Review of the Effects of Circle Hooks on Elasmobranchs

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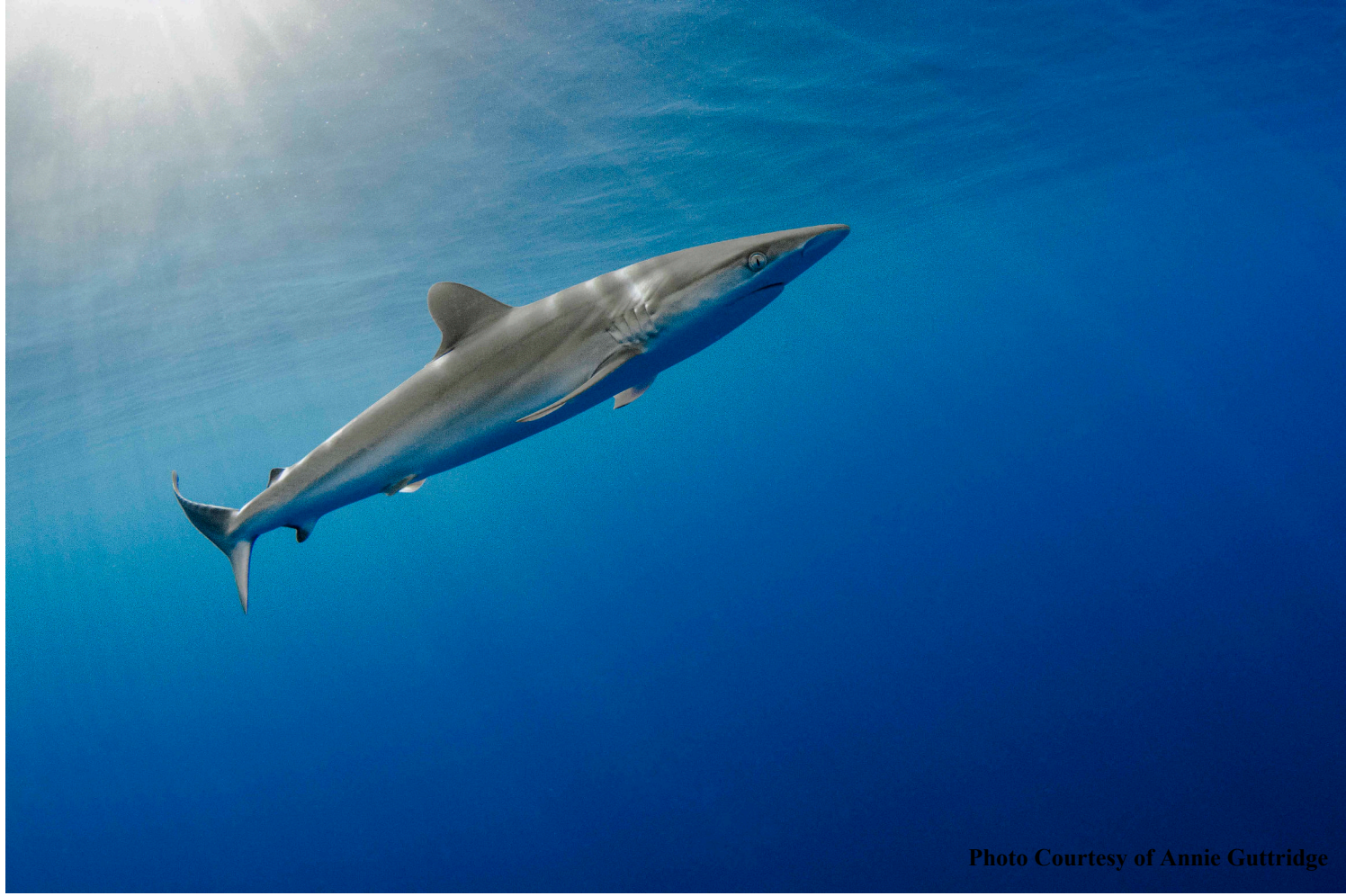

NOAA FISHERIES

Introduction

- Dissertation focused on elasmobranchs
- Currently in NOAA Fisheries Office of International Affairs
- Expertise in shark bycatch reduction in longline fisheries

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PERSPECTIVE

Conservation Science and Practice
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A call to assess the impacts of electromagnetic fields from subsea cables on the movement ecology of marine migrants

A. Peter Klimley PhD[1] | Nathan F. Putman PhD[2] | Bryan, A. Keller PhD[3] | David Noakes PhD[4]

Current Biology
CellPress

Report

Map-like use of Earth's magnetic field in sharks

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SUMMARY

Migration is common in marine animals,[1–5] and use of the map-like information of Earth's magnetic field appears to play an important role.[2,6–9] While sharks are iconic migrants[10–12] and well known for their sensitivity to electromagnetic fields,[13–20] whether this ability is used for navigation is unresolved.[14,17,21,22] We conducted magnetic displacement experiments on wild-caught bonnetheads (*Sphyrna tiburo*) and show that magnetic map cues can elicit homeward orientation. We further show that use of a magnetic map to derive positional information may help explain aspects of the genetic structure of bonnethead populations in the northwest Atlantic.[23–26] These results offer a compelling explanation for the puzzle of how migratory routes and population structure are maintained in marine environments, where few physical barriers limit movements of vagile species.

- Some studies have indicated higher retention rates on circle hooks

- Circle hooks may also be beneficial for sharks, especially due to a higher probability of survival

- Today we have heard about the effects of circle hooks on sea turtles

- Concern has been expressed about potential trade offs for other taxa, such as sharks

Bycatch of sharks in longline fisheries

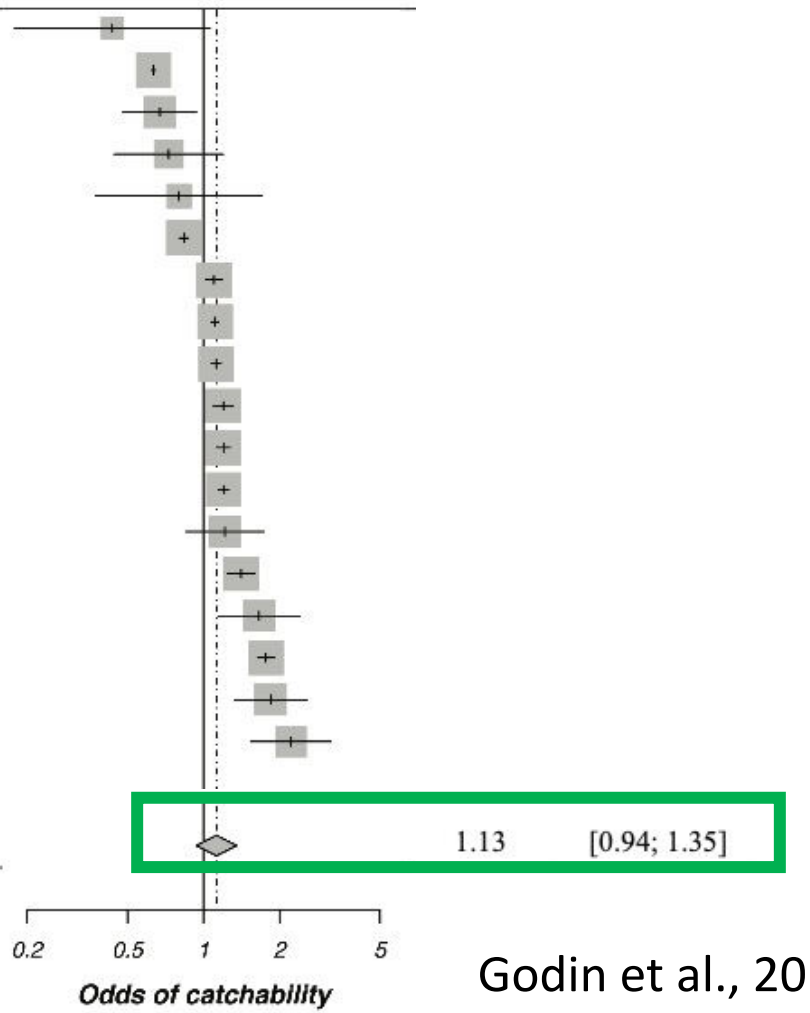
- Various meta-analyses conducted

to understand the effect of fishing gears

- Retention rate
- At-haulback mortality
- Hooking location
- Post-release survival

Retention rates on circle hook use

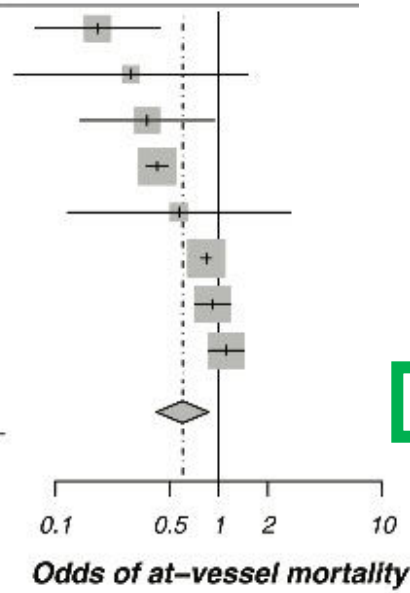
Study	Circle hook Events	Circle hook Total	J-hook Events	J-hook Total
Promjinda et al. (2008)	7	3,113	16	3,113
Gilman et al. (2007)	30,109	2,150,674	28,092	1,282,748
Kim et al. (2006)	82	29,400	61	14,700
Kerstetter and Graves (2006, fall)	27	7,020	37	7,020
Kerstetter and Graves (2006, spring)	12	8,280	15	8,280
Curran and Bigelow (2011)	4,229	1,386,713	5,051	1,386,713
Yokota et al. (2006)	2,318	32,400	1,060	16,200
Coelho et al. (2012)	6,027	203,568	2,691	101,784
Watson et al. (2005)	6,555	213,621	5,915	213,691
Bolten et al. (2005) (1)	796	46,040	1,333	92,081
Sales et al. (2010)	2,116	72,914	1,773	72,914
Carruthers et al. (2010)	8,573	458,964	2,587	165,890
Pacheco et al. (2011)	68	25,085	56	25,085
Bolten et al. (2005) (4A)	976	27,225	350	13,613
Ward et al. (2009)	73	47,575	44	47,575
Bolten et al. (2005) (2)	3,095	58,767	896	29,383
Kim et al. (2007)	232	46,848	42	15,616
Afonso et al. (2011)	92	3,900	42	3,900
Pooled effects estimate	65,387	4,822,107	50,061	3,500,306



Godin et al., 2012

Reduction in at-haulback mortality on circle hooks

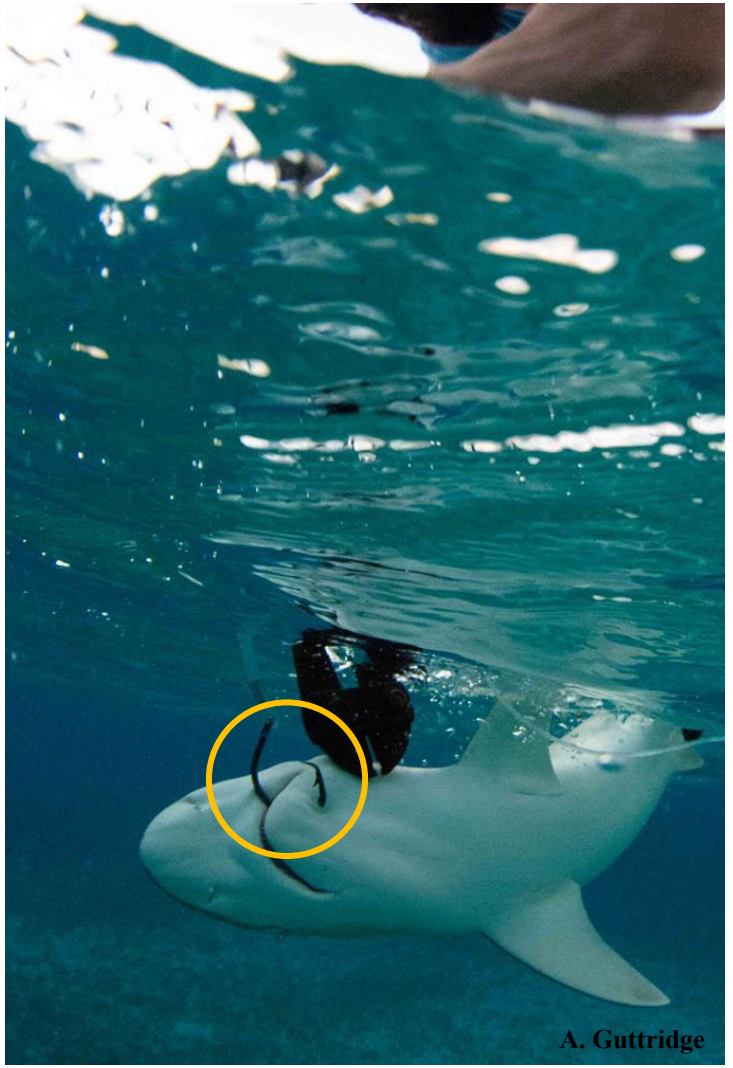
Study	Circle hook Events	Circle hook Total	J-hook Events	J-hook Total
Afonso et al. (2011)	40	92	34	42
Kerstetter and Graves (2006, fall)	2	27	8	37
Pacheco et al. (2011)	8	68	15	56
Carruthers et al. (2009)	559	8,397	313	2,152
Kerstetter and Graves (2006, spring)	4	12	7	15
NOAA (unpubl data)	2,267	11,355	1,619	7,073
Yokota et al. (2006)	200	2,330	99	1,066
Curran and Bigelow (2011)	127	4,229	137	5,051
Pooled effects estimate	3,207	26,510	2,232	15,492



0.60	[0.42; 0.86]	100.0

- Meta-analyses demonstrate that circle hook use results in a significantly lower level of at-haulback mortality for sharks (Godin et al., 2012; Reinhardt et al., 2017; Gilman et al., 2016)
- “Our results suggest that circle hooks would reduce at-vessel mortality in three ram-ventilating sharks—oceanic whitetip, scalloped hammerhead and shortfin mako. This result is particularly promising for their management because these species are commonly caught in pelagic longline fisheries (Coelho, Santos, & Amorim, 2012)”

Hooking location



- Circle hook use results in significantly less foul or gut hooking (Carruthers et al., 2009; Epperly et al., 2012; Watson et al., 2005; Saidi et al., 2019)
- Hooking location is a main driver for injuries, stress and mortality (Coelho et al., 2020)
- Circle hook use therefore improves the condition of sharks at-haulback and prior to release

Post-release survival

- Accurate estimates of post-release survival are critical for stock assessments

- “Hooking location provides an indicator of the degree of injury and probability of …post-release survival (Gilman et al., 2016)”

- As circle hooks are more likely to stay in the mouth/jaw, the injury to the animal is less severe and the likelihood of survival is likely greater

Survivorship tag being deployed on a bonnethead

Retention Rates and the role of Bite-offs

- A “bite-off” occurs when a gut-hooked animal bites through the leader or fishing line and evades capture
- This is most likely to occur with a non-wire leader
- Sharks captured on J-hooks may have lower retention rates, artificially inflating the “catch” rates on circle hooks (Afonso et al., 2012)

Circle hook size

- Most studies compare the difference amongst J-hooks, tuna hooks, and/or circle hooks
- Few studies include treatments with various sizes of circle hooks (Foster et al., 2012; Ward et al., 2009; Kim et al., 2006)
- Small sample sizes of sharks are restrictive in drawing conclusions; confounding variables, such as body size, remain problematic

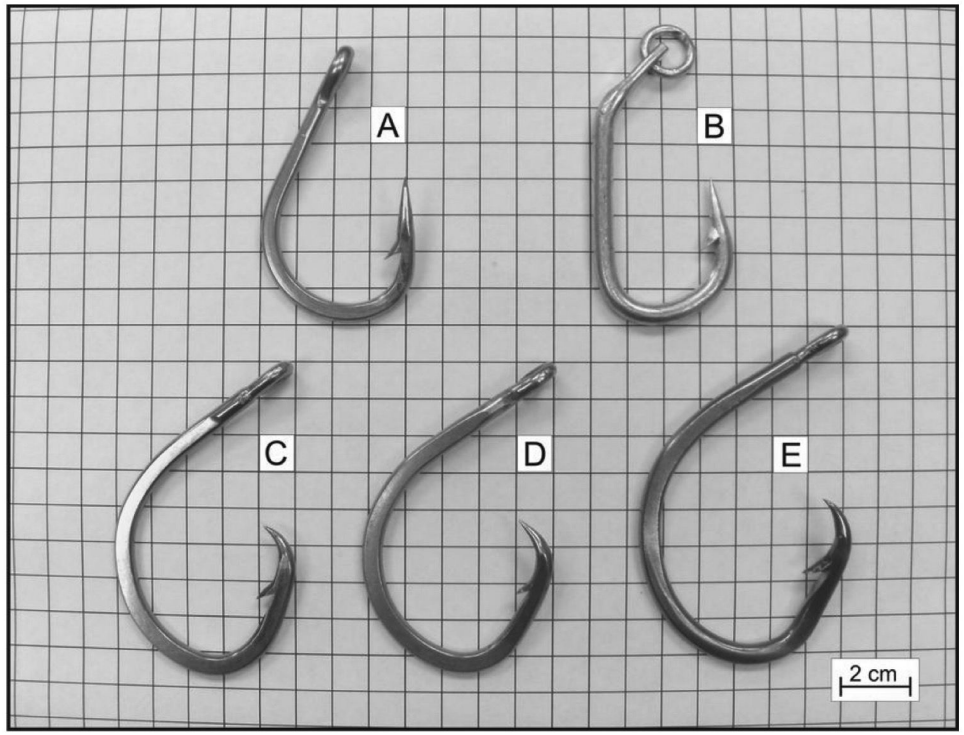


Figure 1. Hooks used during the 2002 and 2003 pelagic longline experiments in the western North Atlantic (NED): (A) LP-SW 10° offset J-hook, (B) 0° offset 10/0 Japanese tuna (J-tuna) hook, (C) 0° offset 18/0 circle hook, (D) 10° offset 18/0 circle hook, (E) 10° offset 20/0 circle hook.

Foster et al., 2012

Circle Hooks and Pelagic stingrays

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Short communication

Reducing longline bycatch: The larger the hook, the fewer the stingrays

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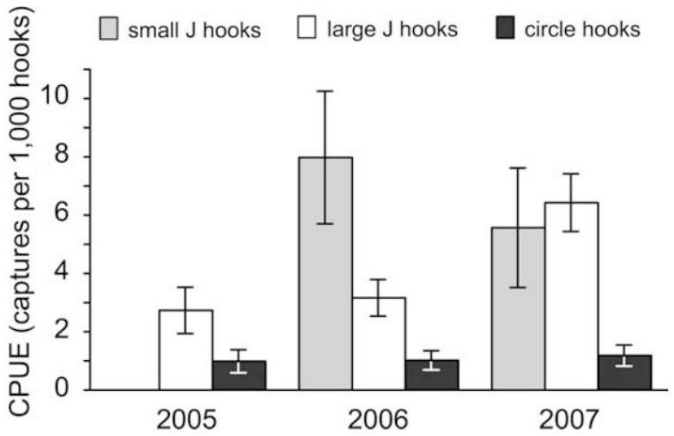

Fig. 2. Mean (± standard error) pelagic stingray CPUEs (captures per 1000 hooks) of each trialled type of hook, per year.

- Retention on circle hooks (16/0) is significantly reduced relative to J-hooks (Piovano et al., 2010;)
  - "These results suggest that the adoption of large circle hooks by commercial and artisanal swordfish longlining may be a measure to reduce their environmental footprint."
- At-haulback mortality is also significantly reduced on circle hooks (Carruthers et al., 2009)

Final considerations

- Meta-analyses indicate overall significant reductions in at-haulback mortality due to circle hook use
- Differences in retention rates may be due to bite offs
- There is little evidence to indicate that total mortality associated with circle hook use is higher than J-hooks
- On the contrary, reduced injury and at-haulback mortality, in addition to the cryptic mortality associated with bite offs, may result in a lower total mortality associated with circle hook use