Review of warp strike mitigation methods on <28m commercial trawl vessels in New Zealand

MIT2022-07A

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DOC CSP TWG, 8 June 2023

Proteus

Knowledge | Results | Data

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Objectives

Phase 1

Literature review

- Effectiveness of warp mitigation in inshore commercial trawl fisheries
- Collate existing data on mitigation use
- Review data collection methods for at-sea trials

Expert workshop

- Determine practical, at-sea methods for evaluating inshore trawl warp mitigation

Phase 2

(MIT2022-07B)

At-sea trials

- Quantify relative effectiveness of mitigation options currently being used
- Inform best practice and recommendations

Literature review

Google Scholar

inshore AND commercial trawl AND fisheries AND seabird AND warp strike AND mitigate

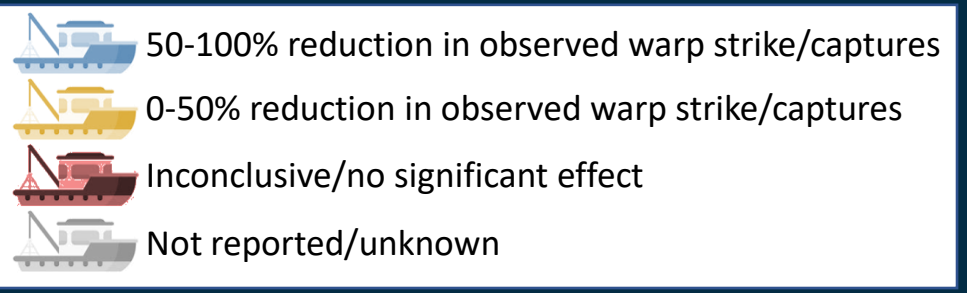
+

DOC provided list of data sources

14 published papers or reports

- Seabird warp strike or captures
- International and national mitigation methods
- Small <28m (4 studies) + large (10 studies) trawl vessels
- ACAP recommendations

Literature review



Reference	Fishery	Vessel class (# of vessels)	Tori lines	Bird baffler	Warp scarer	Warp deflector: pinkie buoy	Warp deflector: plastic cones	Water sprayer	Lasers
González-Zevallos et al. (2007)	ARG hake	Small (3)							
Pierre et al. (2014)	AUS (SESSF)	Small (9)							
Koopman et al. (2018)	AUS	Small (2)		+ pinkie buoy				+ pinkie buoy	
Parker and Rexer-Huber (2019)	NZ	Small, large (33)							
Sullivan et al. (2006)	FLK finfish	Large (1)							
Middleton and Abraham (2007)	NZ squid	Large (18)							
Abraham & Thompson (2009)	NZ squid, hoki	Large							
Melvin et al. (2011)	USA pollock	Large (2)							
Cleal et al. (2012)	NZ hoki	Large (1)							
Snell et al. (2012)	FLK finfish	Large (2)							
Maree et al. (2014)	SA hake	Large (19)							
Tamini et al. (2015)	FLK hake	Large (2)							
Melvin et al. (2016)	USA hake	Large (1)							
Kuepfer (2017)	FLK finfish	Large (1)							

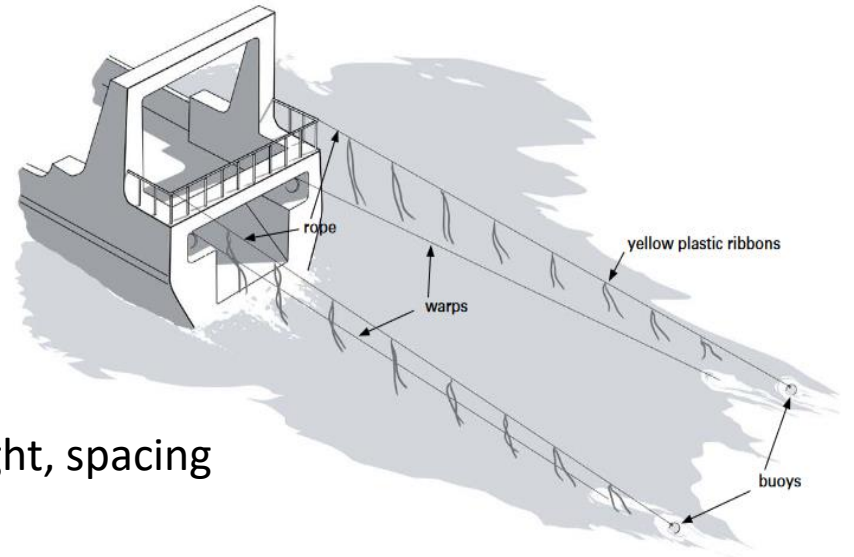
Tori lines

Recommended for testing and continued use

- Accepted as the most effective mitigation measure internationally
- 10% observed inshore tows used tori lines 2013-2017 (Parker & Rexer-Huber 2019)
- **ACAP: recommended best practice**

Cons:

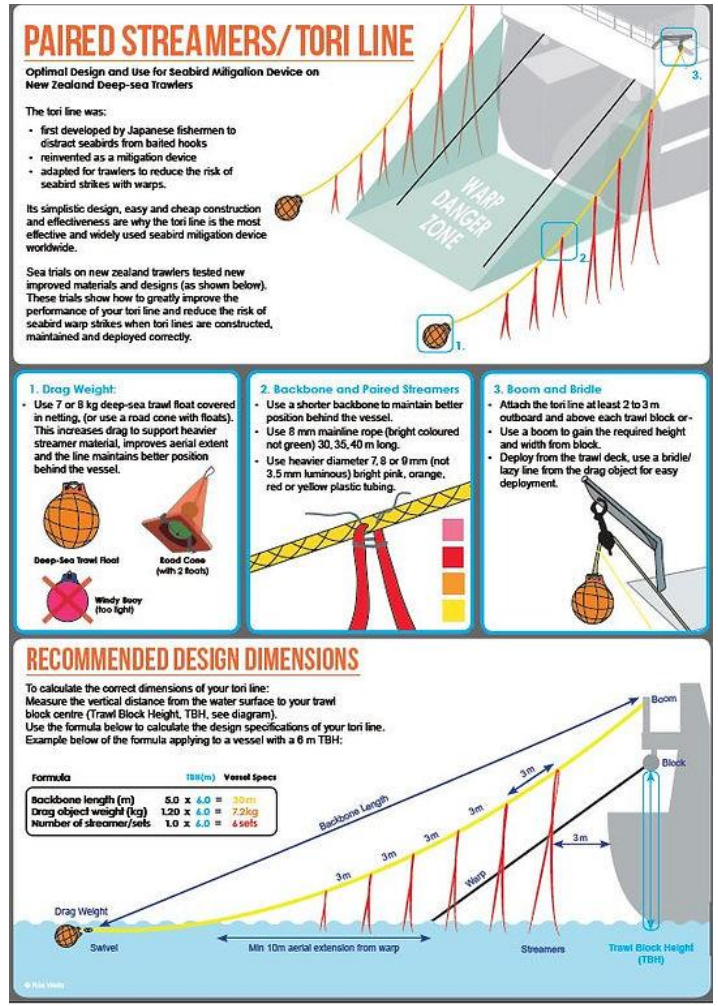
- Tangles with warp cable
- Safety risk; harder to deploy, trawl blocks outboard of hull
- Streamers break/fade
- Limited by weather conditions
- Tori line strike, with reduced severity and mortality rates
- Requires proper position, length, weight, spacing



Source: Sacchi (2021).

Pros:

- Inexpensive
- Easier to setup
- Requires less space on vessel

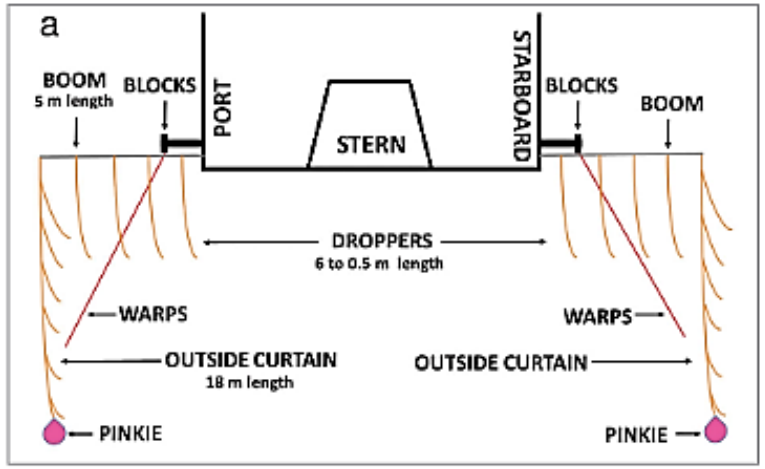


Source: Deepwater Group Ltd. (2018).

Bird bafflers

Recommended for testing and continued use

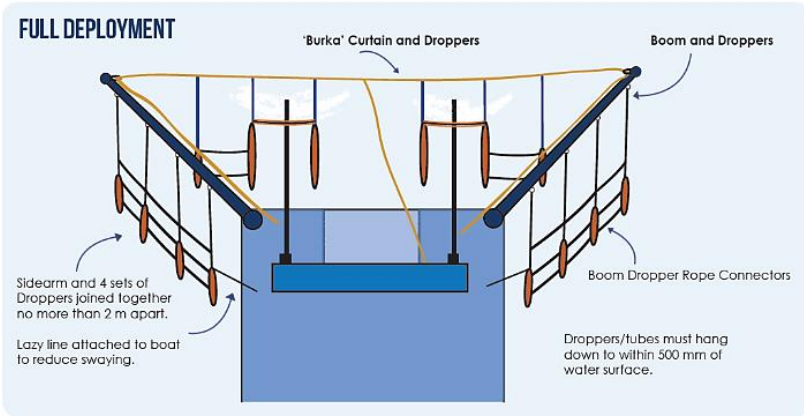
- Varying results on effectiveness
- Many different designs (e.g., 2-boom, 4-boom, curtain)
- 25-36% observed inshore tows used bafflers 2013-2017 (Rexer-Huber & Parker, 2019; Parker & Rexer-Huber 2019)
- **ACAP: acceptable; more testing required**



One design of a 2-boom bird baffler. Source: Koopman et al. (2018).

Cons:

- Requires proper boom/dropper length.
- Requires proper position, height of warp-block, spacing
- Expensive
- Difficult to install
- Requires structure on vessel, takes up deck space



Prototype Curtain baffler. Source: Cleal et al. (2012); Cleal & Pierre (2016).

Pros:

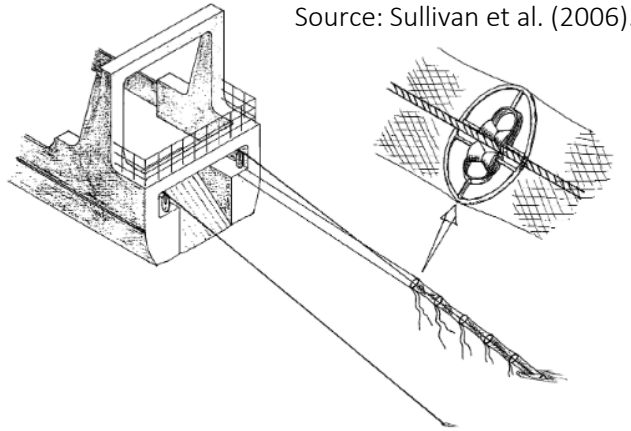
- Deployed at beginning of trip (set/forget)
- Internationally used
- Easier to maintain and may be more effective for small vessels

Warp scarers

Not recommended for testing

- Varying results on effectiveness
- Not currently used on large or small trawlers due to limited efficacy and safety concerns
- May be more effective for small seabirds (Sullivan et al. 2006)
- **ACAP: not recommended; more testing required**

Source: Sullivan et al. (2006).



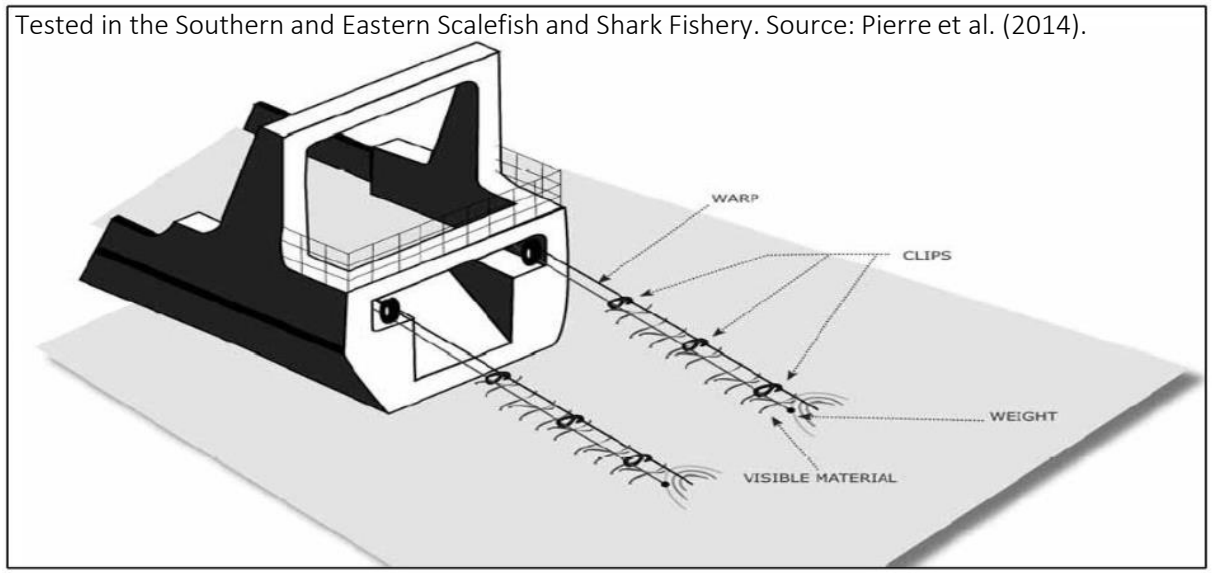
Cons:

- Tangles with warp cable
- Streamers break/fade
- Requires proper weighting
- Difficult to deploy/retrieve
- Safety risk
- Limited by weather conditions

Pros:

- Inexpensive

Tested in the Southern and Eastern Scalefish and Shark Fishery. Source: Pierre et al. (2014).



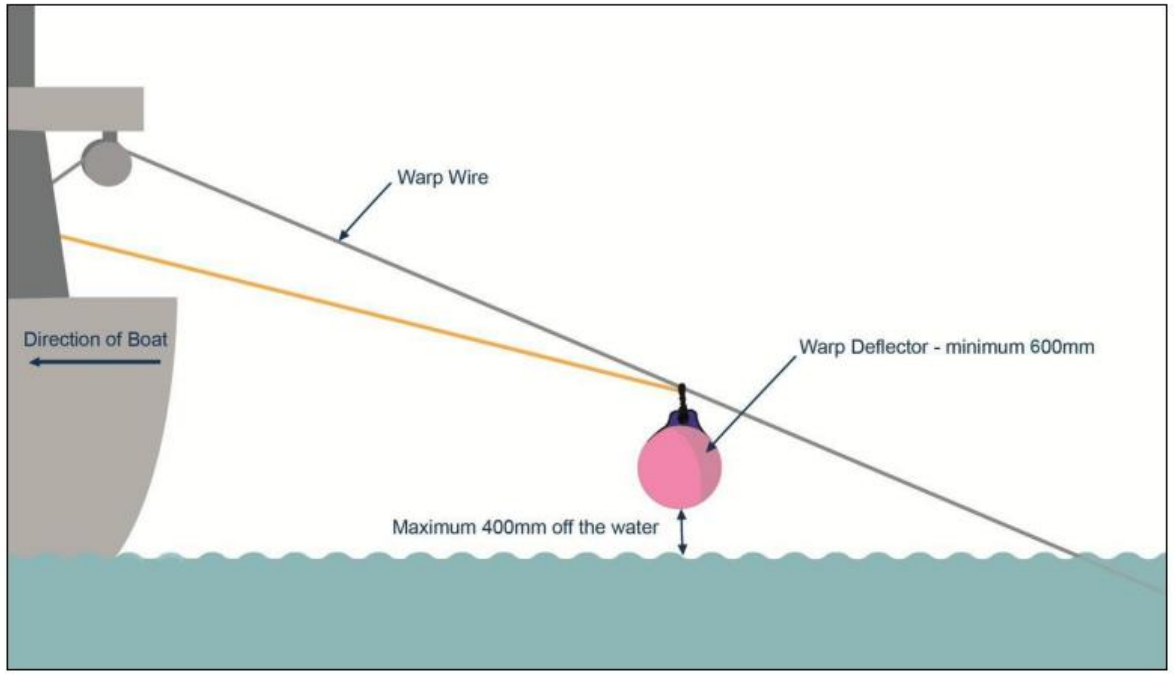
Warp deflector-
pinkie buoy system

Recommended for testing

- Varying and limited results on effectiveness
- May be more effective for large seabirds (Pierre et al. 2014)
- Considerable safety concerns and entanglement risk
- **ACAP: not recommended; more testing required**

Cons:
- Tangles with warp cable
- Difficult to position along warp and above water
- Requires proper size, weight, position
- Prone to device loss
- Requires frequent adjustment
- Limited by weather conditions
- Limited reduction in flying bird strike high up on warps

Pros:
- Inexpensive



Source: Pierre et al. (2014).

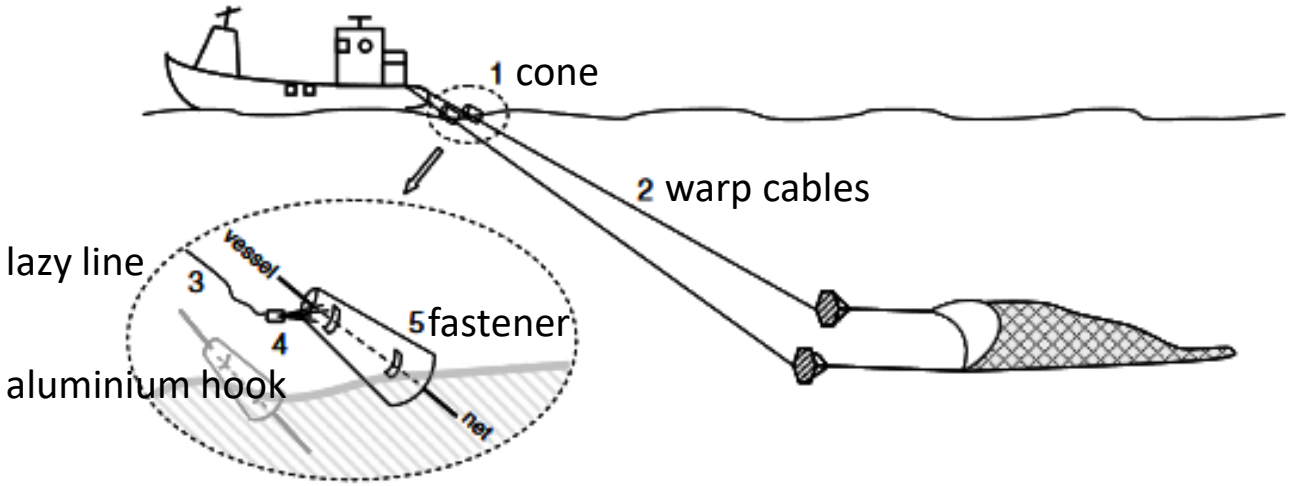
Warp deflector-
plastic cones

Recommended for testing

- Only one reviewed study
- 89% reduction in warp strike
- Cost effective for smaller vessels
- Suitable for small vessels
- **ACAP: not recommended; more testing required**

Cons:
- Requires adjustment throughout trip

Pros:
- Reduced severity and mortality rates if bird strikes cone
- 1 person can deploy/haul
- Inexpensive
- Easy to deploy/retrieve
- Covers the warp-water interface, may be useful as dual deployment device



Source: González-Zevallos et al. (2007).

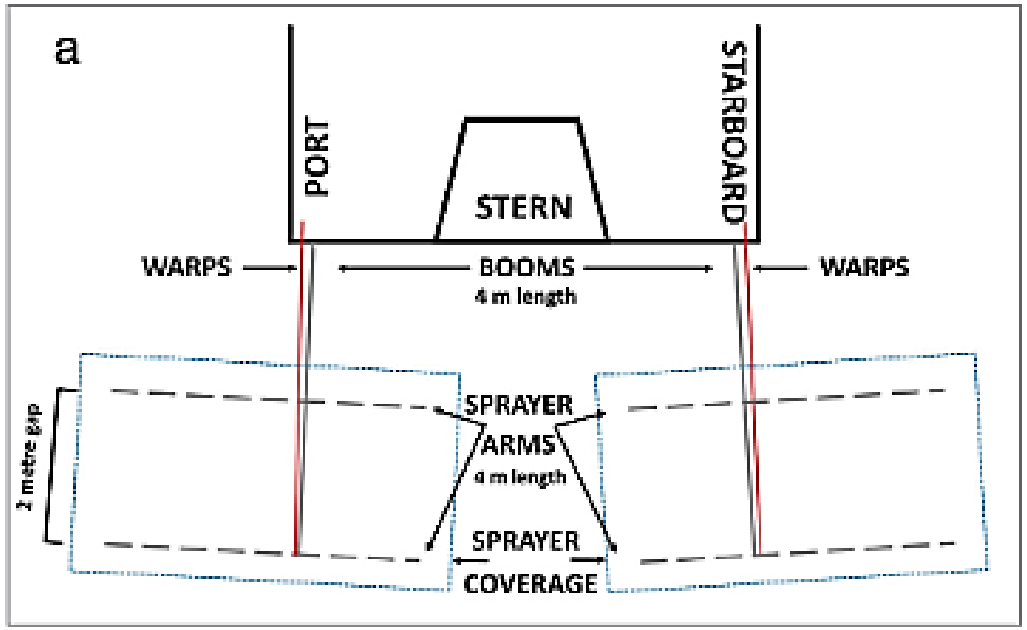
Water sprayer

Recommended for testing

- Only one reviewed study
- Different designs e.g., boom/arm length, number, positioning
- 58.9% - 92% reduction in warp strike
- Safer option
- **ACAP: not recommended**

Cons:

- Safety hazard; deck and crew get wet
- Potential of mechanical malfunctioning pump or sprayers
- Specific configuration required
- Requires a structure on the vessel
- Requires maintenance
- Expensive
- Difficult to install



Source: Koopman et al. (2018).

Pros:

- Deployed at the beginning of trip (set and forget)
- Safer to use

Lasers

Not recommended for testing

- Few studies
- Many types of lasers e.g., Seabird Saver, the Dazzler
- Fixed or hand-held, can be accompanied by deterrent sounds
- Some evidence that seabirds follow the vessel at greater distances
- **ACAP: not recommended**

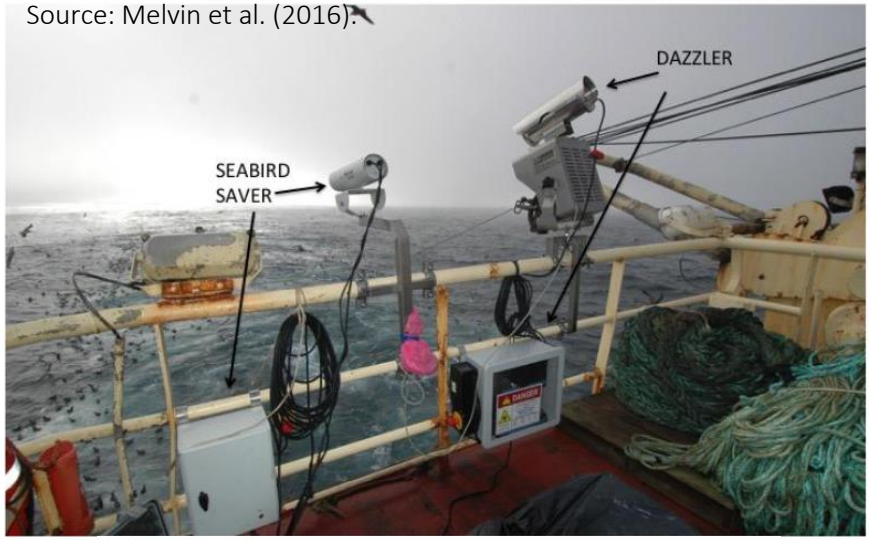
Cons:

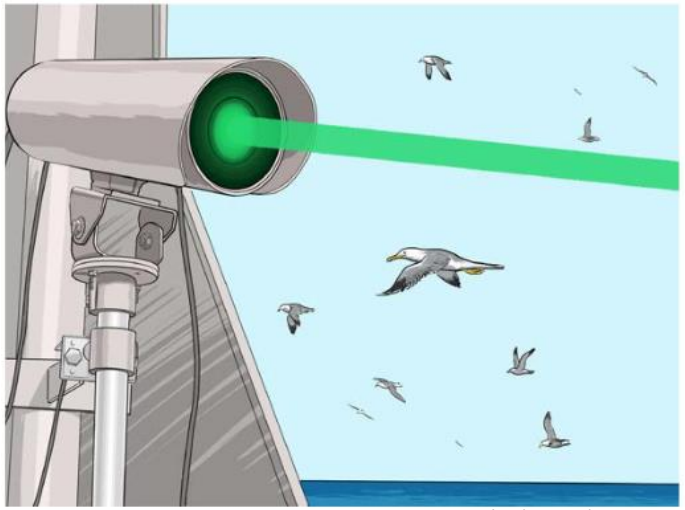
- Potential injury to seabirds
- Not effective in high light levels
- Difficult to manoeuvre or change beam direction
- Requires specific power level, strength/length of beam, field of view
- Electronic device failure

Pros:

- Deployed at the beginning of trip (set and forget)
- Easy to use
- Reduced space requirements

Source: Melvin et al. (2016).





Source: Sacchi (2021).

Other methods

Offal/discharge management

- TIMING e.g., during setting, hauling, towing
- QUANTITY
- FREQUENCY e.g., batch, continuous, holding
- POSITION e.g., port, stern, offside
- Batch discharge + tori line reduced capture rates in small vessels (Rexer-Huber & Parker, 2019)

Modification of warp cables

- Material like Dyneema

Modification of fishing practices

- Net cleaning
- Night fishing
- Proper deck lighting

Offal discharge. https://www.doc.govt.nz/our-work/conservation-services-programme/csp-resources-for-fishers/resources-for-trawl-fisheries/

Observed captures

	Warp captures							*Mitigation device captures*						
	Number of captures					**Total**	**Rate**	**Number of captures**					**Total**	**Rate**
Mitigation method	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	All	All	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	All	All
No mitigation	3	-	1	1	1	6	0.08	-	-	-	-	-	-	-
Tori lines	-	-	-	1	2	3	0.29	-	1	5	-	1	7	0.67
Bird baffler	1	5	-	1	-	7	0.35	-	-	-	-	-	-	-
Bird scarer	1	-	3	-	6	10	2.44	-	-	-	-	1	1	0.24
Other	-	-	-	2	-	2	0.34	-	-	-	-	-	-	-
Tori lines + baffler	-	-	1	1	-	2	0.39	-	-	4	-	-	4	0.78
Tori lines + other	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tori lines + scarer	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bird baffler + other	-	-	-	-	5	5	1.66	-	-	-	-	-	-	-
Tori lines + baffler + other	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tori lines + baffler + scarer + other	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total captures	**5**	**5**	**5**	**6**	**14**	**35**	**0.59**	**0**	**1**	**9**	**0**	**2**	**12**	**0.20**

Number of observed seabird captures on small trawl vessels 2015-2020 from PSC database

Observed capture rate = $C/(E_o/100)$

C = sum of observed captures
E_o = observed effort (# tows)

Invited Expert Workshop-
22 March, 2023

Mitigation devices

- Practicality
- Applicability
- Perceived effectiveness

Recommendations for devices to trial

Study design

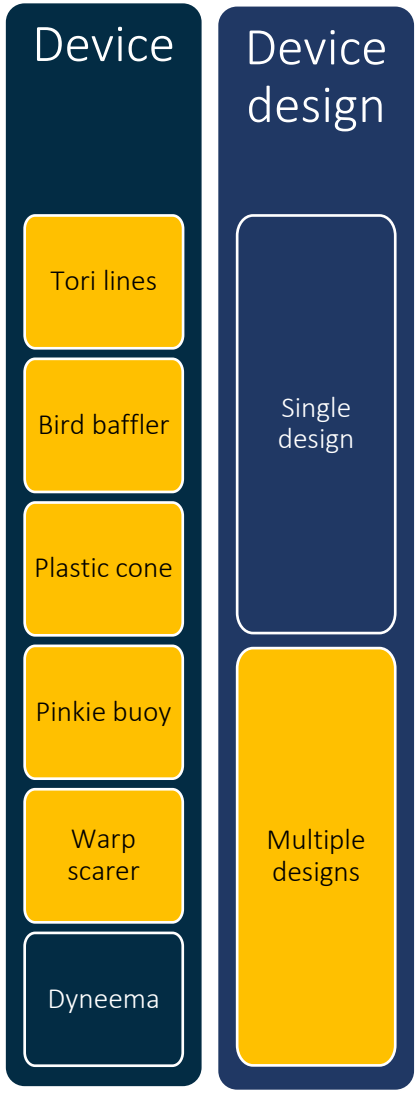
- Trial scope
- Data collection methods
- Limitations

Recommendations for study design

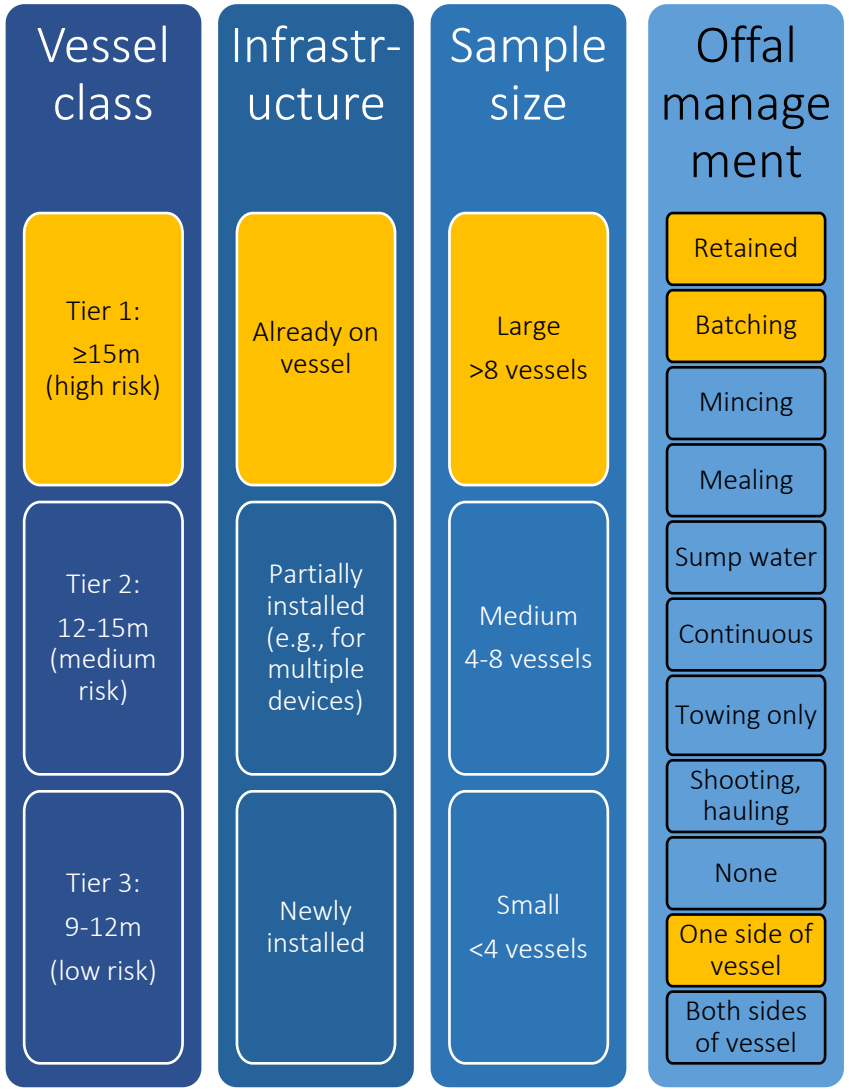
Study design recommendations

Device	Device design	Vessel class	Infrastr-ucture	Sample size	Offal management	Timing	Frequ-ency	Fishing area	Position	Collect-ion method	Data
Tori lines	Single design	Tier 1: ≥15m (high risk)	Already on vessel	Large >8 vessels	Retained	Concurrent, multiple vessels	Single tow/trip	Single, high risk areas (e.g., FMA 3, 5, 7)	Both warps	Paper forms	Warp strikes
Bird baffler					Batching	Opportun-istic	Multiple tow/trip			Electronic forms	Warp captures
Plastic cone		Tier 2: 12-15m (medium risk)	Partially installed (e.g., for multiple devices)	Medium 4-8 vessels	Mincing	During setting	One trip/vessel	Multiple, high risk areas	Single warp, same side as discharge	ERS reports	Abundance in danger zone
Pinkie buoy					Mealing	During towing	Multiple trip/vessel			On-board observers	Abundance outside danger zone
Warp scarer	Multiple designs	Tier 3: 9-12m (low risk)	Newly installed	Small <4 vessels	Sump water	During hauling	Random, tow by tow	Medium risk areas	Single warp, opposite side from discharge	Cameras	Pictures of devices
Dyneema					Continuous	During times of no fishing	Random, trip by trip	Low risk areas		Go Pros	Pictures of captures
					Towing only	Morning, midday, evening					
					Shooting, hauling						
					None						
					One side of vessel						
					Both sides of vessel						

Device recommendations



Vessel recommendations

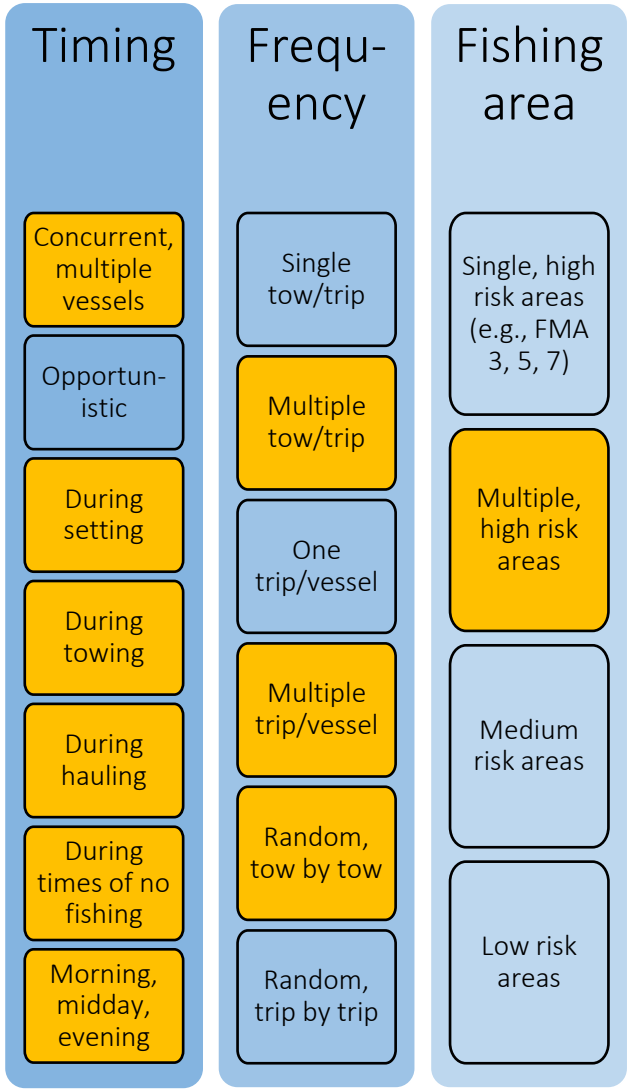


Vessel class	Tier 1	Tier 2	Tier 3
Vessel size	≥ 50ft/15m	40-50ft/12-15m	30-40ft/9-12m
Seabird warp strike risk	High	Moderate	Low
Tori lines	✓	✓	✓ (pole)
Bird baffler	✓	✓	X
Warp deflector: pinkie buoy	X	✓	✓
Warp deflector: plastic cone	X	✓	✓
Offal discharge	✓	✓	No discharge

Vessel specifications

- Size
- Fishery
- Fishing area/target species
- Already on vessel/in use
- Large sample size
- Randomly assign to vessels of similar specs (e.g., gear, skipper, location, timing)
- Consistent offal management (or no discharge at all)

Sources of variation recommendations



(Some) sources of variation
• Vessel configuration/construction • Location/frequency/method of offal discharge • Mitigation device design • Location • Vessel speed, orientation • Trawl block height/position • Location of warp/water interface • Time of day • Weather • Target species • Observer bias • Data collection methods etc.

Data collection recommendations

Collection method	Position	Data
Paper forms	Both warps	Warp strikes
Electronic forms		Warp captures
ERS reports	Single warp, same side as discharge	Abundance in danger zone
On-board observers		Abundance outside danger zone
Cameras	Single warp, opposite side from discharge	Pictures of devices
Go Pros		Pictures of captures

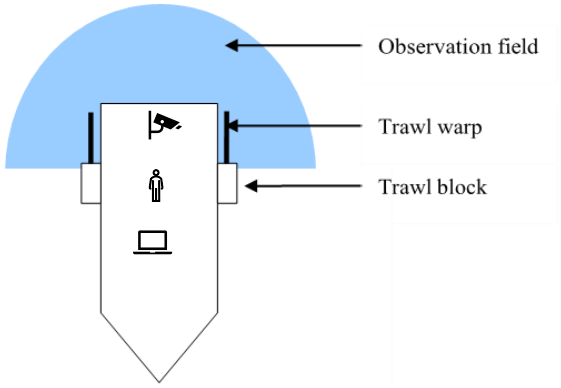
Methods

DOC and ACAP abundance and warp strike protocols
Modified for this trial, specific to small vessels

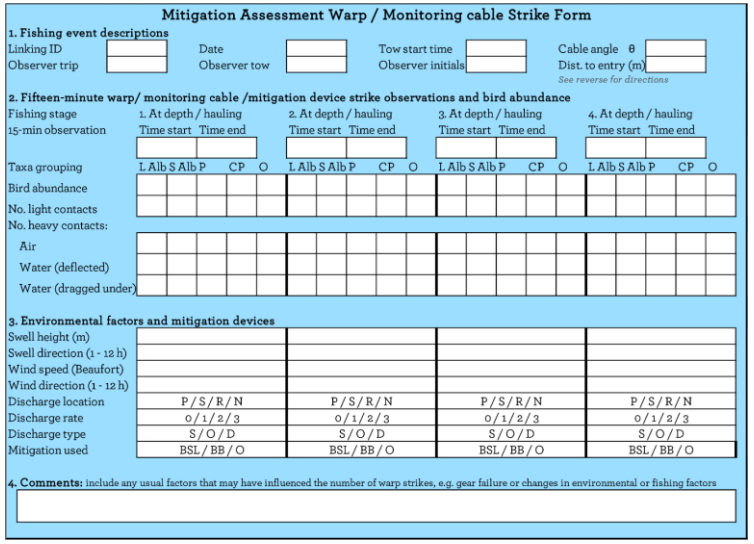
FORMS: Mitigation Assessment Warp Strike
Modified mitigation details
Non-Fish or Protected Fish Species Catch Report

ERS: Vessel and catch data

CAMERAS: Mitigation method, abundance, warp strikes?



Above: Warp entry points with a 25m observation field.
Source: Ramm et al. (2015) and ACAP (2021).



Mitigation Assessment Warp / Monitoring cable Strike Form

1. Fishing event descriptions

Linking ID | Observer trip | Date | Observer tow | Tow start time | Observer initials | Cable angle θ | Dist. to entry (m) — See reverse for directions

2. Fifteen-minute warp/ monitoring cable /mitigation device strike observations and bird abundance

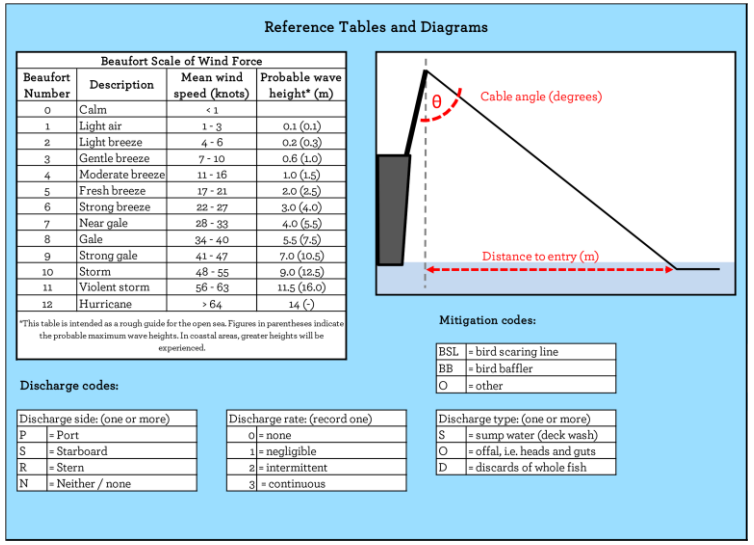
Fishing stage / 15-min observation	1. At depth / hauling Time start	Time end	2. At depth / hauling Time start	Time end	3. At depth / hauling Time start	Time end	4. At depth / hauling Time start	Time end

Taxa grouping	L	Alb S	Alb P	CP	O	L	Alb S	Alb P	CP	O	L	Alb S	Alb P	CP	O	L	Alb S	Alb P	CP	O
Bird abundance																				
No. light contacts																				
No. heavy contacts:																				
Air																				
Water (deflected)																				
Water (dragged under)																				

3. Environmental factors and mitigation devices

Swell height (m)				
Swell direction (1 - 12 h)				
Wind speed (Beaufort)				
Wind direction (1 - 12 h)				
Discharge location	P / S / R / N	P / S / R / N	P / S / R / N	P / S / R / N
Discharge rate	0 / 1 / 2 / 3	0 / 1 / 2 / 3	0 / 1 / 2 / 3	0 / 1 / 2 / 3
Discharge type	S / O / D	S / O / D	S / O / D	S / O / D
Mitigation used	BSL / BB / O	BSL / BB / O	BSL / BB / O	BSL / BB / O

4. Comments: include any usual factors that may have influenced the number of warp strikes, e.g. gear failure or changes in environmental or fishing factors



Reference Tables and Diagrams

Beaufort Scale of Wind Force

Beaufort Number	Description	Mean wind speed (knots)	Probable wave height* (m)
0	Calm	< 1	
1	Light air	1 - 3	0.1 (0.1)
2	Light breeze	4 - 6	0.2 (0.3)
3	Gentle breeze	7 - 10	0.6 (1.0)
4	Moderate breeze	11 - 16	1.0 (1.5)
5	Fresh breeze	17 - 21	2.0 (2.5)
6	Strong breeze	22 - 27	3.0 (4.0)
7	Near gale	28 - 33	4.0 (5.5)
8	Gale	34 - 40	5.5 (7.5)
9	Strong gale	41 - 47	7.0 (10.5)
10	Storm	48 - 55	9.0 (12.5)
11	Violent storm	56 - 63	11.5 (16.0)
12	Hurricane	> 64	14 (-)

*This table is intended as a rough guide for the open sea. Figures in parentheses indicate the probable maximum wave heights. In coastal areas, greater heights will be experienced.

θ Cable angle (degrees)

Distance to entry (m)

Mitigation codes:

BSL	= bird scaring line
BB	= bird baffler
O	= other

Discharge codes:

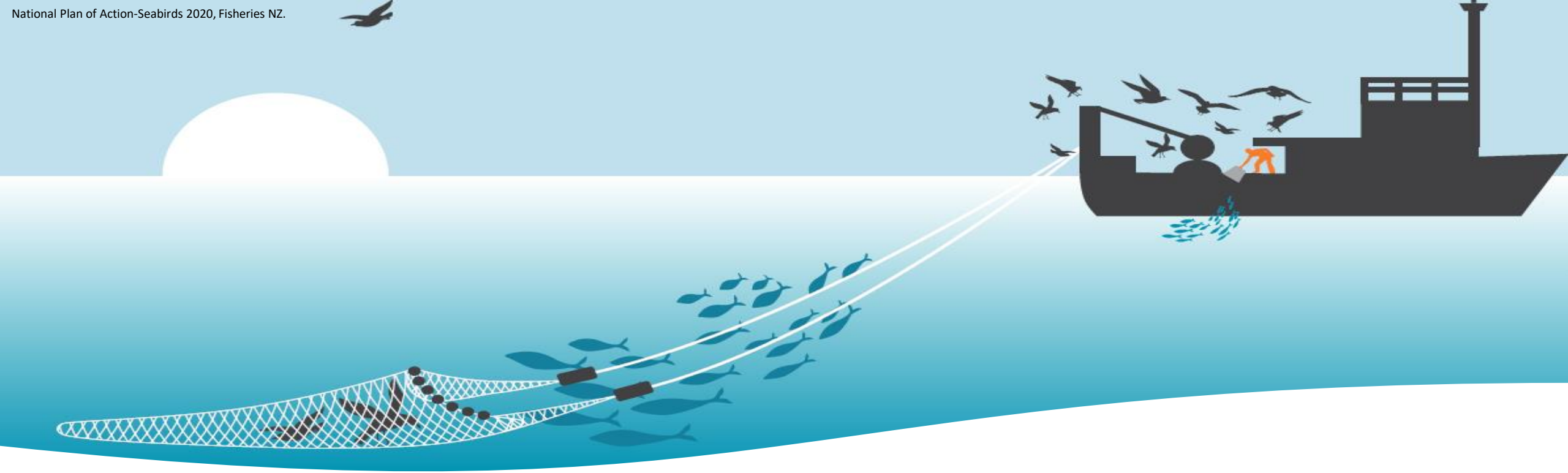
Discharge side: (one or more)	
P	= Port
S	= Starboard
R	= Stern
N	= Neither / none

Discharge rate: (record one)	
0	= none
1	= negligible
2	= intermittent
3	= continuous

Discharge type: (one or more)	
S	= sump water (deck wash)
O	= offal, i.e. heads and guts
D	= discards of whole fish

Source: Ramm et al. (2015) and ACAP (2021).

National Plan of Action-Seabirds 2020, Fisheries NZ.



Conclusions

- Tori lines, bird bafflers, cones, pinkie buoy
- Simultaneous use of multiple devices
- Device selection based on trial scope, feasibility, cost, vessel availability
- Reduce confounding effects
- Consider offal management
- Integrate trial of Dyneema with warp mitigation devices

- Collect abundance (proxy) and warp strike/capture data
- Modified DOC and ACAP data collection protocols
- Randomised approach

Acknowledgements

Workshop attendees

Darryl MacKenzie	Proteus
Stefan Meyer	Proteus
Rachel Hickcox	Proteus
Tiffany Plencner	DOC
Igor Debski	DOC
Rosa Edwards	Fisheries Inshore NZ
Graham Parker	DOC; Parker Conservation
John Cleal	DOC; FV Management Services
Ben Leslie	DOC; Coastal-Equilibrium Ltd.
Richard Wells	Fisheries New Zealand; Resourcewise Ltd.
Robert Win	Fisheries New Zealand
Olivia Hamilton	Fisheries New Zealand
John Richardson	Fisheries New Zealand
Matthew Rolfe	Fisheries New Zealand
Jonathon Barrington	Australian Department of Climate Change, Energy, the Environment and Water

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Knowledge | Results | Data

Department of Conservation
Te Papa Atawhai

References (see report for full list)

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