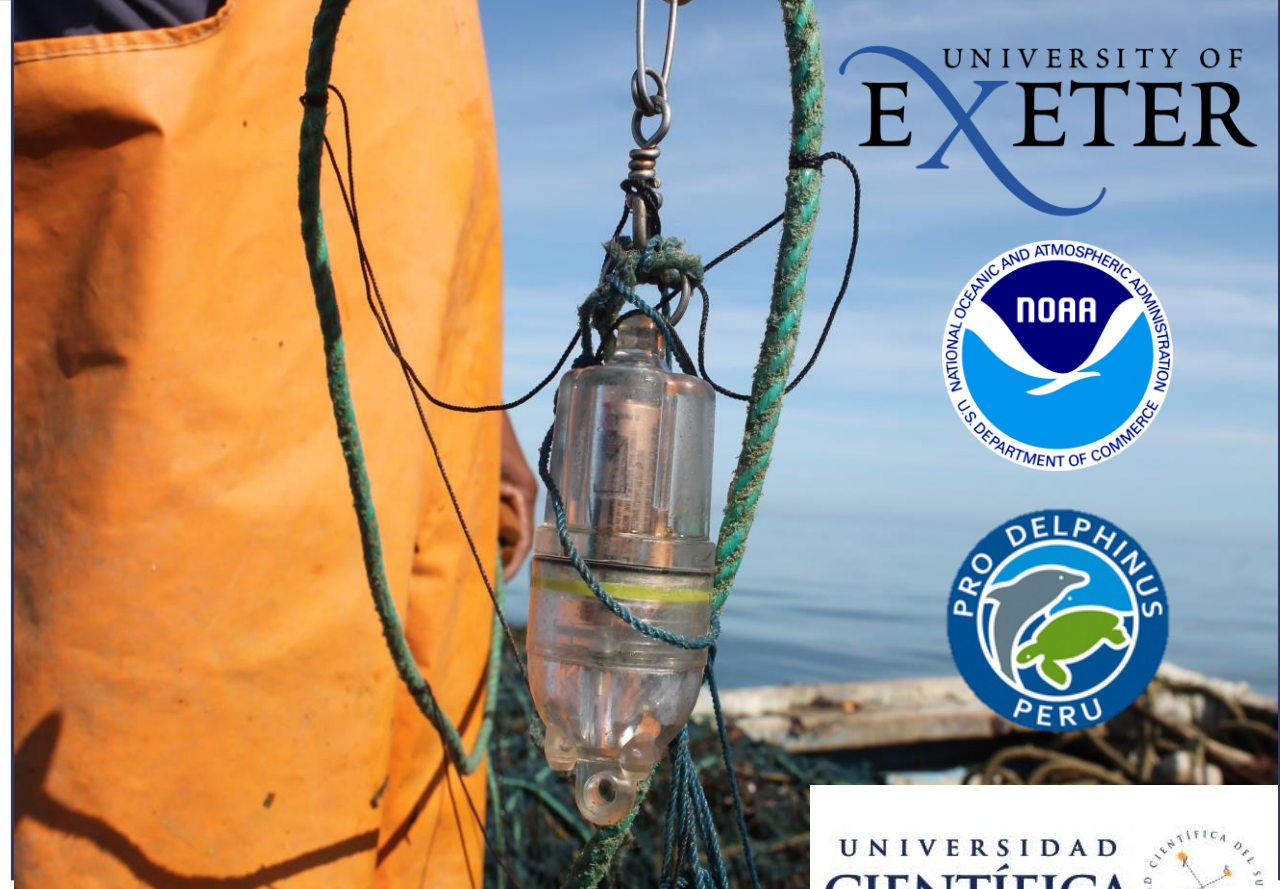




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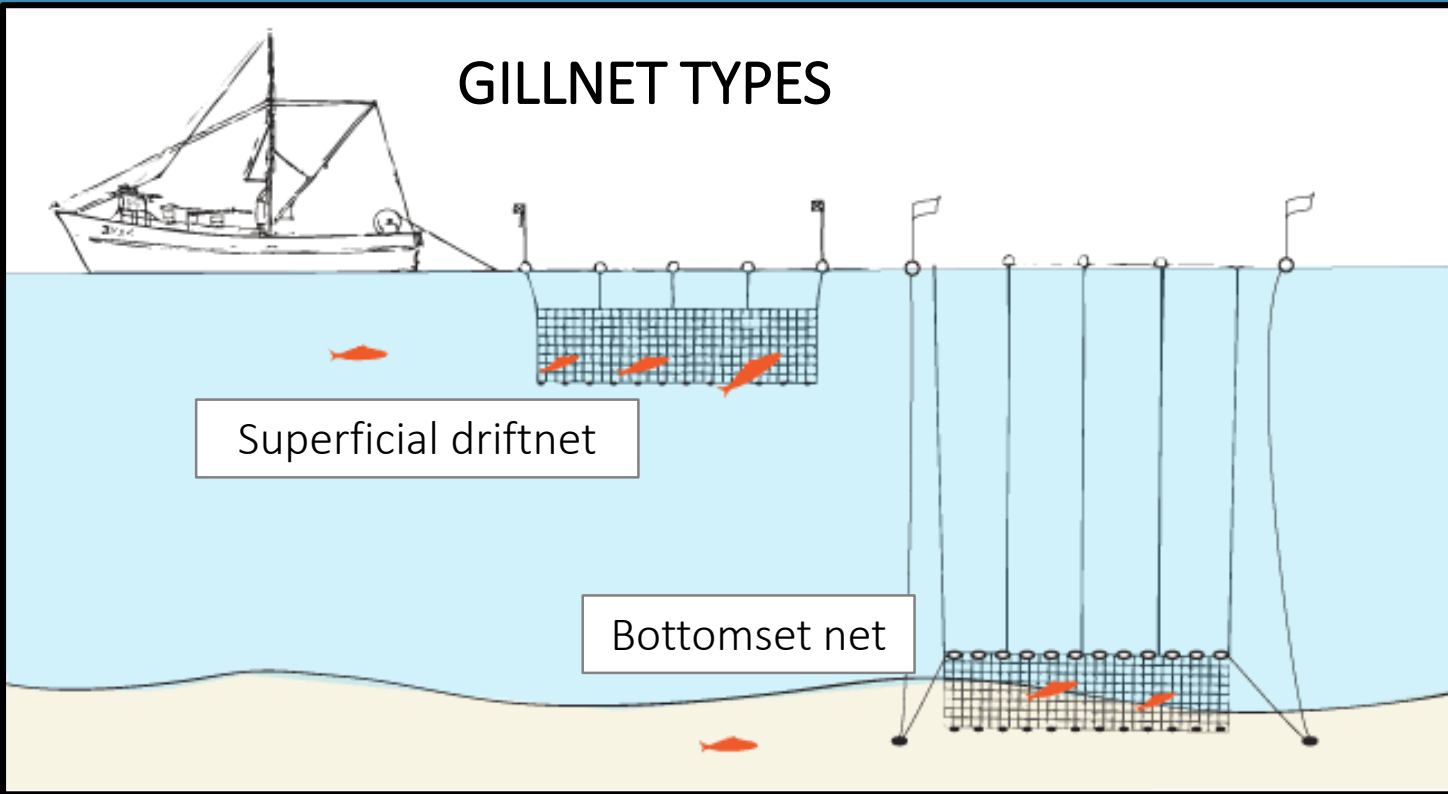
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ILLUMINATED GILLNETS TO REDUCE BYCATCH IN THE SMALL-SCALE PERUVIAN FISHERY

Alessandra Bielli*, Joanna Alfaro-Shigueto, Phil Doherty, Brendan Godley,
Clara Ortiz, Andrea Pasara, John Wang, Jeff Mangel

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GILLNET TYPES



The fishery

- Vessels < 15 m
- Gillnets: driftnets and bottomset nets
- Opportunistic: sharks, rays, tuna, dolphinfish, mackerel, sailfish
- 100 000 km/year



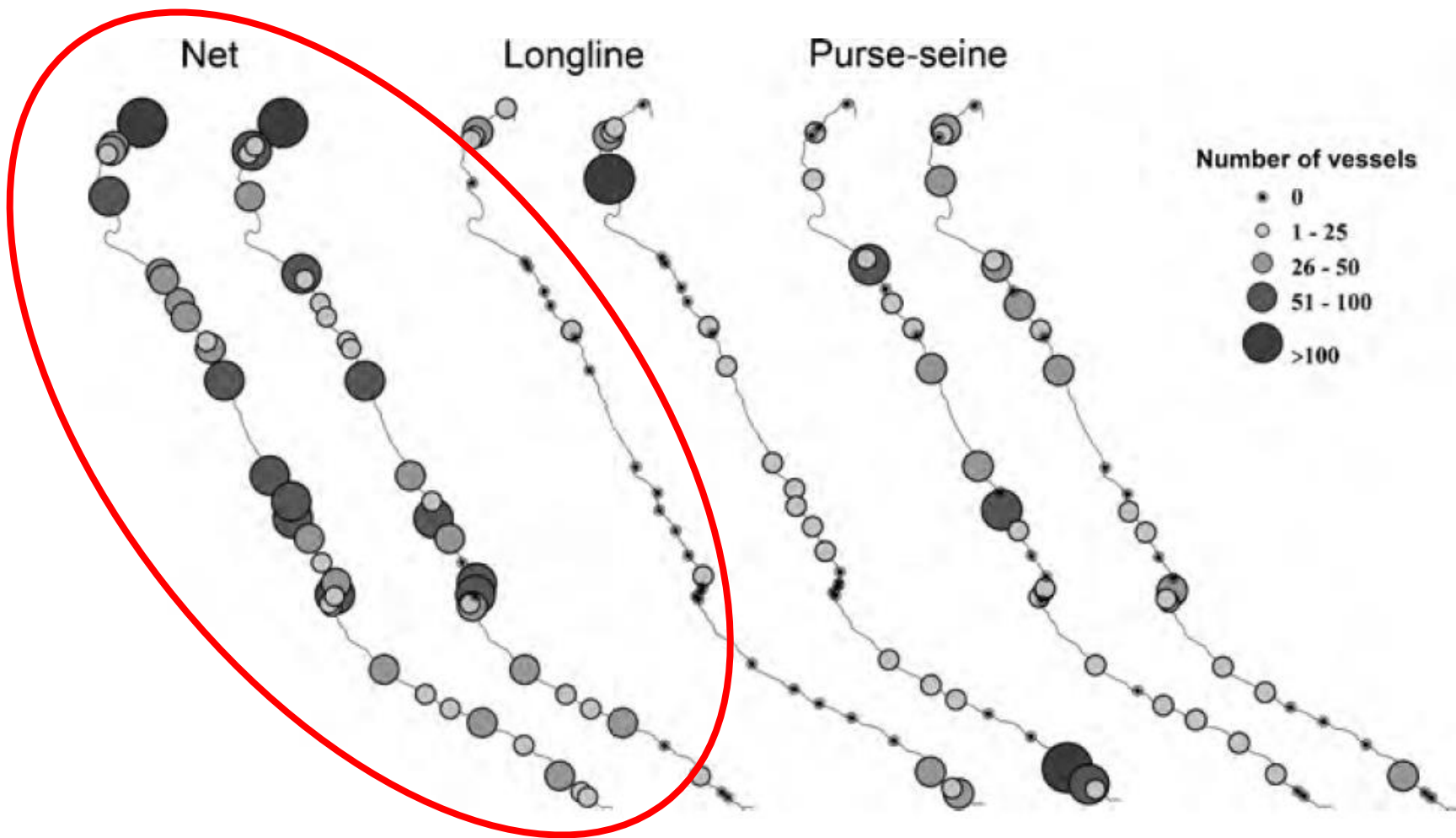


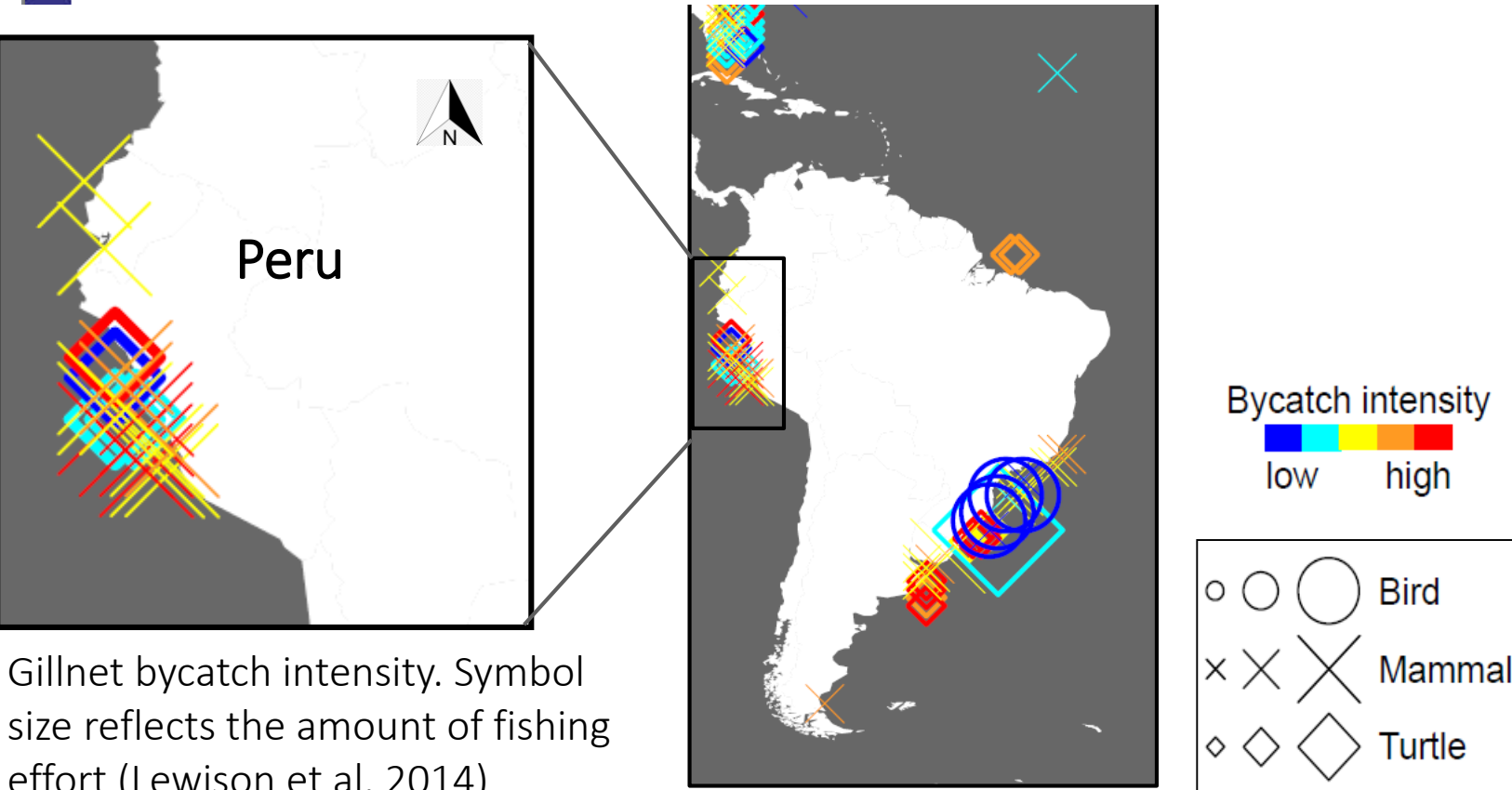
Fig. 2. Coastline maps of Peru showing the change in distribution of net, longline, and purse seine vessels at each sampled port ($n = 30$; cf. [Appendix 1](#)) from 1994–1995 (Escudero, 1997; left map of each pair) to 2004 (this study; right map of each pair). Number of vessels is indicated by the scaled bubbles.

(Alfaro-Shigueto et al. 2010)

Bycatch in Peru

Global patterns of marine mammal, seabird, and sea turtle bycatch reveal taxa-specific and cumulative megafauna hotspots

Rebecca L. Lewison^{a,1}, Larry B. Crowder^b, Bryan P. Wallace^c, Jeffrey E. Moore^d, Tara Cox^e, Ramunas Zydelis^f, Sara McDonald^g, Andrew DiMatteo^h, Daniel C. Dunnⁱ, Connie Y. Kotⁱ, Rhema Bjorkland^j, Shaleyla Kelez^k, Candan Soykan^l, Kelly R. Stewart^{d,m}, Michelle Simsⁿ, Andre Boustany^g, Andrew J. Readⁱ, Patrick Halpin^g, W. J. Nichols^o, and Carl Safina^p



Bycatch in Peru

- Sea turtles
- Small cetaceans
- Seabirds

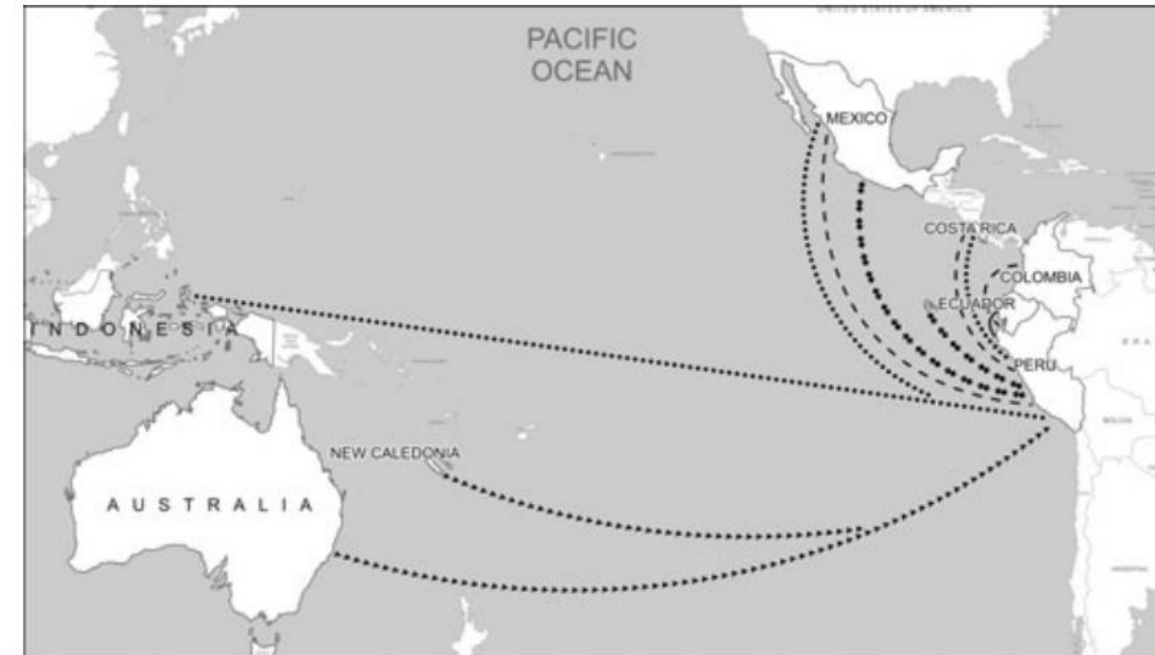
838 km of nets observed in which 172 turtles caught

Tens of thousands/year



Small-scale fisheries of Peru: a major sink for marine turtles in the Pacific

Joanna Alfaro-Shigueto^{1,2}, Jeffrey C. Mangel^{1,2}, Francisco Bernedo², Peter H. Dutton³, Jeffrey A. Seminoff³ and Brendan J. Godley^{1*}



Bycatch in Peru

- Sea turtles
- **Small cetaceans**
- Seabirds



Contents lists available at [ScienceDirect](#)

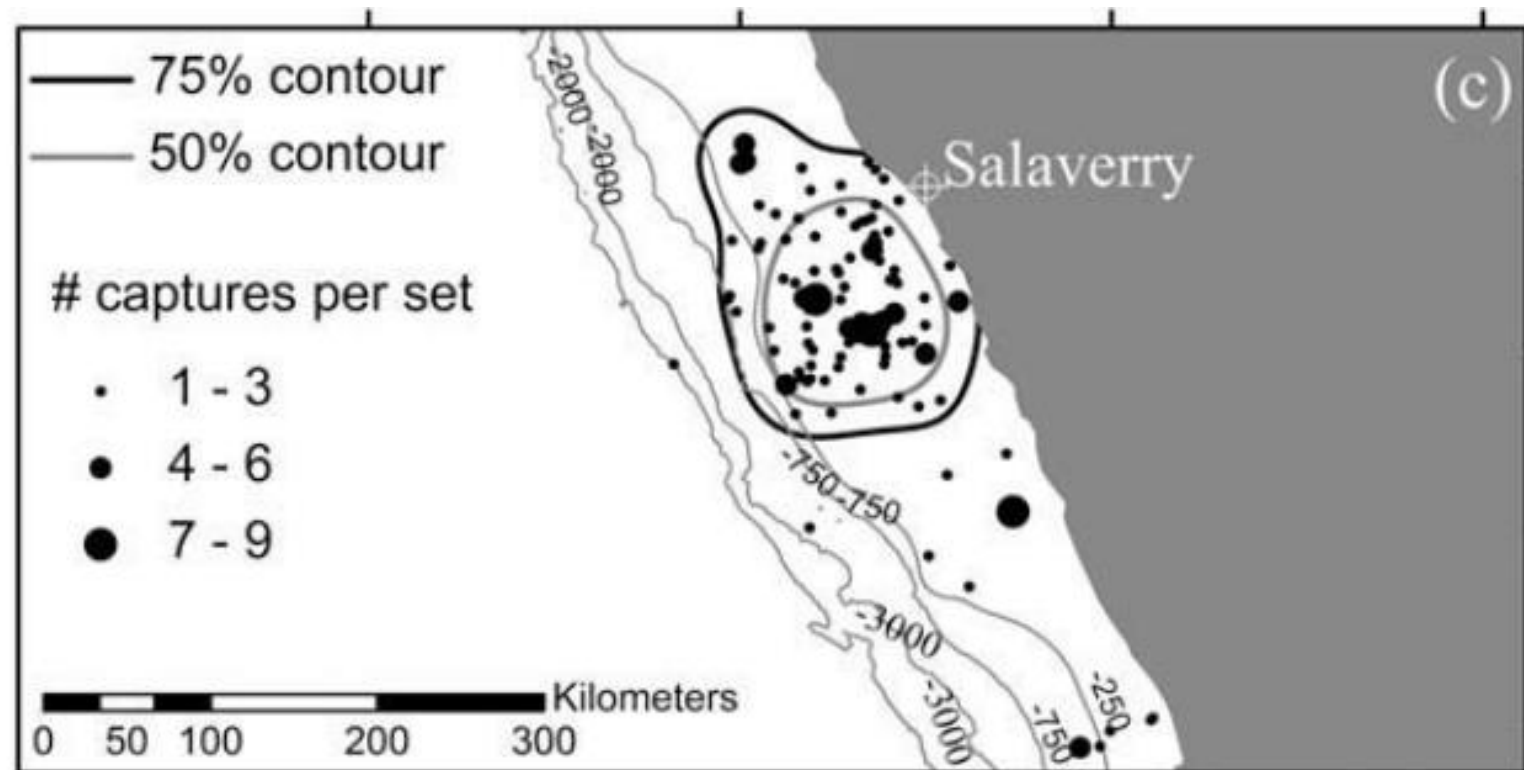
Biological Conservation

journal homepage: www.elsevier.com/locate/biocon



Small cetacean captures in Peruvian artisanal fisheries: High despite protective legislation

Jeffrey C. Mangel^{a,b,*}, Joanna Alfaro-Shigueto^{a,b}, Koen Van Waerebeek^c, Celia Cáceres^a, Stuart Bearhop^b, Matthew J. Witt^b, Brendan J. Godley^b



Bycatch in Peru

- Sea turtles
- Small cetaceans
- **Seabirds**

Conservation Biology 

Catch and Bycatch of Sea Birds and Marine Mammals in the Small-Scale Fishery of Punta San Juan, Peru

Captura Accidental de Aves y Mamíferos Marinos en la Pesquería de Pequeña Escala en Punta San Juan, Perú

Patricia Majluf, Elizabeth A. Babcock, Juan Carlos Riveros, Milena Arias Schreiber, William Alderete



Net illumination

- Green turtles: ↘ 63.9% (Ortiz et al. 2016)
- Guanay cormorants: ↘ 85.1% (Mangel et al. 2018)
- Not only in Peru (Wang et al. 2010; Virgili et al. 2018)

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Research



Cite this article: Mangel JC, Wang J, Alfaro-Shigueto J, Pingo S, Jimenez A, Carvalho F, Swimmer Y, Godley BJ. 2018 Illuminating gillnets to save seabirds and the potential for multi-taxa bycatch mitigation. *R. Soc. open sci.*

Illuminating gillnets to save seabirds and the potential for multi-taxa bycatch mitigation

Jeffrey C. Mangel^{1,2}, John Wang³, Joanna Alfaro-Shigueto^{1,2,4}, Sergio Pingo¹, Astrid Jimenez¹, Felipe Carvalho³, Yonat Swimmer³ and Brendan J. Godley²

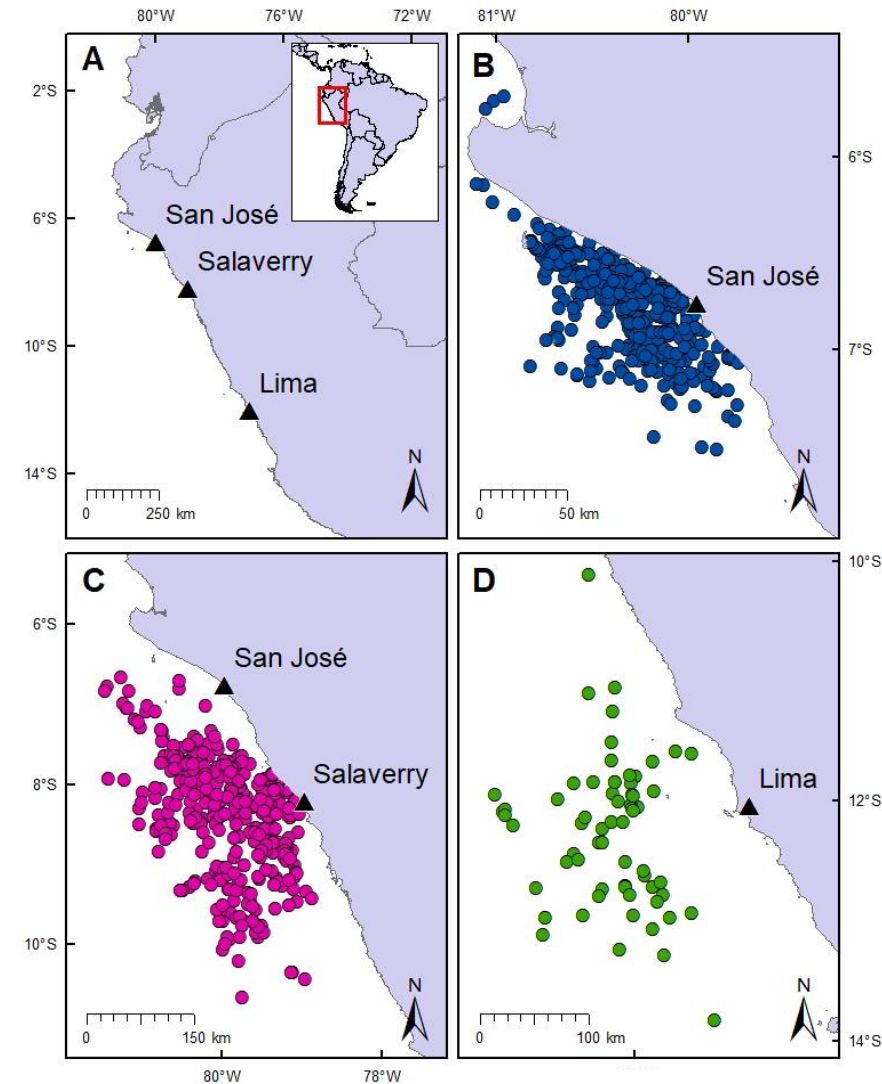
Reducing green turtle bycatch in small-scale fisheries using illuminated gillnets: the cost of saving a sea turtle

Natalia Ortiz¹, Jeffrey C. Mangel^{1,2,*}, John Wang³, Joanna Alfaro-Shigueto^{1,2,4}, Sergio Pingo¹, Astrid Jimenez¹, Tania Suarez¹, Yonat Swimmer³, Felipe Carvalho^{3,5}, Brendan J. Godley²



LEDs – Bielli et al. 2019

Under review



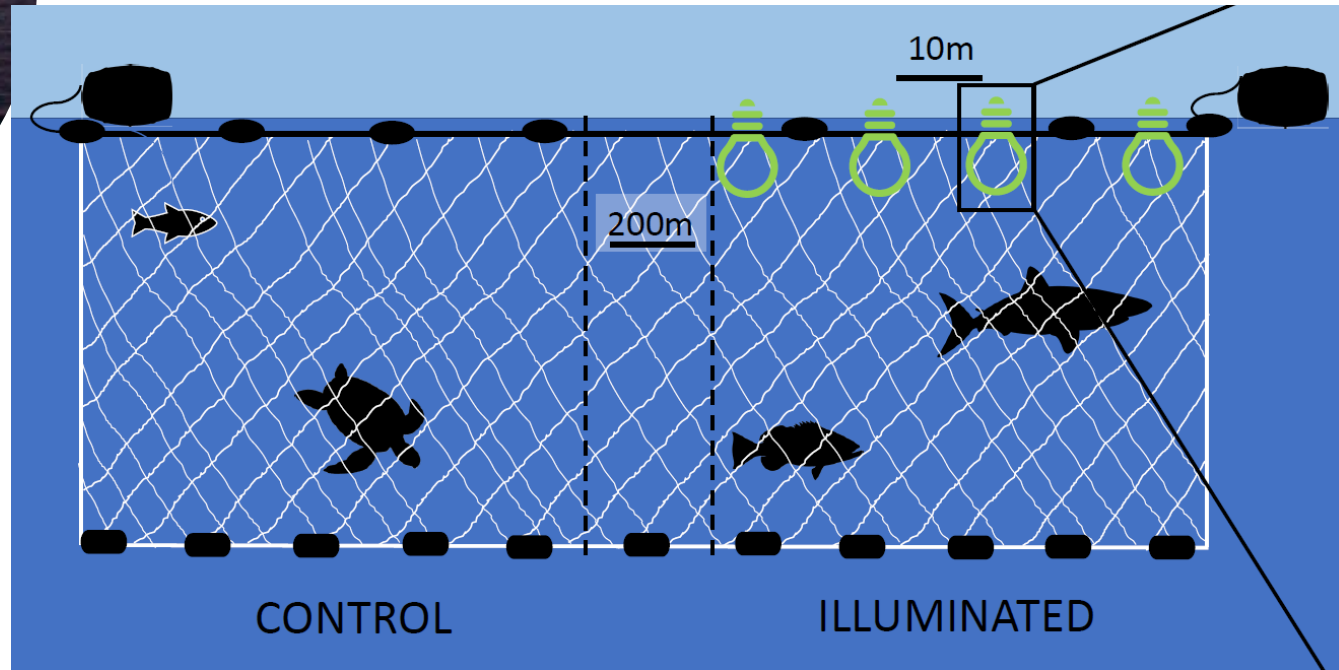
2015 – 2018

864 sets

Real fishery
conditions

Fishing set locations.

LEDs – light emitting diodes



Experimental design, not to scale

Analysis

Generalized linear mixed-effect models (GLMM)

- Full models:

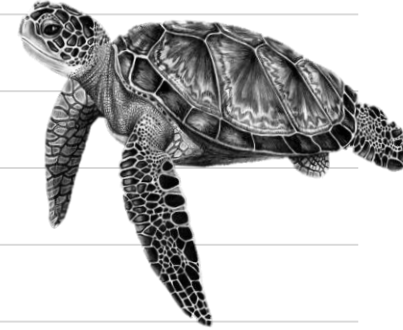
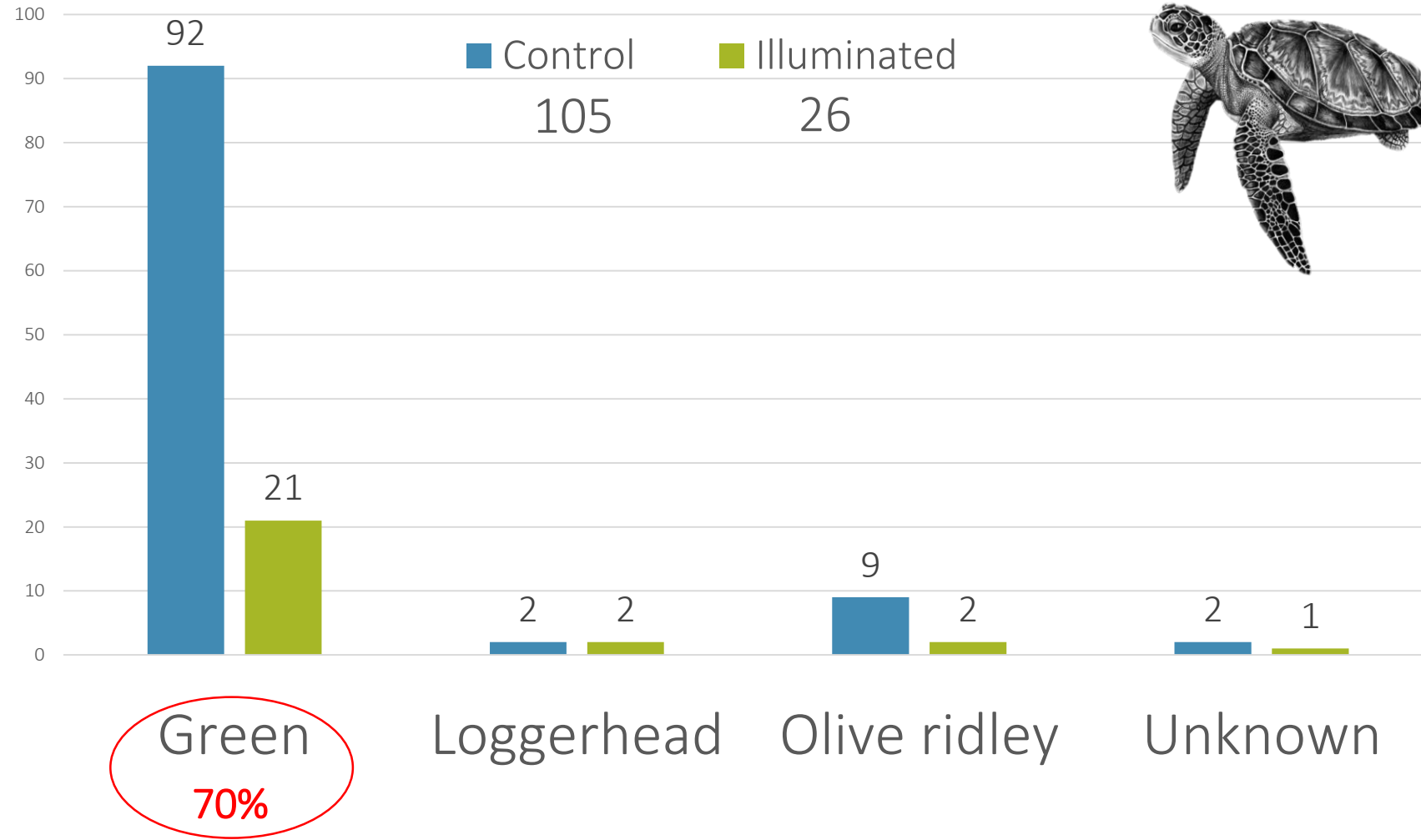
Bycatch probability $\sim$ Effort + Treatment + Net type



Target catch $\sim$ Treatment + Net type + offset(log(Effort))

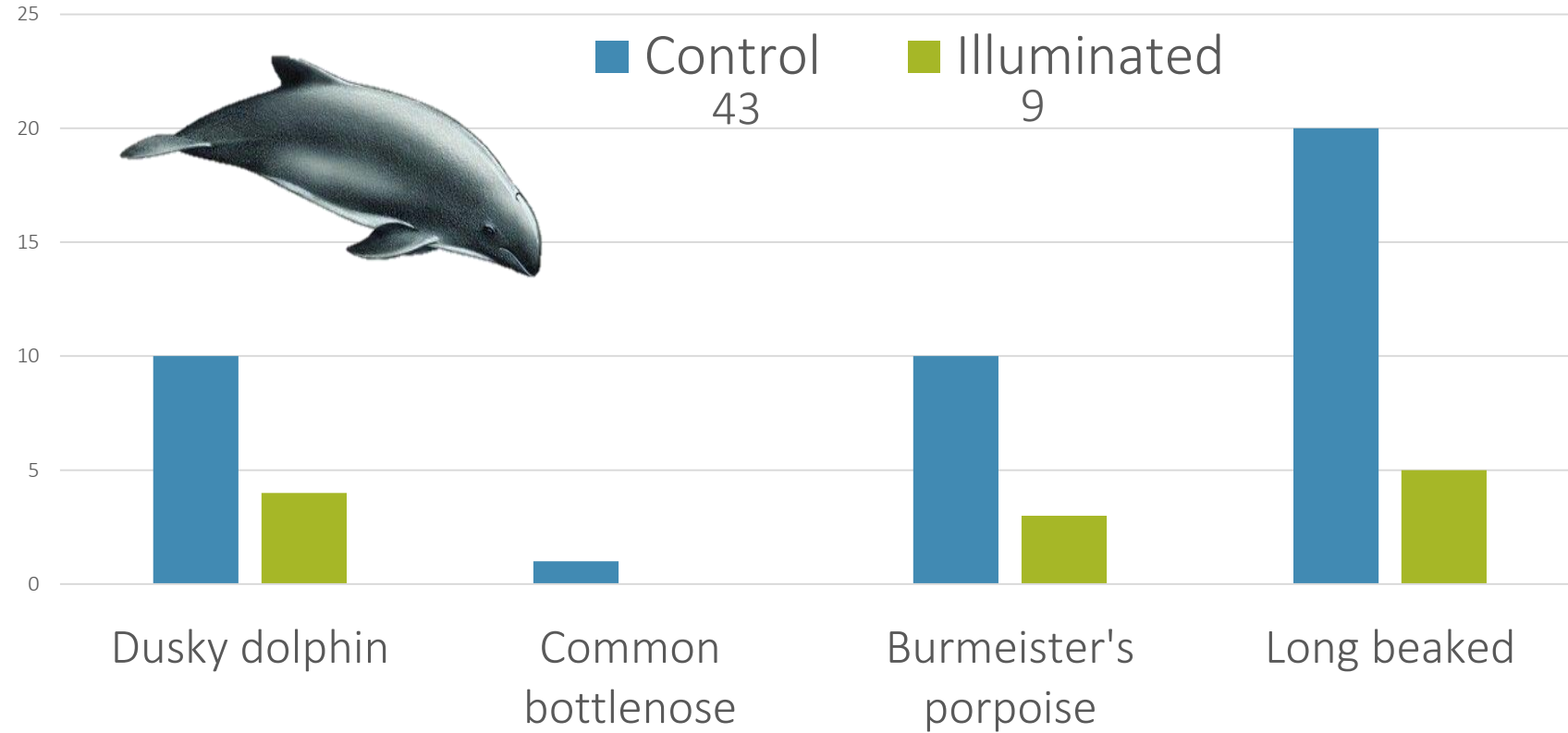


Results -bycatch



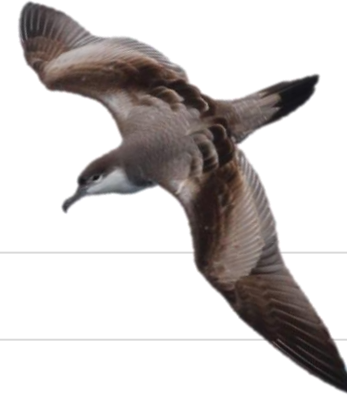
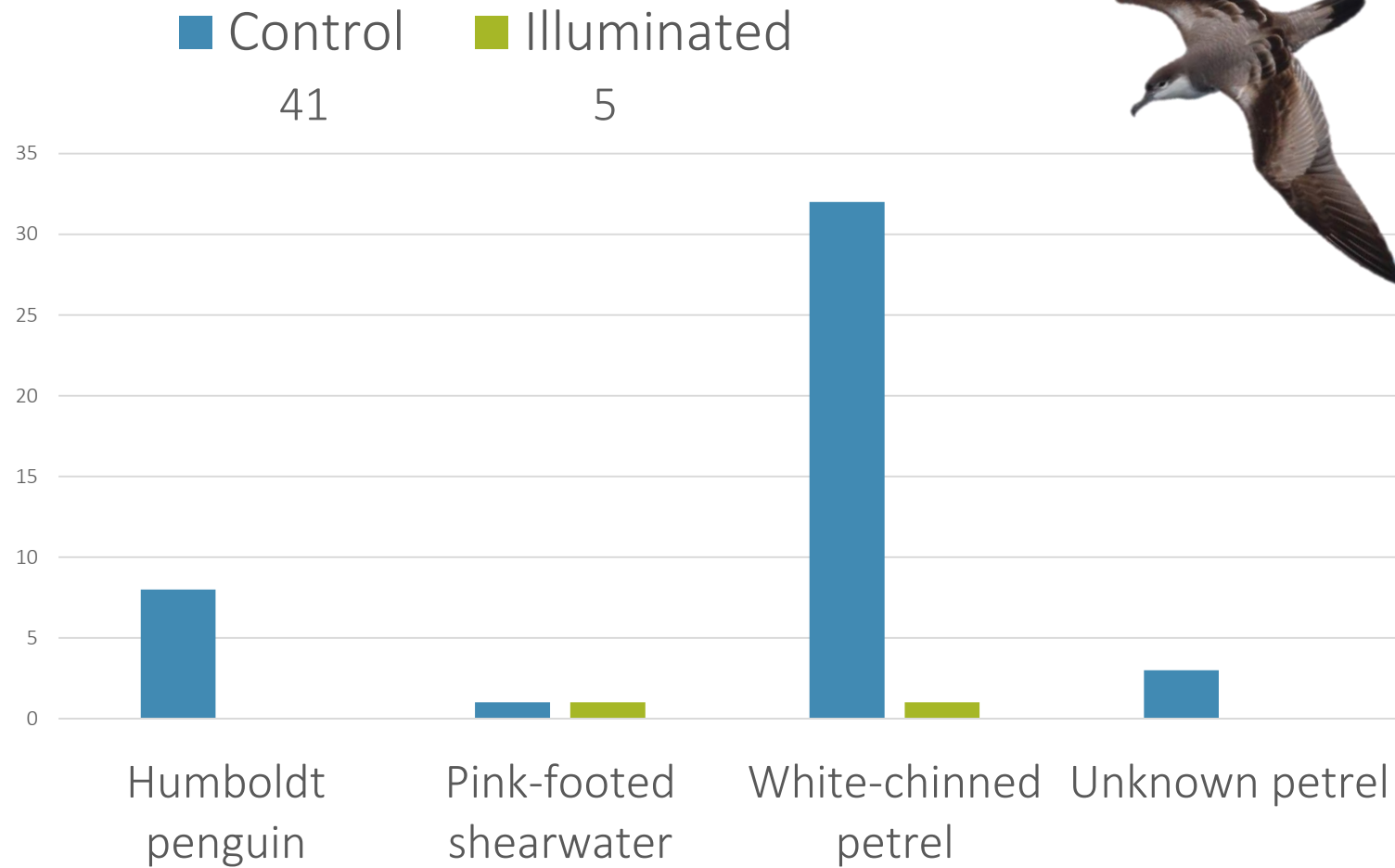
Number of individuals captured by species, in control and illuminated nets

Results -bycatch



Number of individuals captured by species, in control and illuminated nets

Results -bycatch



Number of individuals captured by species, in control and illuminated nets

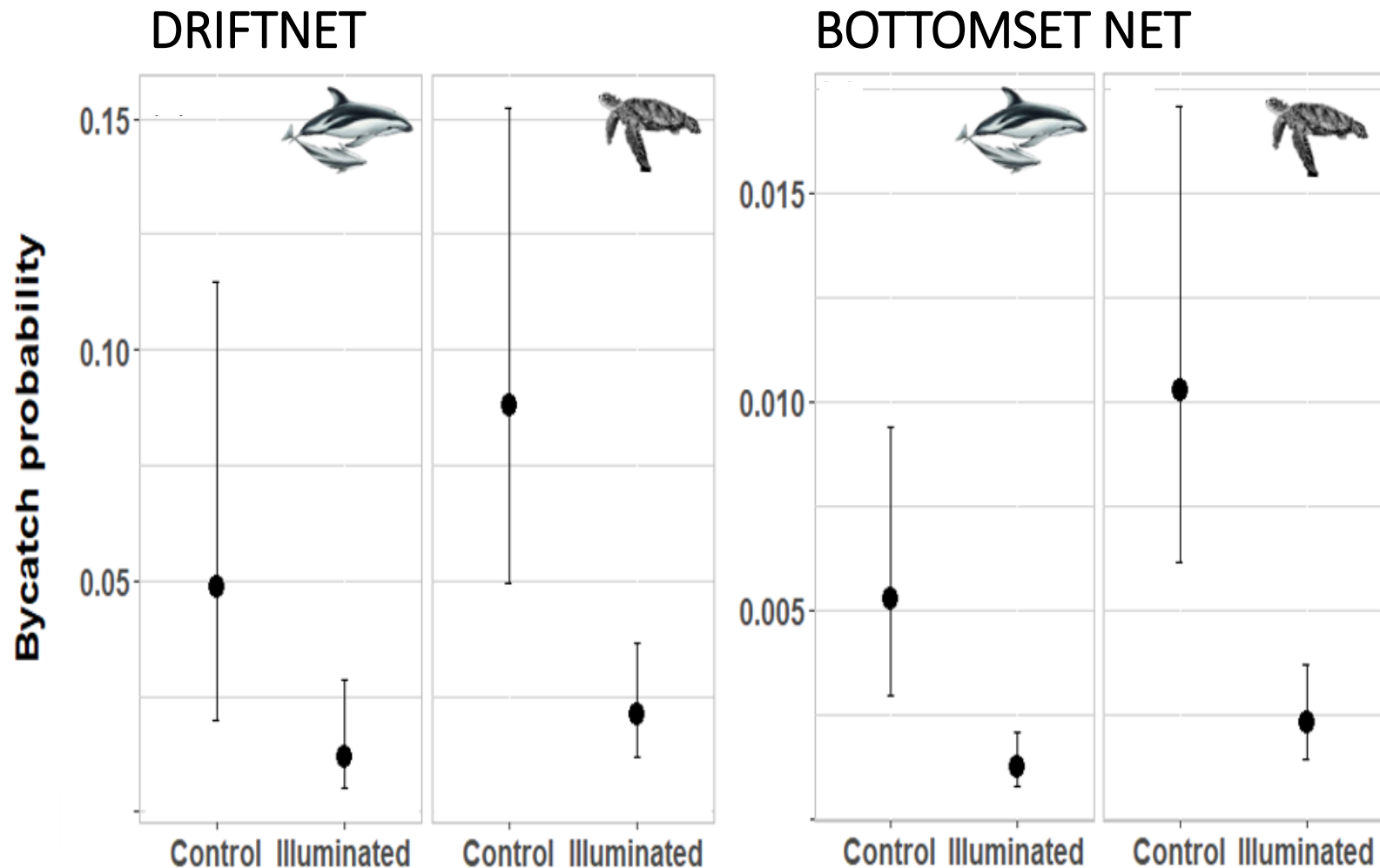
Best model: ~ Treatment + Net type

Bycatch probability reduction

	Driftnet	Bottomset
Turtles	- 80.0%	- 76.1%
Small cetaceans	- 80.0%	- 75.0%

Bycatch probability reduction when LEDs applied

- Seabirds: no convergence



Expected bycatch probability per set estimated from the models.

Results – target CPUE

SHARKS AND BONY FISH

Best model:

~ Net type + offset(log(Effort))

Treatment does not affect CPUE



RAYS

Best model:

~ Treatment + Net type + offset(log(Effort))

Presence of LEDs increases CPUE

- bottomset ↗ 66.7%
- driftnets ↗ 60.0%



Discussion

- LEDs – a successful multitaxa Bycatch Reduction Technology

	Driftnet	Bottomset
Turtles	- 80.0%	- 76.1%
Small cetaceans	- 80.0%	- 75.0%

- Target catch remained the same
- Promising method to reduce bycatch
- Encourage further testing in other locations, in collaboration with IATTC and IAC staff



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Thanks for
listening

References

- Alfaro-Shigueto, J., Mangel, J. C., Pajuelo, M., Dutton, P. H., Seminoff, J. A., & Godley, B. J. (2010). Where small can have a large impact: structure and characterization of small-scale fisheries in Peru. *Fisheries Research*, 106(1), 8-17.
- Alfaro-Shigueto, J., Mangel, J. C., Bernedo, F., Dutton, P. H., Seminoff, J. A., & Godley, B. J. (2011). Small-scale fisheries of Peru: a major sink for marine turtles in the Pacific. *Journal of Applied Ecology*, 48(6), 1432-1440.
- Bielli*, A., Alfaro-Shigueto, J., Doherty, P., Godley, B., Ortiz, C., Pasara, A., Wang, J. & Mangel, J. (2019). An illuminating idea to reduce bycatch in the Peruvian small-scal gillnet fishery. *Biological Conservation*. Under review.
- Lewison, R.L., Crowder, L.B., Wallace, B.P., Moore, J.E., Cox, T., Zydelis, R., McDonald, S., DiMatteo, A., Dunn, D.C., Kot, C.Y., Bjorkland, R., Kelez, S., Soykan, C., Stewart, K.R., Sims, M., Boustany, A., Read, A.J., Halpin, P., Nichols, W.J., Safina, C., 2014. Global patterns of marine mammal, seabird, and sea turtle bycatch reveal taxa-specific and cumulative megafauna hotspots. *Proc. Natl. Acad. Sci.* 111, 5271–5276.
- Mangel, J.C., Alfaro-Shigueto, J., Van Waerebeek, K., Cáceres, C., Bearhop, S., Witt, M.J., Godley Pro Delphinus, B.J., Bernal, O., 2010. Small cetacean captures in Peruvian artisanal fisheries: High despite protective legislation. *Biol. Conserv.* 143, 136–143. <https://doi.org/10.1016/j.biocon.2009.09.017>
- Mangel, J. C., Wang, J., Alfaro-Shigueto, J., Pingo, S., Jimenez, A., Carvalho, F., ... & Godley, B. J. (2018). Illuminating gillnets to save seabirds and the potential for multi-taxa bycatch mitigation. *Royal Society open science*, 5(7), 180254.
- Ortiz, N., Mangel, J. C., Wang, J., Alfaro-Shigueto, J., Pingo, S., Jimenez, A., ... & Godley, B. J. (2016). Reducing green turtle bycatch in small-scale fisheries using illuminated gillnets: the cost of saving a sea turtle. *Marine Ecology Progress Series*, 545, 251-259.
- Virgili, M., Vasapollo, C., & Lucchetti, A. (2018). Can ultraviolet illumination reduce sea turtle bycatch in Mediterranean set net fisheries?. *Fisheries Research*, 199, 1-7.
- Wang, J., Barkan, J., Fisler, S., Godinez-Reyes, C., & Swimmer, Y. (2013). Developing ultraviolet illumination of gillnets as a method to reduce sea turtle bycatch. *Biology letters*, 9(5), 20130383.