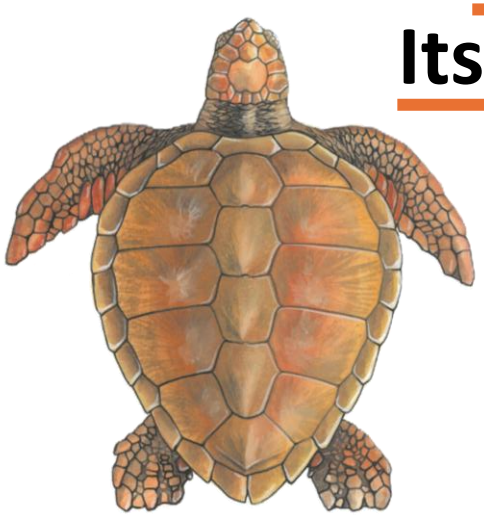
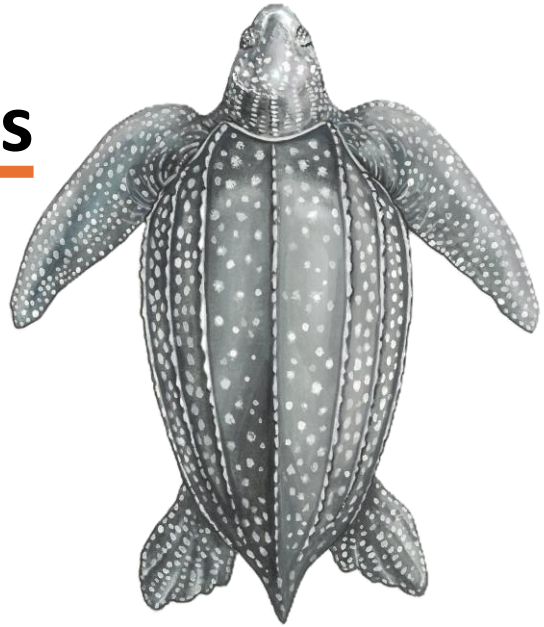
A Synthesis Review of Sea Turtle Interaction Processes, Mitigation Measures and Its Limitations in Tuna Longline Fisheries





WCPFC-SC22-2026-EB-WP06

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Fisheries Research and Education Agency

WCPFC meeting of the scientific committee 22 regular session

Introduction

Background

- Sea turtle bycatch is one of the major concerns in longline fisheries.
- The effects of hook and bait modifications on target and non-target species have been widely evaluated.

However...

- Results are inconsistent among studies.
- Effects may depend on fishing depth and target species.

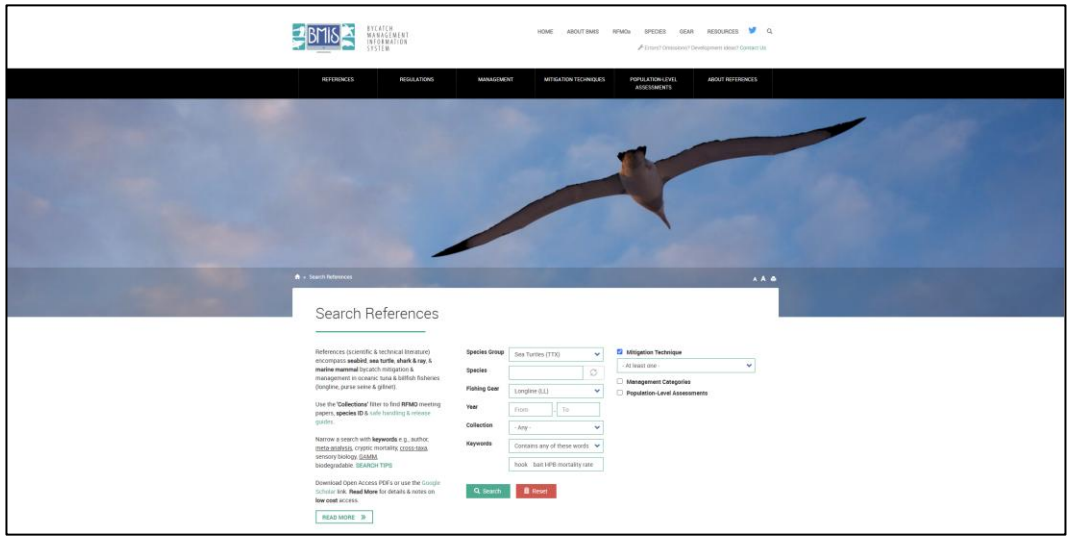
Objective of this study

To review previous studies on hook and bait modifications and summarize their effects on sea turtles and other bycatch species (Sharks and Rays).

Materials and methods

Literature search & study selection

- Bycatch Management Information System (BMIS) ,Google Scholar, and Reference lists were used to search literatures
- Only using Studies evaluating hook type or bait type independently
- Excluded studies combining shallow- and deep-set fisheries



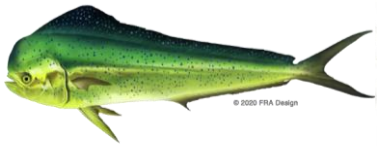
Materials and methods

Classification

Deep-set

Explicitly described as deep-set, or Target fishing depth >100 m

Possibly shallow-set



Remaining studies (Considered to be shallow-set based on HBF, target fishing depth, and target species)

Materials and methods

Data summary (Hook comparison)

For each species, we counted the numbers of cases reporting

- **Large circle hook vs. J hook**
  Higher catch rate with **large circle hook**
  Higher catch rate with **J hook**
  No significant difference

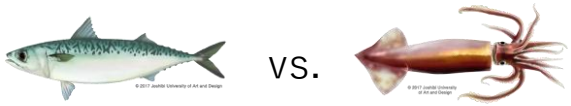
- **Large circle hook vs. Japanese tuna hook**
  Higher catch rate with **large circle hook**
  Higher catch rate with **Japanese tuna hook**
  No significant difference

Materials and methods

Data summary (Bait comparison)

For each species, we counted the numbers of cases reporting

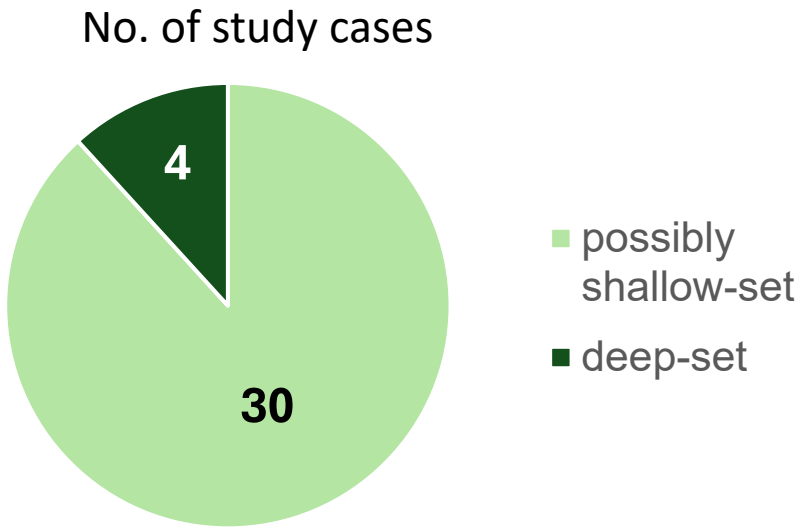
- **Finfish bait vs. squid bait**
  Higher catch rate with **Finfish bait**
  Higher catch rate with **Squid bait**
  No significant difference



Results

Summary or reviewed studies (Hook type)

34 study cases from 29 publications

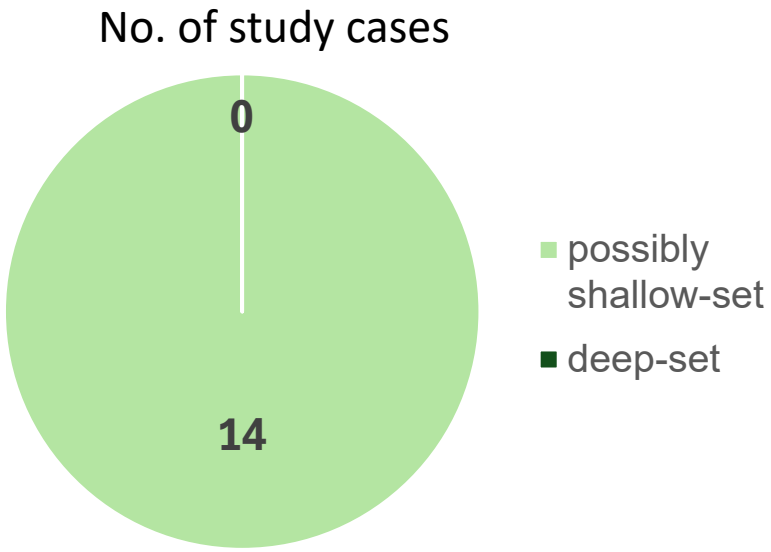


Reference	Fishing depth	Hooks between floats	No of hooks	No of sets	Hook type	Target	Ocean	Classification
Afonso et al. (2011)		5	7,800	12	J,C	TUN	EqAtl	Possibly Shallow-set
Afonso et al. (2012)		5	17,000	17	J,C	TUN, SWO	SW EqAtl	Possibly Shallow-set
Andraka et al. (2013)-1		2-3	356,674	2,068	T,C	TUN, BIL, SHK	E Pac	Possibly Shallow-set
Andraka et al. (2013)-2		3-12	75,509	110	T,C	TUN, BIL, SHK	E Pac	Possibly Shallow-set
Andraka et al. (2013)-3		3-5	134,643	248	T,C	TUN, BIL, SHK	E Pac	Possibly Shallow-set
Andraka et al. (2013)-4		3-5	75,041	122	T,C	TUN, BIL, SHK	E Pac	Possibly Shallow-set
Andraka et al. (2013)-5		5-6	46,496	261	J,C	DOL	E Pac	Possibly Shallow-set
Andraka et al. (2013)-6		3-6	151,673	317	J,C	DOL	E Pac	Possibly Shallow-set
Coelho et al. (2012) Santos et al. (2012)	20 - 50 m	5	305,352	221	J,C	SWO	EqAtl	Possibly Shallow-set
Coelho et al. (2015) Fernandez-Carvalho et al. (2015)	20 - 50 m	5	254,520	202	J,C	SWO	Trop NE Atl	Possibly Shallow-set
Cambie et al. (2012)		6-9	4,642	13	J,C	ABT	Med	Possibly Shallow-set
Domingo et al. (2009)		8	77,628	165	J,C	SWO, SHK	SW Atl	Possibly Shallow-set
Domingo et al. (2012)-1		5	39,822	61	J,C	SWO, SHK	SW Atl	Possibly Shallow-set
Domingo et al. (2012)-2		8	45,142	107	J,C	BSH	SW Atl	Possibly Shallow-set
Foster et al. (2012)		3or5	973,734	999	J,C	SWO, BET, BSH	NW Atl	Possibly Shallow-set
Kerstetter and Graves (2006)-1		5	14,040	39	J,C	YFT	NW Atl	Possibly Shallow-set
Kerstetter and Graves (2006)-2		5	16,560	46	J,C	SWO	GoM&Carib	Possibly Shallow-set
Kerstetter et al. (2007)		5	16,624	26	J,C	SWO	Eq S Atl	Possibly Shallow-set
Lima et al. (2023)		4or8	497,880	343	J,T,C	SWO, BSH	N Atl	Possibly Shallow-set
Minami et al. (2006) Yokota et al. (2006b)	shallow-set	4	48,600	52	T,C	SWO	NW Pac	Possibly Shallow-set
Mejuto et al. (2008)		5	430,299	342	J,C	SWO	N–S Atl	Possibly Shallow-set
Ochi et al. (2024)	shallow-set	4	286,368	306	T,C	SWO, BSH	NW Pac	Possibly Shallow-set
Pacheco et al. (2011)		5	50,170	81	J,C	SWO, BET	Eq W Atl	Possibly Shallow-set
Piovano et al. (2009)	18 - 50 m	5	29,254	30	J,C	SWO	Med	Possibly Shallow-set
Piovano and Gilman (2016)		-	-	1,679	J,C	TUN	S Pac	Possibly Shallow-set
Sales et al. (2010)	33 - 100 m	5-6	145,828	229	J,C	TUN, SHK	SW Atl	Possibly Shallow-set
Santos et al. (2013)	20 - 50 m	5	446,400	310	J,C	SWO	S Atl	Possibly Shallow-set
Watson et al. (2005)		3	427,382	489	J,C	TUN, SWO, SHK	NW Atl	Possibly Shallow-set
Carbonara et al. (2023)		-	5,040	7	J,C	SWO	C Med	Possibly Shallow-set
García-Cortés et al. (2009)		-	356,600	183	J,C	SWO	SE Pac	Possibly Shallow-set
Cuerran and Bigelow(2011)-1	deep-set	24.7±1.75	2,773,427	211	J,T,C	BET	C Pac	Deep-set
Cuerran and Bigelow(2011)-2	deep-set	24.7±1.75		1,182	J,T,C	BET	C Pac	Deep-set
Huang et al. (2016)	deep-set	16-17	407,677	200	J,T,C	BET	EqAtl	Deep-set
Promjinda et al. (2008)	50 - 300 m	15-20	6,277	13	J,C	TUN, BIL	BoB&And	Deep-set

Results

Summary or reviewed studies (Bait type)

14 study cases from 15 publications



Reference	Fishing depth	Hooks between floats	No of hooks	No of sets	Bait type	Target	Ocean	Classification
Coelho et al. (2012) Santos et al. (2012)	20 - 50 m	5	305,352	221	Squid,Finfish	SWO	EqAtl	Possibly Shallow-set
Coelho et al. (2015) Fernandez-Carvalho et al. (2015)	20 - 50 m	5	254,520	202	Squid,Finfish	SWO	TropNE Atl	Possibly Shallow-set
Foster et al. (2012)		3or5	973,734	999	Squid,Finfish	SWO, BET, BSH	NW Atl	Possibly Shallow-set
Mejuto et al. (2008)		5	430,299	342	Squid,Finfish	SWO	N–S Atl	Possibly Shallow-set
Ochi et al. (2024)	shallow-setting	4	286,368	306	Squid,Finfish	SWO, SHK	NW Pac	Possibly Shallow-set
Santos et al. (2013)	20 - 50 m	5	446,400	310	Squid,Finfish	SWO	S Pac	Possibly Shallow-set
Santos et al. (2024)	shallow-setting	5	92,225	105	Squid,Finfish	SWO, BSH	NE Trop Atl EqAtl	Possibly Shallow-set
Swimmer et al. (2017)-1	shallow-setting	4-5	9,611,623	11,811	Squid,Finfish	SWO	Pac	Possibly Shallow-set
Swimmer et al. (2017)-2		4-5	6,605,840	9,610	Squid,Finfish	TUN, SWO	Atl	Possibly Shallow-set
Yokota et al. (2009)	40 – 90 m	4	36,480	38	Squid,Finfish	SWO, BSH	NW Pac	Possibly Shallow-set
Watson et al. (2005)		3	427,382	489	Squid,Finfish	TUN, SWO, SHK	NW Atl	Possibly Shallow-set
García-Cortés et al. (2009)		-	356,600	183	Squid,Finfish	SWO	SE Pac	Possibly Shallow-set
Brazner & McMillan (2008)		-	-	1,288	Squid,Finfish	TUN, SWO	NW Atl	Possibly Shallow-set
Báez et al. (2010)		-	-	795	Squid,Finfish	SWO	W Med	Possibly Shallow-set

Results

Comparison among hooks (Possibly shallow-set)

No. of cases recording significantly higher or non-significantly different catch rate

J hook vs. Large circle hook

Comparing to J hooks, Large circle hooks resulted in

- lower or similar sea turtle catch rates

- higher or similar shark catch rates

Results

Comparison among hooks (Possibly shallow-set)

No. of cases recording significantly higher or non-significantly different catch rate

Japanese tuna hook vs. Large circle hook

The number of studies were limited.

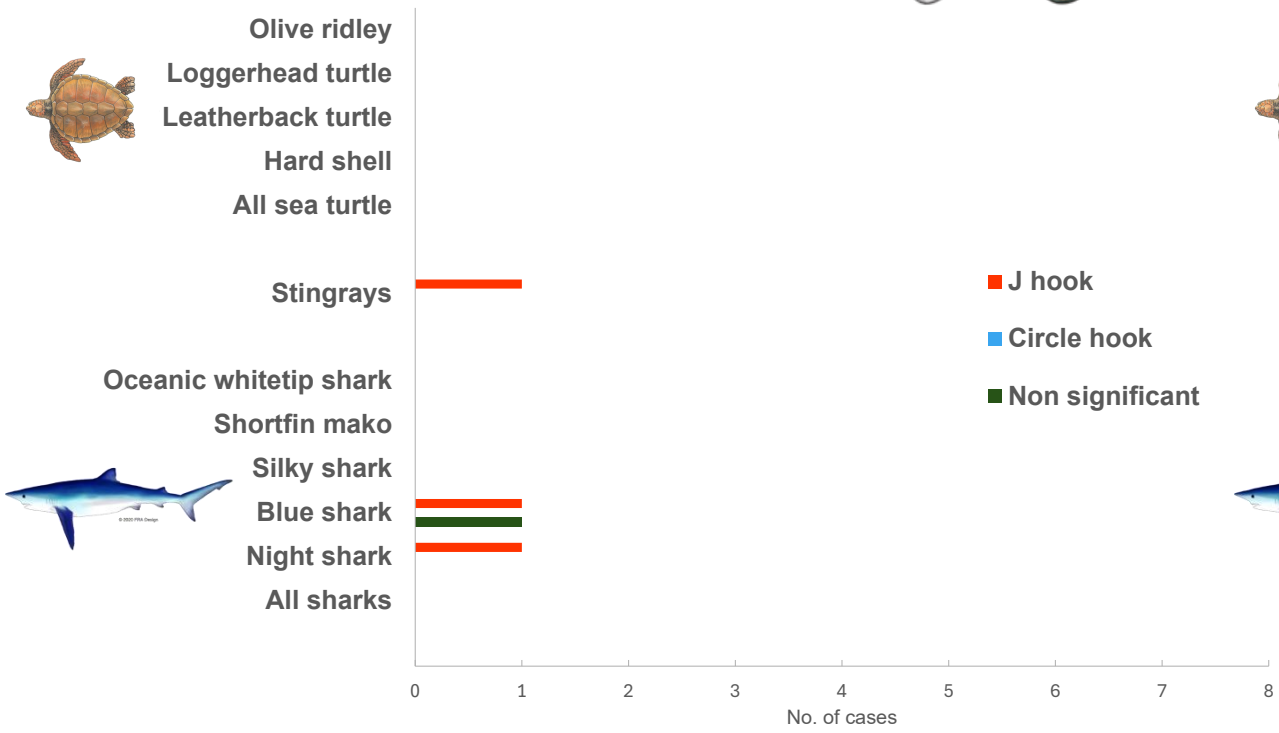
Comparing to Japanese tuna hooks, Large circle hooks generally resulted in
- lower or similar sea turtle catch rates
- higher or similar shark catch rates

Results

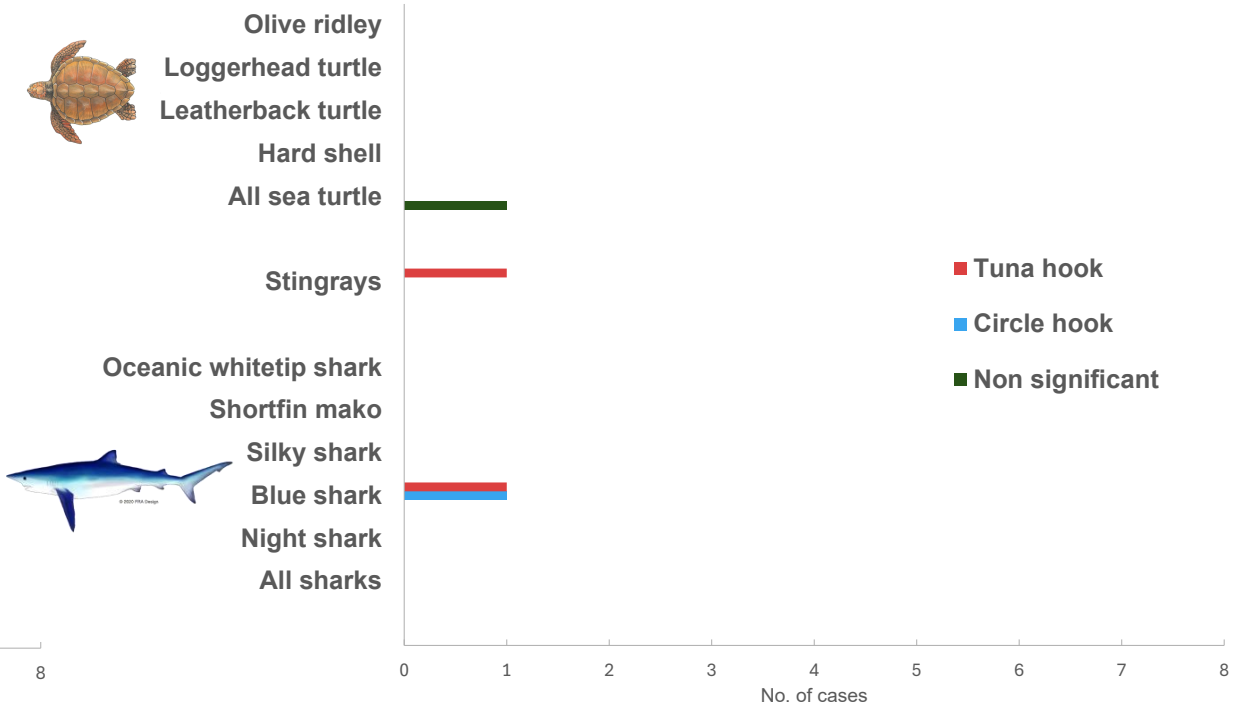
Comparison among hooks(Deep-set)

No. of cases recording significantly higher or non-significantly different catch rate

J hook vs. Large circle hook



Japanese tuna hook vs. Large circle hook



Evidence from deep-set fisheries was limited.
No consistent effects of hook type on catch rates were identified.

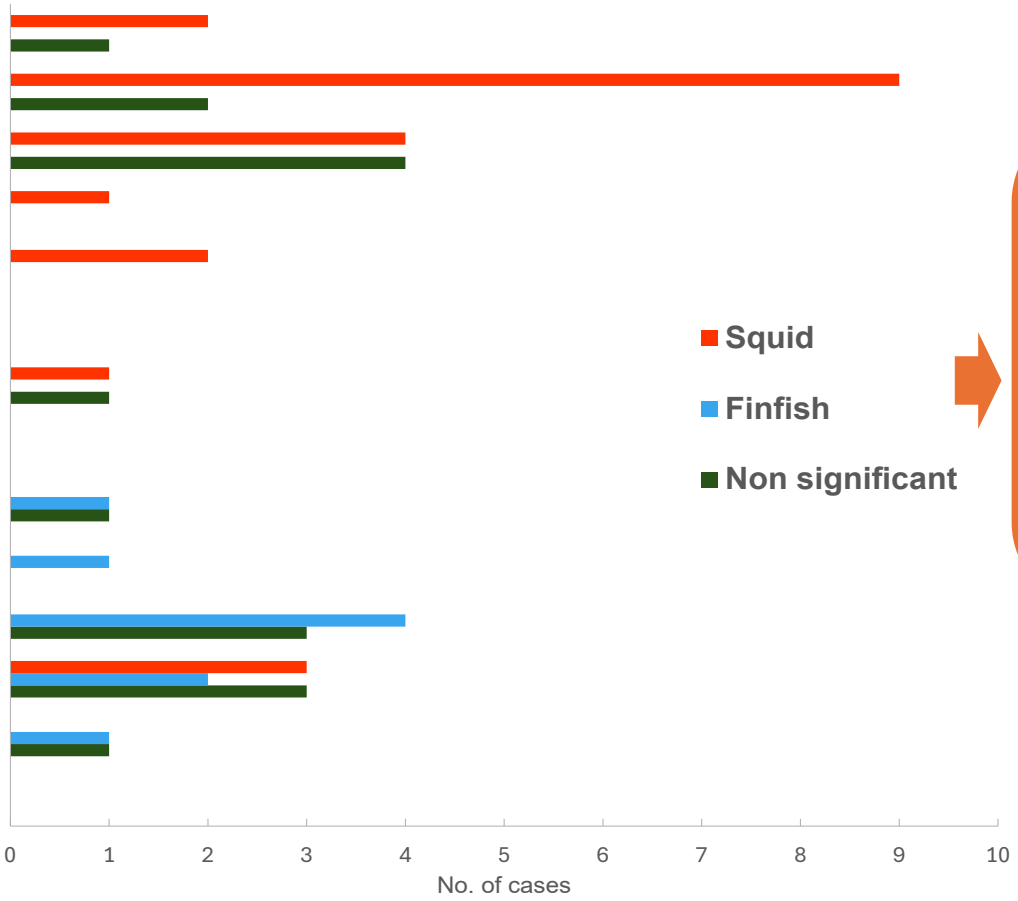
Results

Comparison among baits (Possibly shallow-set)

No. of cases recording significantly higher or non-significantly different catch rate

Squid bait vs. Finfish bait

vs.



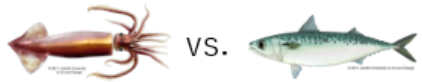
Finfish bait resulted in
- higher or similar shark catch rates, except for blue shark

Squid bait resulted in
- higher or similar catch rates for sea turtles

Results

Comparison among baits(Deep-set)

Squid bait vs. Finfish bait



No study existed for deep-set in the bait comparison.

Discussion

Deep-set

There were only 4 hook comparison studies available for hook type.

There was no bait comparison study available for bait type.

- Evidence is heavily biased toward shallow-set fisheries.
- The effectiveness of current sea turtle mitigation measures in deep-set longline fisheries remains uncertain.

More hook and bait comparison studies in deep-set fisheries are needed

Discussion

Possibly shallow-set

Large circle hooks and finfish bait reduced (or did not increase) sea turtle bycatch. These measures generally increased (or maintained) shark bycatch.

- A potential **trade-off** exists between reducing sea turtle bycatch and increasing shark bycatch.
- Responses are likely species-specific, reflecting differences in habitat depth and feeding ecology.

Future mitigation measures should be evaluated for both sea turtles and other bycatch species.

Suggested recommendations

SC22 is invited to recommend that;

- information on the effects of different hook types and bait types on the bycatch rates of sea turtles and sharks in deep-set longline should be collected.

- deep-set longline refers to except for operations in which the majority of hooks are set at depths of 100 meters or less.

- methods for collecting information may include trial fishing using research vessels or commercial vessels, as well as observer programs; however, these methods are not limited to these examples.

- the collected information will be reported and reviewed at appropriate agenda items in future SC meetings.

- based on the collected information, when reviewing the CMM2018-04, consideration will be given to the positive and negative impacts on bycatch species such as sea turtles and sharks, as well as target species, and to the feasibility of the measures adapted in actual fishing practices.