Bait retention as a driver to mitigation use in the surface longline fishery

(MIT2022-04)

DRAFT (do not cite w/o author's permission)

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Proteus

Knowledge | Results | Data

Disclosure

Draft report review by FNZ prior to TWG:

- Broad-brush calculation of economic consequences of bait loss being considered unsuitable:
  - Too many assumptions required; data on export values not suitable
  - Calculation removed from report
  - General feedback on what would be required were considered as discussion points for report

- Clarification required which SLL fisheries are represented in data summaries and whether fishing effort or no. of fishing events being shown
  - Clarification added that small-vessel SLL fisheries are shown
  - Fishing effort (no. of hooks) being summarized)

Objective

CSP Objective: To quantify bait loss rates in relation to seabird attacks

Key aims discussed in presentation:

1. Extract bait loss rates incl. economic costs and methods used from the scientific literature
2. Identify data sources that allow quantifying bait loss in NZ's commercial surface longline fisheries (SLL)

Background:

This is the first CSP project to investigate this topic and hasn't leveraged off previous years

Aim 1. Bait loss rates, economic costs and methods used from the scientific literature

Bait loss (caused by seabirds) definition

The partial or complete removal of hooked bait from fishing gear by seabirds, which also includes hooks with caught birds (i.e., the bait is not available to attract target fish species).

(Donoghue et al. 2003, Muñoz-Lechuga et al. 2016)

Figure taken from: https://gulfjournal.org.nz/article/what-threats-do-seabirds-face/

Bait loss in NZ SLL fishery

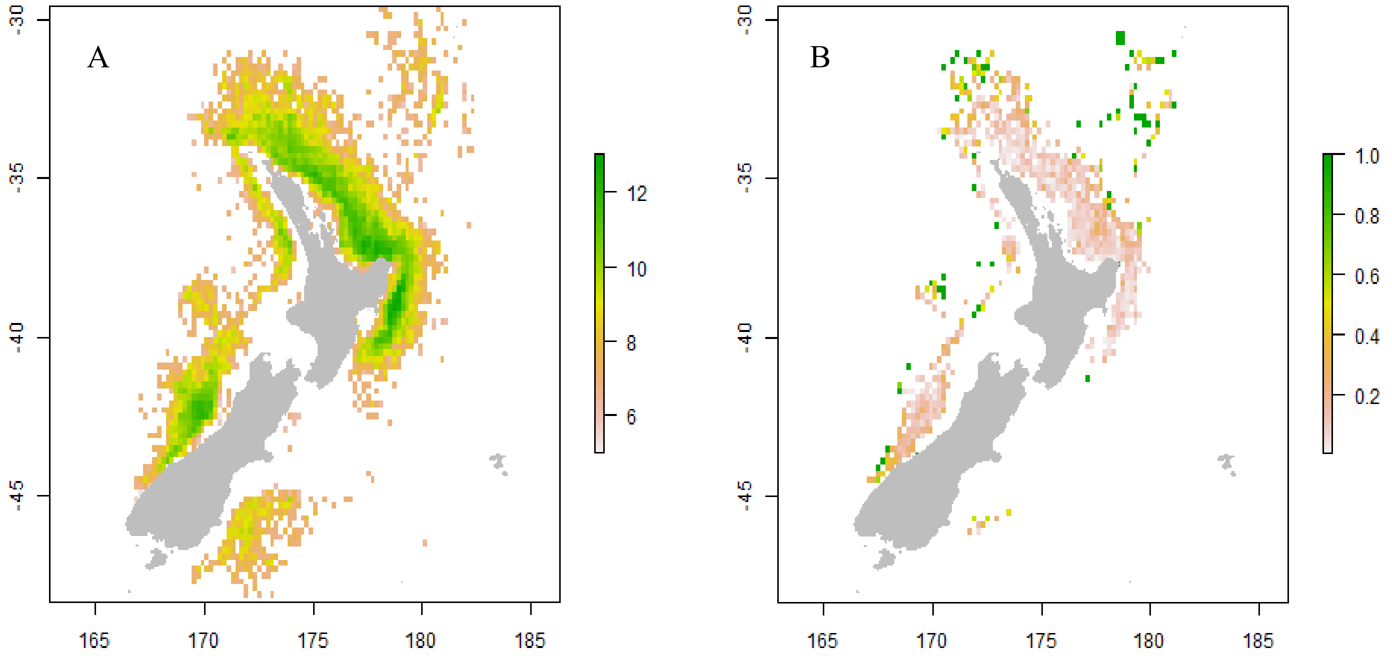
Domestic vessels (except 2006/07 which includes AUS vessel)

Fishing year	No. of hooks	% of hooks observed	Vessel length (m)
2006/07	2 358 702	9%	12.9-29
2007/08	1 677 154	8%	12-25.4
2008/09	2 306 403	7%	11-25.3
2009/10	2 516 706	7%	11-25.3
2010/11	2 684 809	6%	11-21
2011/12	2 548 437	7%	12-23.78
2012/13	2 389 412	3%	12-23.78
2013/14	1 896 434	7%	12-23.78
2014/15	1 791 086	6%	12-23
2015/16	**2 358 541**	**14%**	**5.6-29**
2016/17	**2 094 236**	**16%**	**13.8-23**
2017/18	**2 291 381**	**13%**	**13.4-23**
2018/19	**2 055 736**	**9%**	**13.4-25.4**
2019/20	**2 000 759**	**10%**	**13.4-25.4**

Japanese vessels

Fishing year	No. of hooks	% of hooks observed	Vessel length (m)
2006/07	1 381 210	61%	56-56.37
2007/08	568 285	50%	53.6-56.1
2008/09	809 230	97%	56-56.7
2009/10	478 558	100%	56-56.7
2010/11	503 370	100%	56-56.7
2011/12	551 440	100%	56-56.7
2012/13	487 520	100%	56-56.7
2013/14	653 330	100%	56-56.7
2014/15	622 300	99%	54.7-56.1
2015/16	0	-	-
2016/17	0	-	-
2017/18	0	-	-
2018/19	0	-	-
2019/20	0	-	-

Small-vessel (< 45 m) SLL fishing in NZ



Spatial distribution of total and observed small-vessel surface-longline fishing activity for domestic and Australian vessels between the 2006–07 and 2019–20 fishing years: (A) total fishing effort (number of hooks set) on log-scale per grid cell, (B) proportion of observed fishing effort per grid cell (grid cells without any observed fishing events are blank). The resolution is 0.2° grid cells.

Literature review: Methods

Google Scholar search terms:

- ‘bait depredation seabirds’
- ‘bait loss seabirds’
- ‘bait loss economic cost’

Articles were assessed as to whether they contain information on bait loss rates, economic effects of bait loss, and methods used to estimate bait loss.

The literature review was predominantly limited to SLL fisheries.

Also general Google search done to find potentially relevant technical working group meeting minutes – none found.

Methods (data)

The following data were assessed for their usefulness to inform the estimation of bait loss in New Zealand's SLL fisheries:

- Protected Species Captures Database (PSCDB)
- Centralised Observer Database (COD)
- Catch effort data from the Enterprise Data Warehouse (EDW)
- Seabird necropsy reports
- Counts of seabirds around fishing vessels

No data grooming done.

Results (literature survey)

- 26 initially assessed publications
- 12 containing information on either bait loss or economic consequences of bait loss
  - 11 with information on bait loss, such as estimates and methods to determine bait loss
  - 2 publications provided information on fishery-related data that is needed to estimate the economic consequences of bait loss
- 14 publications without explicit information on bait loss rates in SLL fisheries or economic consequences

Results (literature survey)

3 types of bait loss observations identified:

1. Direct observations of bait loss caused by seabirds
2. Indirect observations of bait loss caused by seabirds
3. Indirect observations of overall bait loss

Estimates of bait loss (refer to report) not shown in presentation, because fishing practices are not comparable across studies and to NZ's SLL fisheries.

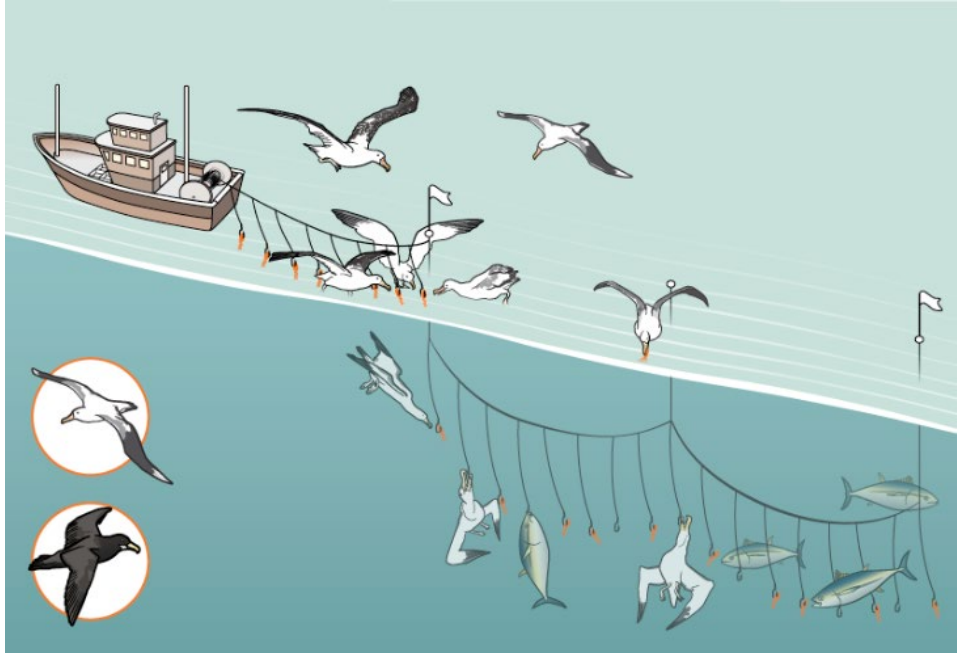


Figure taken from: These Simple Fixes Could Save Thousands of Birds a Year From Fishing Boats | Science | Smithsonian Magazine

Results (literature survey: bait loss)

Direct observations of bait loss caused by seabirds

- Direct observations (details of method unspecified) (Brothers 2017)
- Observer-recorded seabird interactions during first 30 sec. of setting/hauling during daylight: (i) successful, (ii) unsuccessful, (iii) caught, (iv) possibly, and (v) unsure (Brothers et al. 2010)
- Observer-recorded counts of albatrosses behind and astern the vessels and hook stealing attempts from open deck at 3-min intervals: Successful, unsuccessful, bird caught, bird not caught, or unknown (Brothers 1991)
- Observer-recorded seabird attacks on sinking baits during daylight (Melvin & Walker 2008)
- Observer-recorded unsuccessful bait depredation attempts by seabirds and contacts with gear near the bait (Gilman et al. 2003)
- Observer-recorded seabird behaviour during line setting until dusk. 15 min. recording of seabird attacks: primary - direct attempt to steal bait (dives, underwater plunges over baited hooks); secondary - charging bait from bird making primary attack (Sato et al. 2013)
- Observer-recorded seabird attacks (primary and secondary) during daylight (Melvin et al. 2014)

Results (literature survey: bait loss)

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Results (literature survey: bait loss)

Indirect observations of bait loss caused by seabirds

- Lines retrieved immediately after setting to reduce bait loss due to other factors than seabird (Løkkeborg 1998)
- Lines retrieved immediately after setting to reduce bait loss due to other factors than seabird (Løkkeborg & Robertson 2002)
- Count of empty hooks due to seabirds immediately after setting lines without anchors (Sànchez & Belda 2003)

Indirect observations of overall bait loss

- Bait condition on hauling: Bait remaining if >25% of original bait size remaining; Bait lost if <25% of original bait size remaining (Kumar et al. 2015)
- Bait retention was assessed for each haul by checking first 100 hooks for presence/absence of bait (caught fish or seabirds considered bait loss) (Gilman et al. 2003)

Results (literature survey: bait loss)

Indirect detection of bait loss caused by seabirds

- Lines retrieved immediately after setting to reduce bait loss due to other factors than seabird (Løkkeborg 1998)
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Discussion (literature survey: bait loss)

- Bait loss estimates (not presented) not comparable due to different fishing practices between studies and inconsistencies in applied methods to determine bait loss.
- Extrapolating bait loss estimates from other studies to NZ fisheries is risky, because of potentially different fishing practices and seabird species composition – both factors could influence bait loss.
- Differences in bait loss (not presented) between different mitigation measures shown by assessed studies, but statistics to assess accuracy of estimates were often not provided.
- All methods just providing approximations of bait loss caused by seabirds:
  - Gross bait loss (includes all causes): overestimating bait loss caused by seabirds
  - Seabird interactions or primary attacks on bait: still overestimating bait loss caused by seabirds, because bait taking attempts are not always successful
  - Secondary attacks (on successful primary attackers): conservative measure but potentially underestimated bait loss caused by seabirds, because not all primary attackers are attacked.
- Observation need to be done during day light (not representative of actual fishing practices) and/or limited time intervals of total fishing activity.
- False positive and false negative rates not assessed

Results (literature survey: economics)

<u>Brothers (2017)</u>

Assumptions:

- Daily operating cost of (Japanese) longline vessel of $10 000
- 200 operating days per year
- 0.33% average hooking rate of southern bluefin tuna
- Average southern bluefin tuna weight of 62.8kg

Results:

- Without bait throwing devices (bait loss rate of 2.5 baits per 1000 hooks): $15 543 deficiency due to bait loss (i.e., lost fish)
- With bait throwing devices (bait loss rate of 1.5 baits per hook), the fishing fleet might be able to increase fishing effort line setting at a higher rate)!
  - Maintaining current fishing effort: $8704 deficiency due to bait loss (i.e., lost fish)
  - Fishing effort increased: $12 403 deficiency due to bait loss (i.e., lost fish)

Results (literature survey: economics)

Kühn (2016)

*Potential loss ($, per trip) = ((x*a)*b)*y*

x: number of birds around a vessel (unknown; based on different modelled scenarios)

a: average number of bait found in bird stomachs (calculated from data on the frequency and quantity of bait in bycaught seabird stomachs)

b: average price per fish (from literature and market research)

y: % of hooks that catch a fish (unknown; based on different modelled scenarios)

Discussion (literature survey: economics)

- No robust method identified
- Existing methods either requiring strong assumptions (e.g., Brothers 2017) and/or are data hungry (e.g., Kühn 2016)

- Lesson learned:
  - Some bycatch mitigation measure (e.g., line shooter) allow for increased effort and therefore offsetting economic benefits of improved bait retention (e.g., Brothers 2017)
- Concerns:
  - Number of birds around a vessel as used in Kühn (2016): needs to be more location-specific (e.g., birds closer to line with higher chance of stealing bait)
  - Average number of bait found in bird stomachs as used in Kühn (2016): not a random sample of all seabirds that interact with fishing gear (only those getting caught)
  - Variation in input variables (e.g., fishing efficiency, operating costs) need to be considered
  - Modelling needs to account for bait stealing on hooks that would not have caught fish if bait was retained

Aim 2.
Identify data sources that allow quantifying bait loss in NZ’s commercial surface longline fisheries (SLL)

Results (data: PSC database)

Domestic vessels (except 2006/07 which includes AUS vessel)

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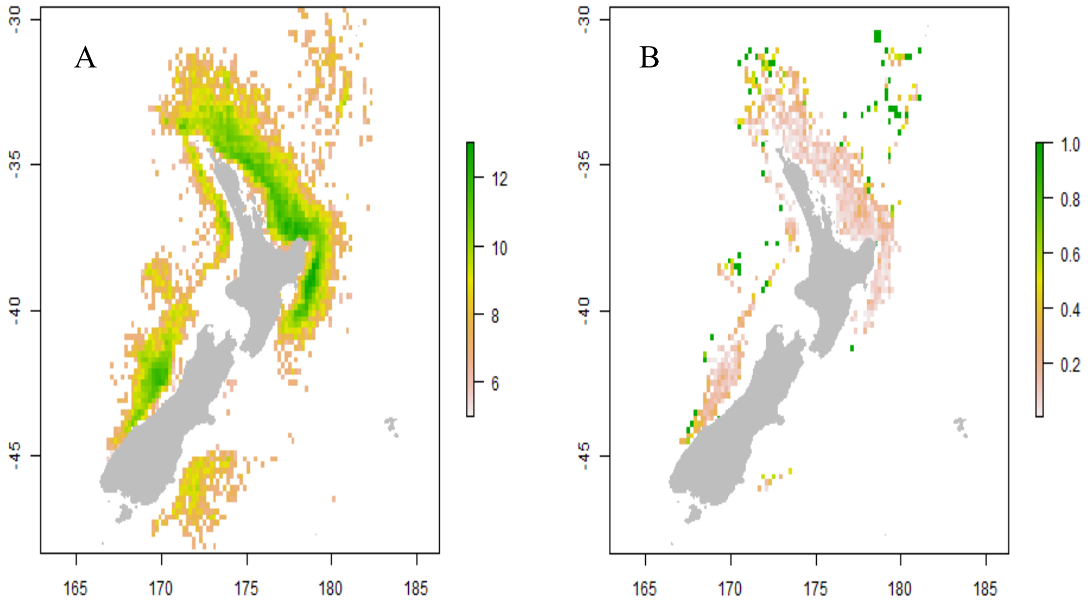

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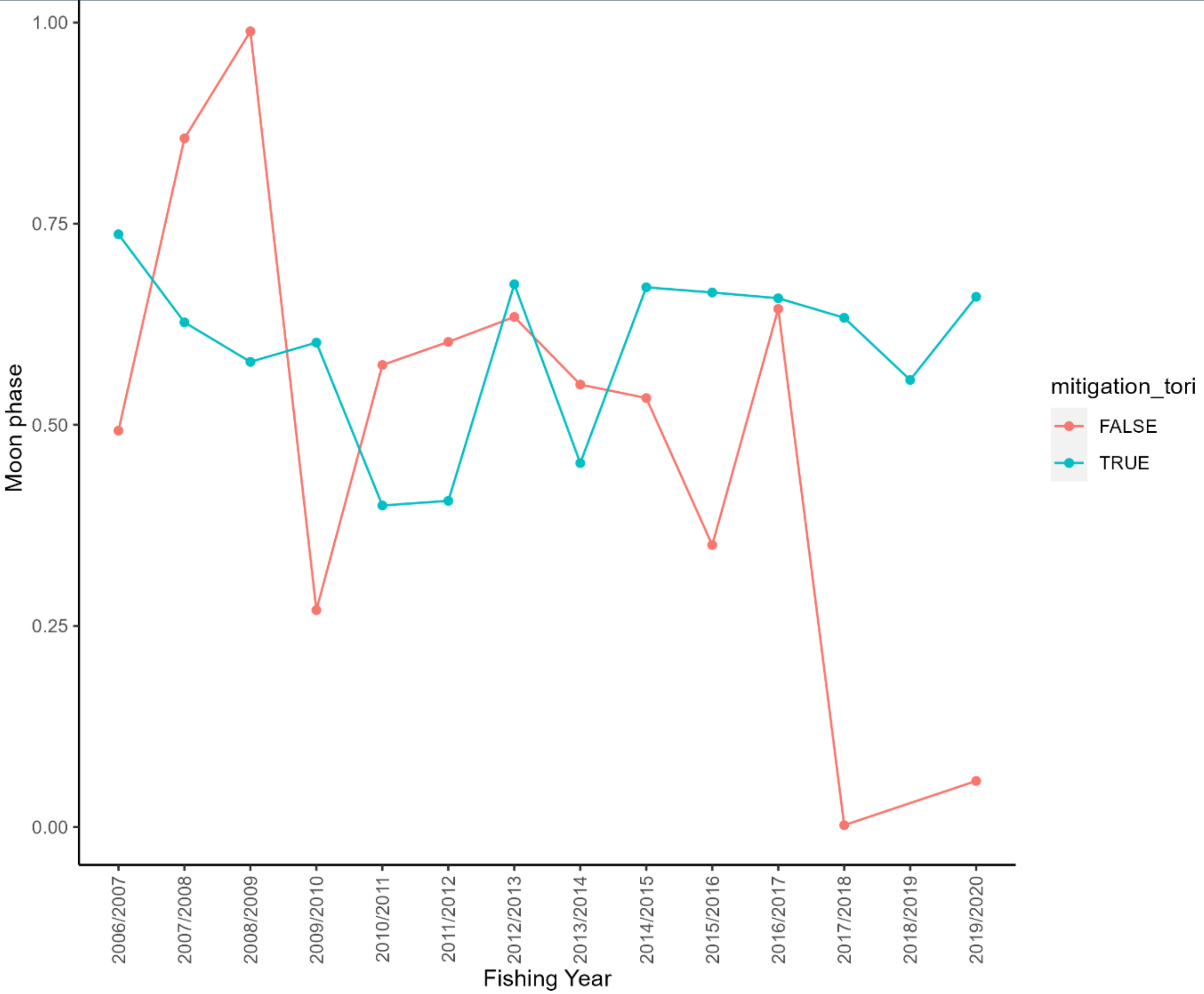

Average moon phase (fractional illumination of the moon's surface) per fishing year for vessel with (TRUE) and without (FALSE) tori line (mitigation_tori) in small-vessel surface-longline fishing (domestic and Australian flagged vessels) in fishery management area 1.

Results (data)

<u>Centralised Observer Database (COD)</u>

- Variables are contained in the COD that could also be correlated with bait loss (e.g., gear configuration variables; fishing practice variables)
- Meyer & MacKenzie (2022):
  - Current data collection protocols allow for subjectivity during data collection (e.g., deck lighting which could attract birds is recorded as to whether there existed unnecessary deck lighting).
  - Moreover, scarce observations for bycatch mitigation measures (e.g., whether tori line was over bait entry point) limit to assess their potential to reduce bycatch (and hence bait loss)

<u>Catch effort data from the Enterprise Data Warehouse (EDW)</u>

See comments made re PSC database and COD

<u>Seabird necropsy reports</u>

- For SLL fishing (2010–11 to 2020–21 fishing years): 375 records of necropsied seabirds
- only 18 records (5%) contained the term ‘bait’ in the column ‘stomach content’

Results (data: Counts of seabirds around fishing vessels)

	Number of observations				
Fishing year	Hauling	Setting	Fishing	Unspecified	Total
2007–08	481	21			502
2008–09	1007	20			1027
2009–10	1048	1	20		1069
2010–11	1635			23	1658
2011–12	1536	16		45	1597
2012–13	1120			21	1141
2013–14	320				320
2014–15	516			89	605
2015–16	2036				2036
2016–17	2118	8		5	2131
2017–18	2421	4			2425

Number of observations in "Count of all seabirds around observed vessels" dataset for SLL fishing between the 2007–08 and 2017–18 fishing years based on paper forms.

Results (data: Counts of seabirds around fishing vessels)

- Linking “Counts of seabirds …” data to PSC database and COD compromised due to lack of unique fishing event identifiers between datasets

Discussion (data)

- Most assessed data are not fit-for-purpose

- PSC database, COD, EDW
  - bait taking attempts by birds not recorded
  - Variables that are potentially correlated with bait loss are scarce (updated data collection protocols are too recent)
  - Green weight could be used, but many confounding variables are not consistently recorded

- Necropsy data:
  - Sparse and not target species-specific
  - Stomach contents data are biased towards bycaught seabirds (data on non-bycaught seabirds needed)

- ‘Counts of seabirds around fishing vessels’ data
  - Mostly collected during hauling: irrelevant for studying economic effects of bait loss

Recommendations

Recommendations (bait loss)

Two options:

1. Updating existing data collection protocols (i.e., observer programme and electronic monitoring) to monitor
    a) bait loss caused by seabirds or
    b) catch-per-unit-effort (CPUE) as indirect indicator of bait loss
2. Implementing specific case-control study re (a) bait loss caused by seabirds or (b) CPUE

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- a) Focused on mechanistics of bait loss
- b) Focused on relevant metric for commercial fishers: reduced catch-per-unit-effort -> financial deficit
- a) & b) Potentially many confounding factors influencing bait loss and/or CPUE
- a) & b) Would require significant expansion of observer coverage

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Required instructions:

- Consistent definition of bait taking attempts (and whether these were successful)
- Timing of observations (e.g., observing hooks until these are fully submerged)
- Area of observations (e.g., bait-taking attempts until 150 m astern the vessel)
- Collecting of confounding variables (e.g., moon phase, time and location of fishing)
- Collection of secondary attacks as a conservative estimate of bait loss caused by seabirds
- Expand necropsies to assess stomach contents to species level of ingested bait, and include stomach contents of seabirds not being bycaught

Recommendations (bait loss)

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2. Implementing specific case-control study re (a) bait loss caused by seabirds or (b) CPUE

- A case-control study design would allow assessing how bait loss caused by seabirds or catch per unit effort changes with different seabird bycatch mitigation strategies
- Within NZ: Alternative bycatch mitigation strategies could be compared vs. existing legally required strategies
- Outside NZ: Different bycatch mitigation strategies could be compared vs. no bycatch mitigation (though fishing practices might not be applicable to NZ fisheries)

Recommendations (bait loss)

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I. Fishing practices need to be held constant between vessels with different bycatch mitigation measures (not all relevant fishing practices would be reflected in the bait loss estimates) OR

II. Vessels with different fishing practices could alternate bycatch mitigation measures (e.g., switching bycatch mitigation measures half-way through the season) such that all assessed vessels were operating under different bycatch mitigation strategies OR

III. Hybrid of (I) and (II), to fix as many factors as possible but also control for between-vessel variability

Recommendations (bait loss)

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Applicable to (1) and (2):

- Report standard statistics (e.g., standard error) of estimated bait loss
- The selection of studied vessels should be based on a random sampling design, and not based on logistic factors (e.g., better communication with specific fisheries, length of fishing trip etc.) to avoid bias in estimated bait loss

Recommendations (economics)

- Collect data on direct revenue for catch and costs of bycatch mitigation measure and other operational costs, because the scope of such work would be to incentivize fishers for the use of specific bycatch mitigation measures.
    - Include information on possible changes of fishing practice as a result of bycatch mitigation strategies (e.g., bait shooter)
- Within New Zealand, commercial fishers can only sell fish to licensed fish receivers, and data on fish sold and prices for fish at the time of selling might be available through seafood industry owned databases such as FishServe (https://www.fishserve.co.nz/).
- Alternatively, revenue and costs could be directly collected as part of a study dedicated to assessing bait loss (i.e., bait loss could be linked to fisher specific revenue and costs)

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