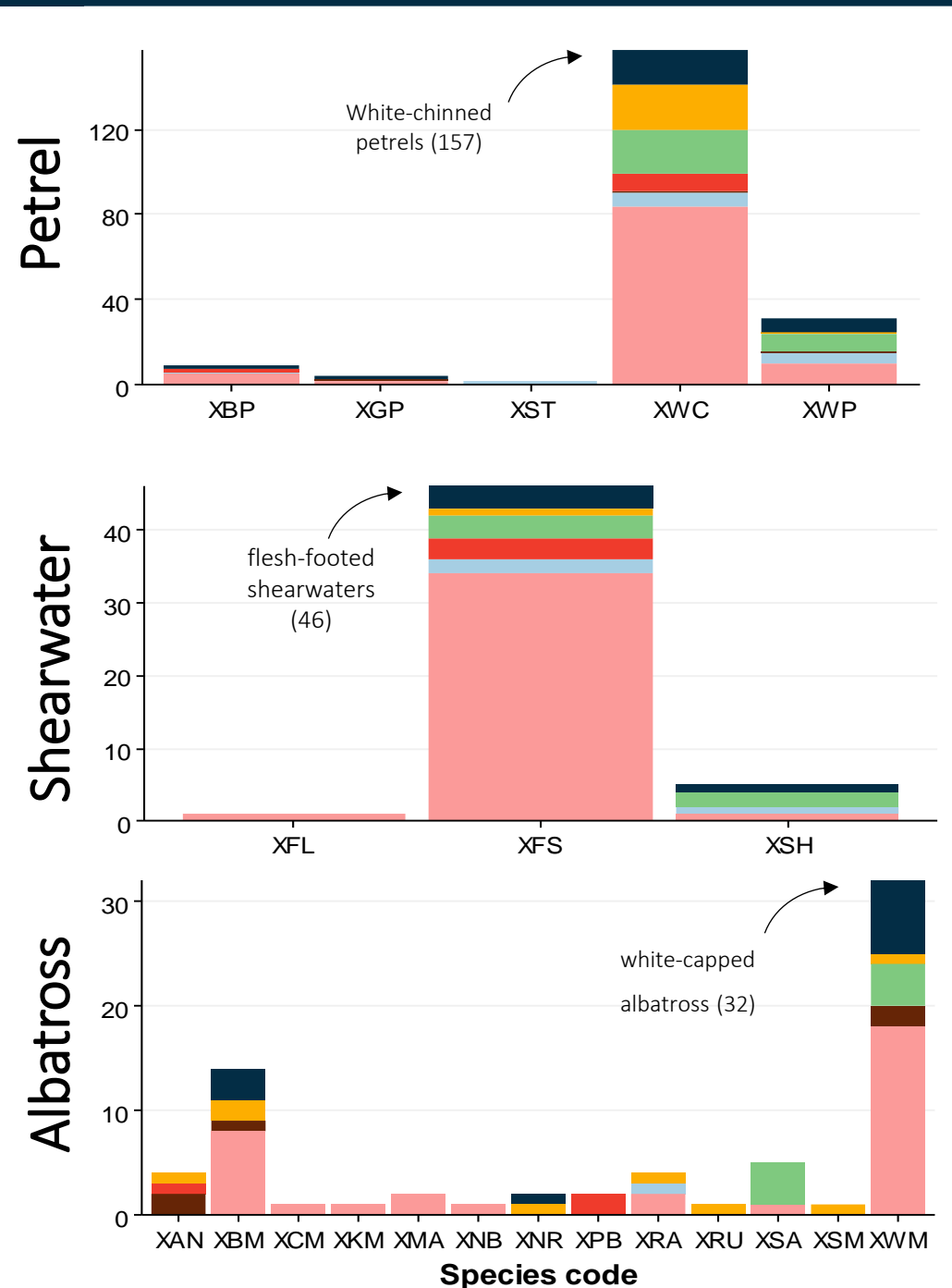
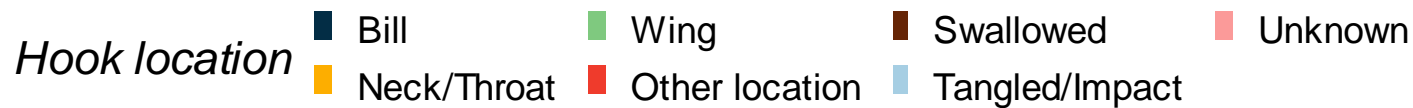
*Centralised Observer Database (COD) - MPI*  
*Protected Species Captures Database (PSCDB) - MPI*

- 265 captures with reported hook/bait type 2017-2021
- Mostly flesh-footed shearwaters (95), white-chinned petrels (42)
- **Circle hooks** used exclusively since 2018
- **16/0 (77% trips)**; 14/0, 15/0, 17/0, 18/0 used for <3 trips each
- **Squid** for all protected species capture
- **Not sufficient to make any comparisons between capture rates**

# Data sources

## *Seabird necropsy database (DOC/Wildlife Management International)*

- 329 necropsies 2020-2024
- 52% necropsies - hook location undetermined
- No information on hook size or bait type



# Objectives

①

## Literature review longline fisheries

1. Hook, bait type on seabird + turtle bycatch rates
2. Recommendations for improved data collection

③

## Available data sources of bycatch with hook, bait type information

②

## International literature review on fisheries best practice

④

## Questionnaire for SLL operators

1. Design and summarise responses
2. Characterise current gear set-ups in SLL fisheries
3. Identify hooks, baits effective for bycatch mitigation
4. Inform protected species risk management plans

# Questionnaire

- MS forms; multiple choice, free text
- Consulted with DOC,
- 4 target species: SWO, BIG, STN, OTH (ALB)
- 71 questions, but most skipped if same gear used for different target species
- Administered by John Cleal (DOC Liaison Office; CSP project MIT2023-05)

**17 responses from SLL fleet**

**11 South Island**

**6 North Island**

Target species 1- Hook/bait combination **currently used most often**

Fill in answers for the primary target species

1. What is your primary target species?

Select your answer

2. Hook type/size used most often

Select your answer

3. Barb offset angle of hook

None

10 degrees

Other

4. Bait type used most often

Select multiple answers if you use more than 1 bait but on DIFFERENT sets. Enter a species if 'Other' selected.

Squid

Mackerel

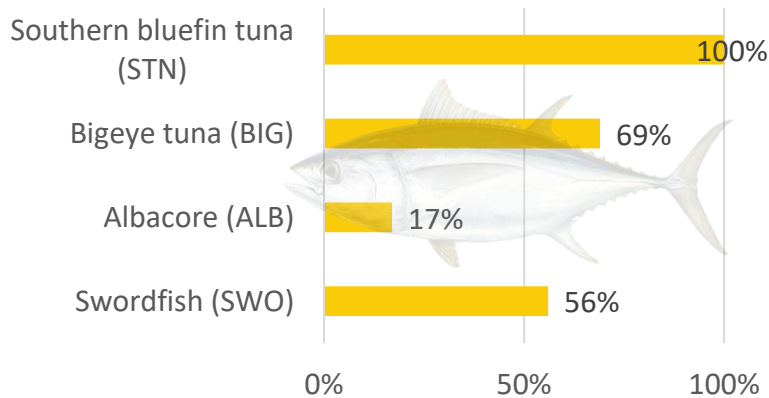
Squid and mackerel - same set

Artificial

# Questionnaire

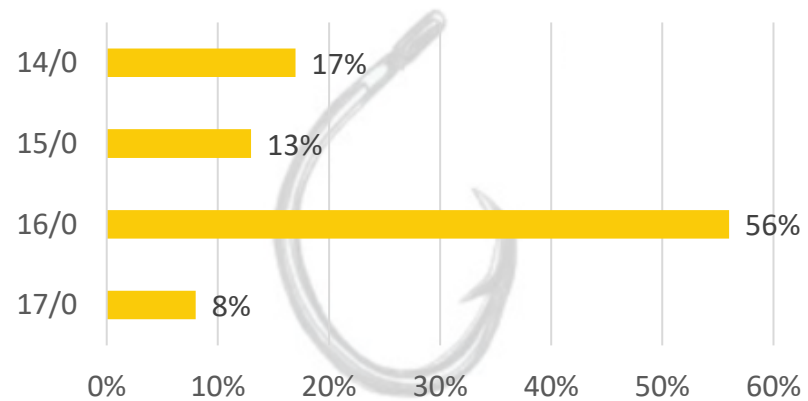
100%

STN



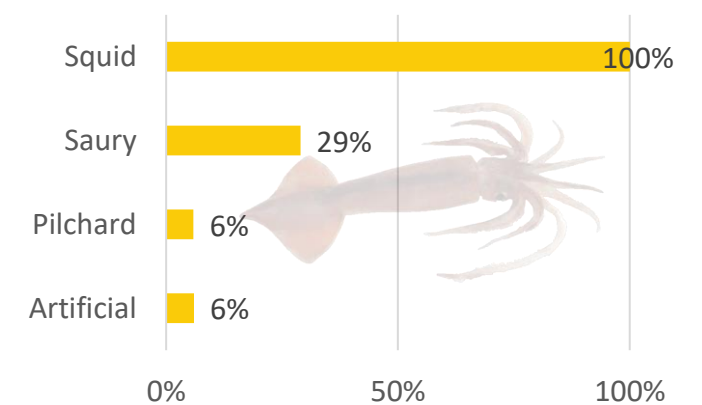
100%

Circle hooks



100%

Squid bait



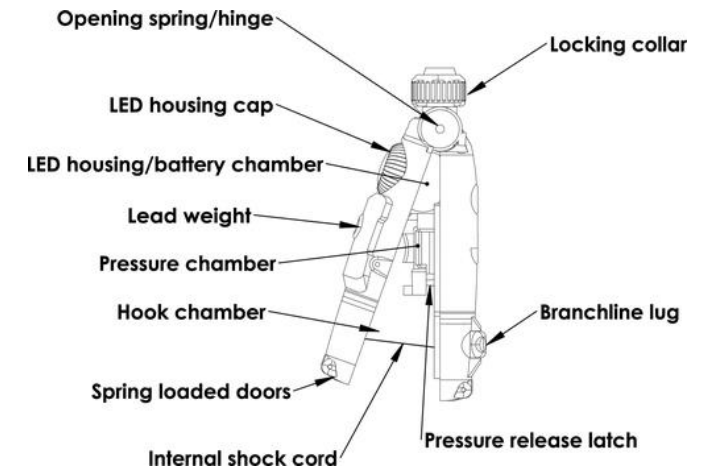
2 -> STN  
11 -> STN, BIG, SWO  
3 -> STN, BIG, ALB  
1 -> STN, SWO

64% blue dyed squid  
(usually at full moon)

# Other responses

## Gear

- Hookpods (59%)
- Line and/or hook weighting (18%)
- Lumo leads (29%)



Reproduced from Sullivan et al. (2017)

## Other

## Comments

- All foresee problems changing from squid to fish (8 'maybe') due to target species catch reductions, price, difficulty dying fish blue
- 41% foresee problems increasing to >16/0 hooks (most will not use >17/0 hooks)
  - All (3) ALB fishers said >14/0 hooks will reduce target catch rates
  - Underwater bait-setter set 14/0 or 15/0 hooks

# Conclusions

Limited conclusive evidence of hook/bait type effects on sea turtles and (especially) seabirds

Data limitations prevent bycatch rate comparisons in NZ

## Best practices and recommendations

- **BAIT:** Fish rather than squid
- **HOOKS:** Larger circle hooks  $\geq 17/0$
- **MITIGATION:** Dying bait, use of Hookpods/weighted hooks/lines, tori lines, night setting, offal management
- Improved data collection for bycatch required (e.g., hook, bait type)

# Thank you

## Acknowledgements:

Dr. Karen Middlemiss (DOC)

Dr. Tiffany Plencner (DOC)

Dr. Igor Debski (DOC)

John Cleal (LO)

Biz Bell

Wildlife Management International

Ministry for Primary Industries

SLL operators



# Proteus

*Knowledge | Results | Data*

[www.proteus.co.nz](http://www.proteus.co.nz)



- ACAP. (2023). *ACAP summary advice for reducing the impact of pelagic longline fisheries on seabirds* [Thirteenth Meeting of the Advisory Committee]. Agreement on the Conservation of Albatrosses and Petrels.
- Báez, J. C. et al. (2010). Captures of swordfish *Xiphias gladius* (Linnaeus 1758) and loggerhead sea turtles *Caretta caretta* (Linnaeus 1758) associated with different bait combinations in the Western Mediterranean surface longline fishery. *Journal of Applied Ichthyology*, 26(1).
- Bolten, A. B. & Bjorndal, K. A. (2005). *Experiment to evaluate gear modification on rates of sea turtle bycatch in the swordfish longline fishery in the Azores*. Final report prepared for NOAA.
- Brazner, J. C. & McMillan, J. (2008). Loggerhead turtle (*Caretta caretta*) bycatch in Canadian pelagic longline fisheries: Relative importance in the western North Atlantic and opportunities for mitigation. *Fisheries Research*, 91(2–3).
- Brothers, N. (2023). *Procella Hook development update and heavy hook inclusion in ACAP best practice pelagic longline seabird bycatch mitigation advice* (pp. 1–7) Eleventh Meeting of the Seabird Bycatch Working Group. Agreement on the Conservation of Albatrosses and Petrels (ACAP).
- Cambiè, G. et al. (2012). Effects of small (13/0) circle hooks on loggerhead sea turtle bycatch in a small-scale, Italian pelagic longline fishery. *Bulletin of Marine Science*, 88(3).
- Cocking, L. J. et al. (2008). Seabird bycatch mitigation and blue-dyed bait: A spectral and experimental assessment. *Biological Conservation*, 141(5).
- Coelho, R. et al. (2015). Effects of hook and bait in a tropical northeast Atlantic pelagic longline fishery: Part I—Incidental sea turtle bycatch. *Fisheries Research*, 164.
- Domingo, A. et al. (2012). Circle hook performance in the Uruguayan Pelagic Longline Fishery. *Bulletin of Marine Science*, 88(3).
- Echwikhi, K. et al. (2010). Effect of type of bait on pelagic longline fishery–loggerhead turtle interactions in the Gulf of Gabes (Tunisia). *Aquatic Conservation: Marine and Freshwater Ecosystems*, 20(5).
- Gilman, E. et al. (2007). Reducing sea turtle interactions in the Hawaii-based longline swordfish fishery. *Biological Conservation*, 139(1–2).
- Li, Y., Browder, J. A., & Jiao, Y. (2012). Hook effects on seabird bycatch in the United States Atlantic pelagic longline fishery. *Bulletin of Marine Science*, 88(3).
- Lima, F. D. et al. (2023). Effects of gear modifications in a North Atlantic pelagic longline fishery: A multiyear study. *PLOS ONE*, 18(10).
- Lydon, G. & Starr, P. (2004). *Effect of blue dyed bait on incidental seabird mortalities and fish catch rates on a commercial longliner fishing off East Cape, New Zealand* (p. 22). Department of Conservation.
- Mejuto, J., García-Cortés, B., & Ramos-Cartelle, A. (2008). Trials using different hook and bait types in the configuration of the surface longline gear used by the Spanish swordfish (*Xiphias gladius*) fishery in the Atlantic Ocean. *ICCAT Collective Volume of Scientific Papers*, 62(6).
- Ochi, D., Minami, H., & Sato, N. (2011). *A comparison of two blue-dyed bait types for reducing incidental catch of seabirds in the experimental operations of the Japanese Southern bluefin tuna longline* (WCPFC-SC7-2011/EB-WP-09; p. 16). Western and Central Pacific Fisheries Commission.
- Pacheco, J. C. et al. (2011). A comparison of circle hook and J hook performance in a western equatorial Atlantic Ocean pelagic longline fishery. *Fisheries Research*, 107(1–3).
- Piovano, S. et al. (2012). Evaluation of a bycatch reduction technology by fishermen: A case study from Sicily. *Marine Policy*, 36(1).
- Read, A. J. (2007). Do circle hooks reduce the mortality of sea turtles in pelagic longlines? A review of recent experiments. *Biological Conservation*, 135(2).
- Richards, P.M. et al. (2012). Can circle hook offset combined with baiting technique affect catch and bycatch in pelagic longline fisheries? *Bulletin of Marine Science*, 88(3).
- Santos, C. C. et al. (2023). A review of reported effects of pelagic longline fishing gear configurations on target, bycatch and vulnerable species. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 34(1).
- Santos, M. N. et al. (2012). Effects of hook and bait on sea turtle catches in an equatorial Atlantic pelagic longline fishery. *Bulletin of Marine Science*, 88(3).
- Santos, M. N. et al. (2013). Effects of 17/0 circle hooks and bait on sea turtles bycatch in a Southern Atlantic swordfish longline fishery. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 23(5).
- Sullivan, B.J. et al. (2018). At-sea trialling of the Hookpod: A ‘one-stop’ mitigation solution for seabird bycatch in pelagic longline fisheries. *Animal Conservation*, 21(2).
- Swimmer, Y. et al. (2005). Food color and marine turtle feeding behavior: Can blue bait reduce turtle bycatch in commercial fisheries? *Marine Ecology Progress Series*, 295.
- Watson, J. W. et al. (2005). Fishing methods to reduce sea turtle mortality associated with pelagic longlines. *Canadian Journal of Fisheries and Aquatic Sciences*, 62(5).
- Yokota, K., Kiyota, M., & Okamura, H. (2009). Effect of bait species and color on sea turtle bycatch and fish catch in a pelagic longline fishery. *Fisheries Research*, 97.