

Why (and how) we should embrace the study of juvenile turtles

Brendan Godley

Photo: Brendan Godley

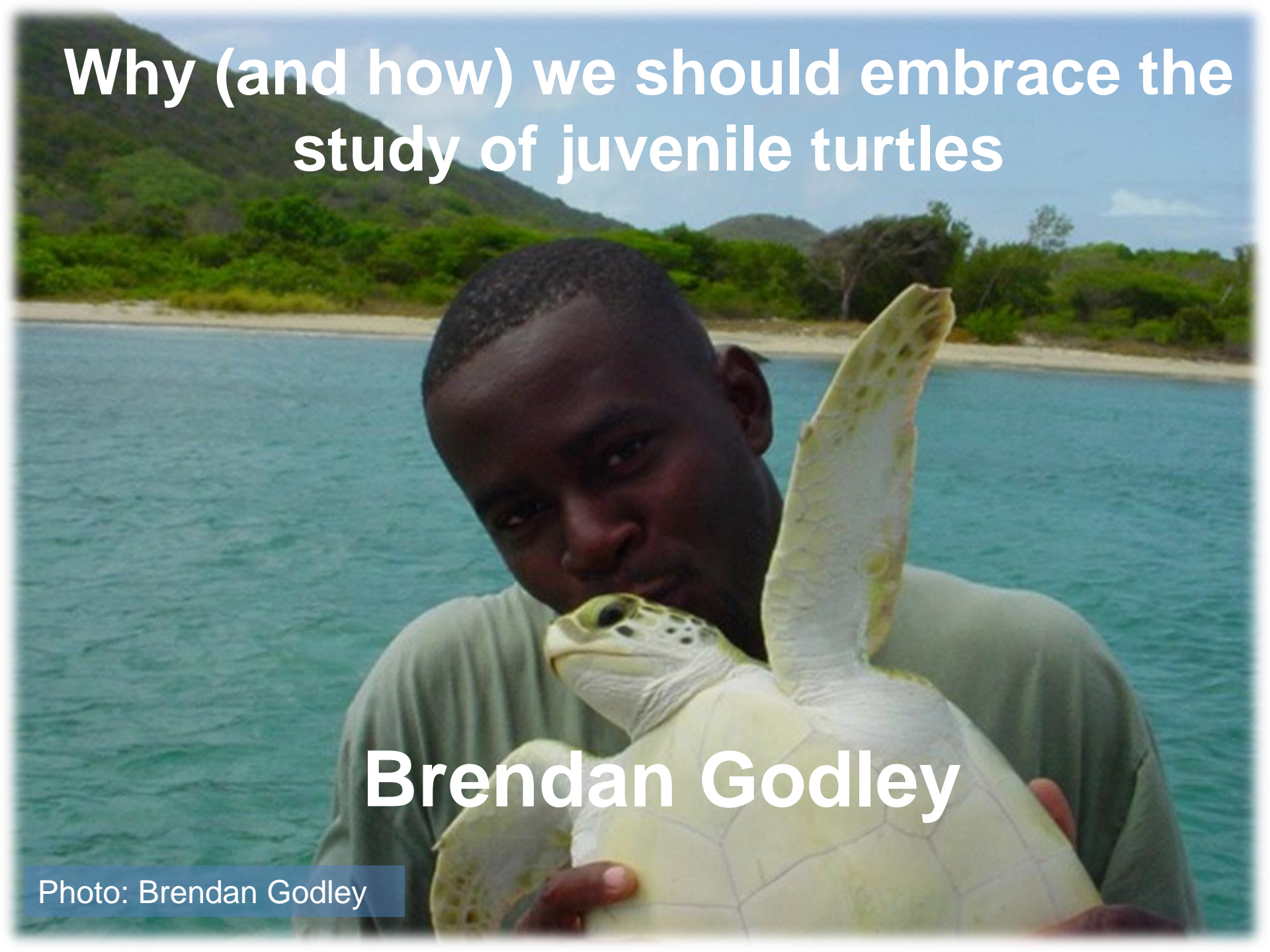




Photo: Annette Broderick

1992

Photo: Annette Broderick





Photo: Brendan Godley



Migratory corridors and foraging hotspots: critical habitats identified for Mediterranean green turtles

K. L. Stokes¹, A. C. Broderick¹, A. F. Canbolat², O. Candan³,
W. J. Fuller^{1,4,5}, F. Glen⁶, Y. Levy^{7,8}, A. F. Rees^{1,9}, G. Rilov^{7,10},
R. T. Snape^{1,5}, I. Stott¹¹, D. Tchernov⁷ and B. J. Godley^{1*}

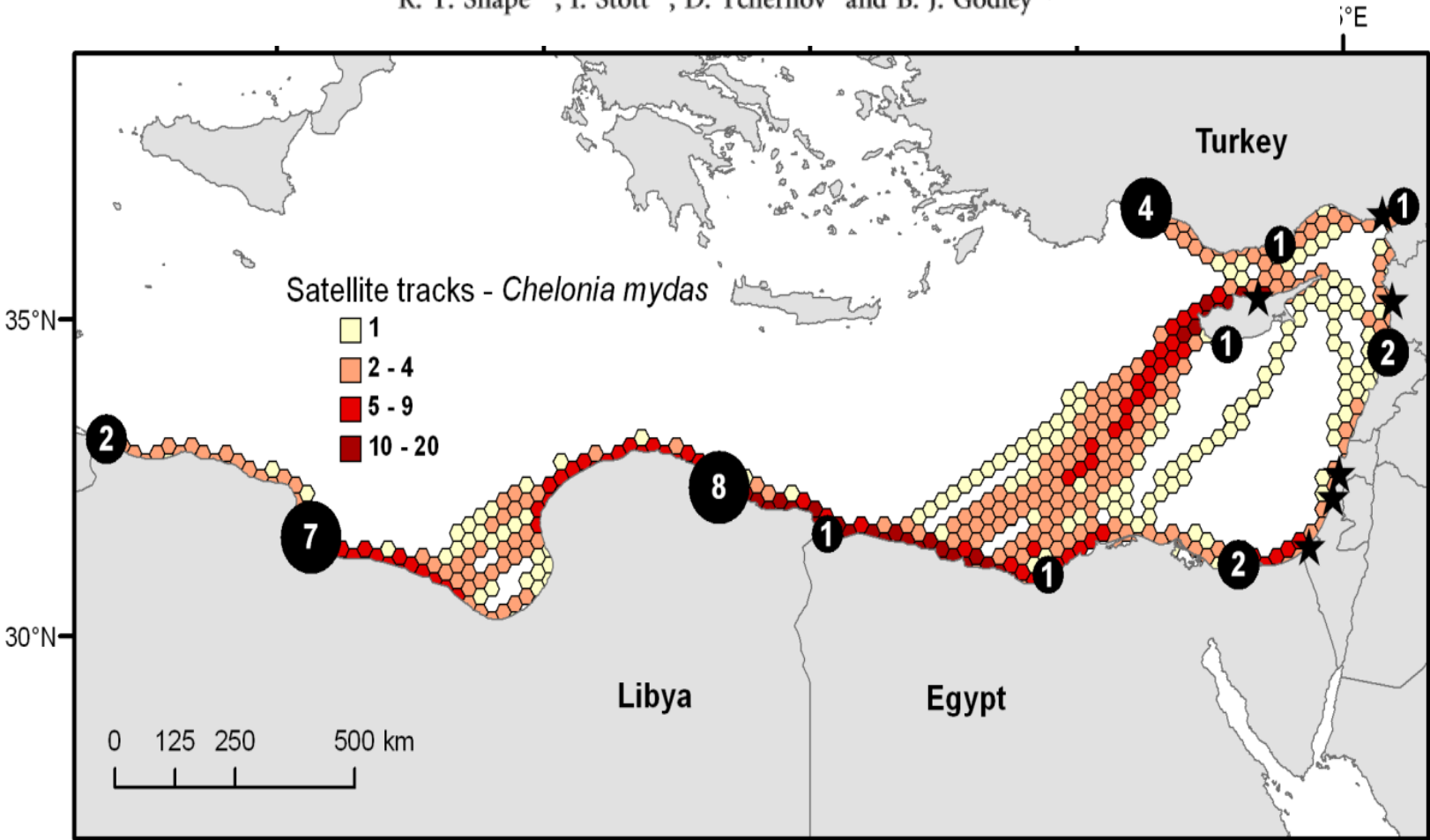




Photo: Jimmy Young




Photo: Annette Broderick

A sea turtle is swimming in clear blue water. A small, silvery fish is perched on the turtle's head. The turtle is moving towards the right side of the frame. The water is a deep, vibrant blue with some ripples on the surface.

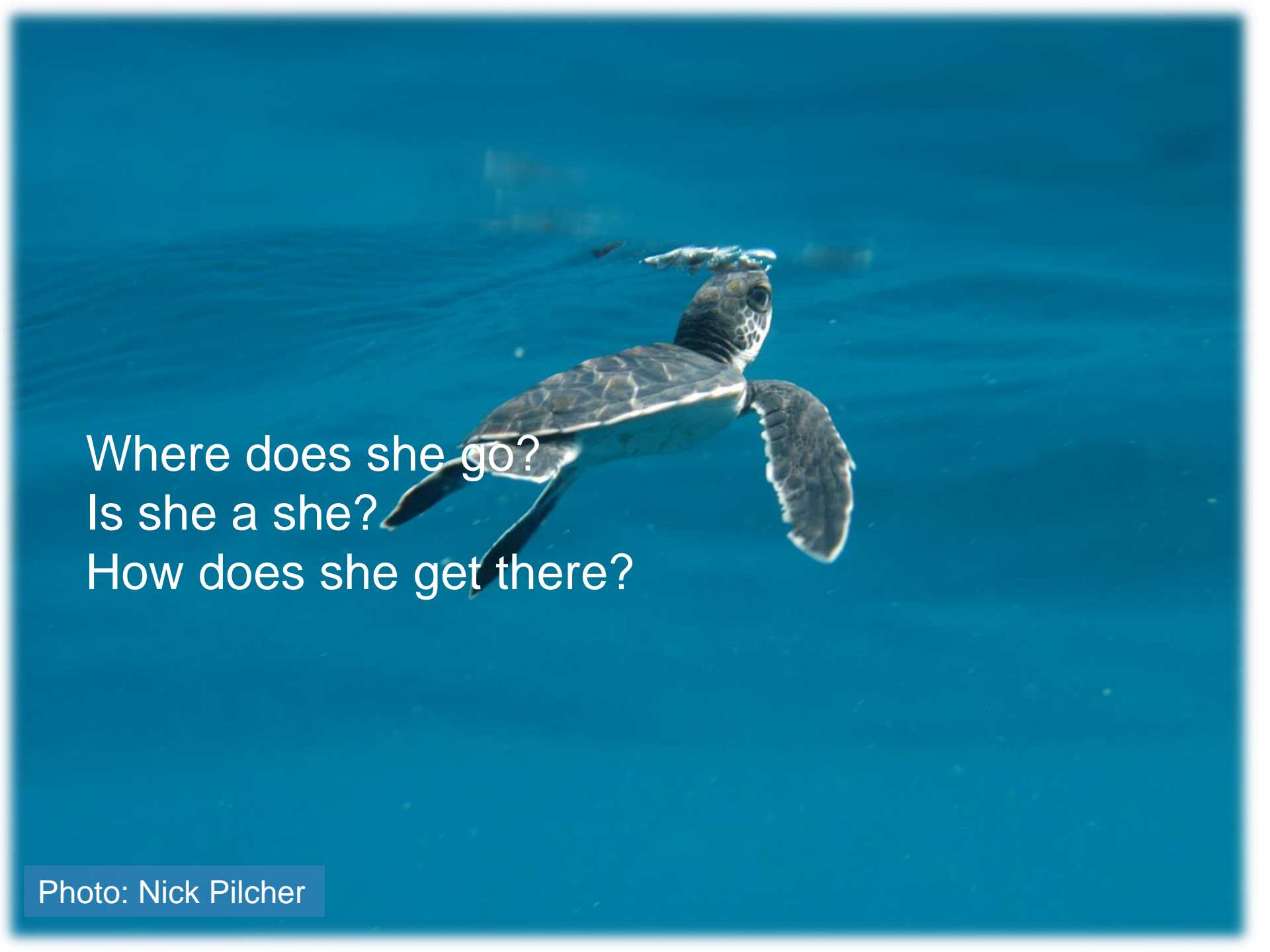
Where does she go?

Photo: Nick Pilcher

A photograph of a sea turtle swimming in clear, deep blue water. The turtle is positioned in the center-right of the frame, facing towards the right. Its head is slightly above the water surface, and its front flipper is extended outwards. The water is a vibrant blue with some ripples on the surface. The turtle's shell is dark with lighter patterns, and its flippers are a lighter shade of brown.


Where does she go?
Is she a she?

Photo: Nick Pilcher

A photograph of a sea turtle swimming in clear, deep blue water. The turtle is positioned in the center-right of the frame, facing towards the right. Its head is slightly above the water surface, and its front flipper is extended outwards. The water is a vibrant blue with some ripples on the surface. The text is overlaid on the left side of the image.


Where does she go?
Is she a she?
How does she get there?

Photo: Nick Pilcher

A photograph of a sea turtle swimming in clear, deep blue water. The turtle is positioned in the center-right of the frame, facing towards the right. Its head is slightly raised, and its front flipper is extended outwards. The water is a vibrant blue with some subtle ripples and light reflections. The overall scene is serene and captures the turtle in its natural habitat.


Where does she go?
Is she a she?
How does she get there?
How long does she stay there?

Photo: Nick Pilcher

A photograph of a sea turtle swimming in clear, deep blue water. The turtle is positioned in the center-right of the frame, facing towards the right. Its head is slightly raised, and its front flipper is extended outwards. The water is a vibrant blue with some subtle ripples and light reflections. The overall scene is serene and captures the turtle in its natural habitat.


Where does she go?
Is she a she?
How does she get there?
How long does she stay there?
What does she do there?

Photo: Nick Pilcher

A photograph of a sea turtle swimming in clear, deep blue water. The turtle is positioned in the center-right of the frame, facing towards the right. Its head is slightly raised, and its front flipper is extended outwards. The water is a vibrant blue with some subtle ripples and light reflections. The overall scene is serene and captures the turtle in its natural habitat.

Where does she go?
Is she a she?
How does she get there?
How long does she stay there?
What does she do there?
Where else does she go?

Photo: Nick Pilcher

A photograph of a sea turtle swimming in clear, deep blue water. The turtle is positioned in the center-right of the frame, facing towards the right. Its head is slightly raised, and its front flipper is extended outwards. The water is a vibrant blue with some subtle ripples and light reflections. The overall scene is serene and captures the turtle in its natural habitat.

Where does she go?
Is she a she?
How does she get there?
How long does she stay there?
What does she do there?
Where else does she go?
What threats does she face before she returns?

Photo: Nick Pilcher



1. More of us need to work on juveniles
2. It will need to be with multiple techniques
(some of them we don't have yet!)
3. It will need to be longterm and widescale
4. At least some will need to be with fishers
5. We need to be open to emerging themes

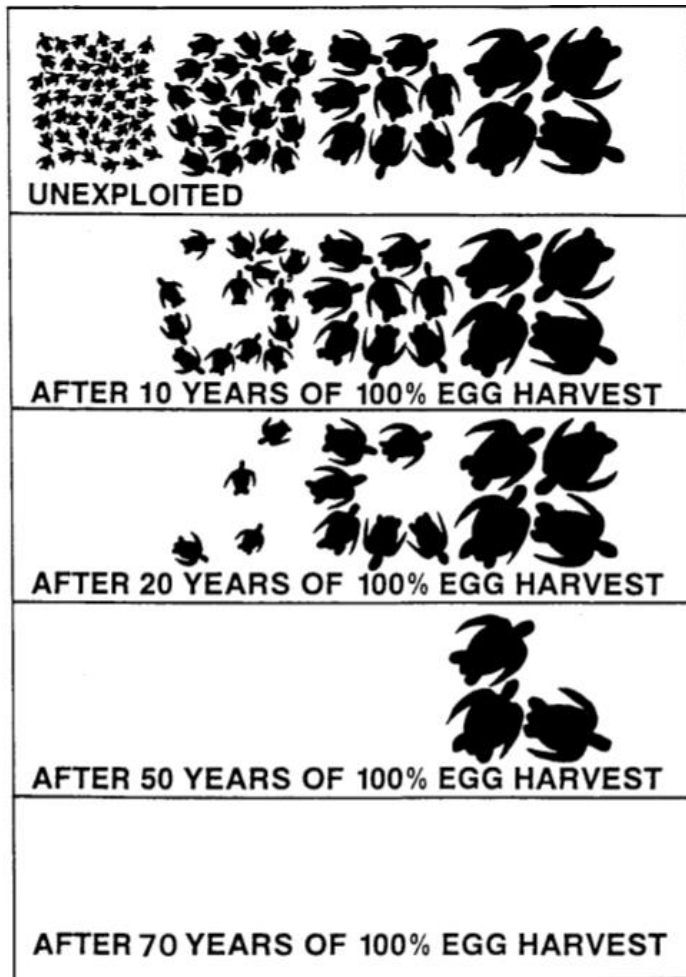
Photo: Nick Pilcher

1. Why more of us need to work on juvenile turtles



Marine Turtle Newsletter

Number 71 October 1995



TEACHING CRITICAL CONCEPTS FOR THE
CONSERVATION OF SEA TURTLES

**Designed to
illustrate the long
term impact of egg
harvest but.....**

Marine Turtle Newsletter

Number 71 October 1995



UNEXPLOITED



AFTER 10 YEARS OF 100% EGG HARVEST



AFTER 20 YEARS OF 100% EGG HARVEST



AFTER 50 YEARS OF 100% EGG HARVEST

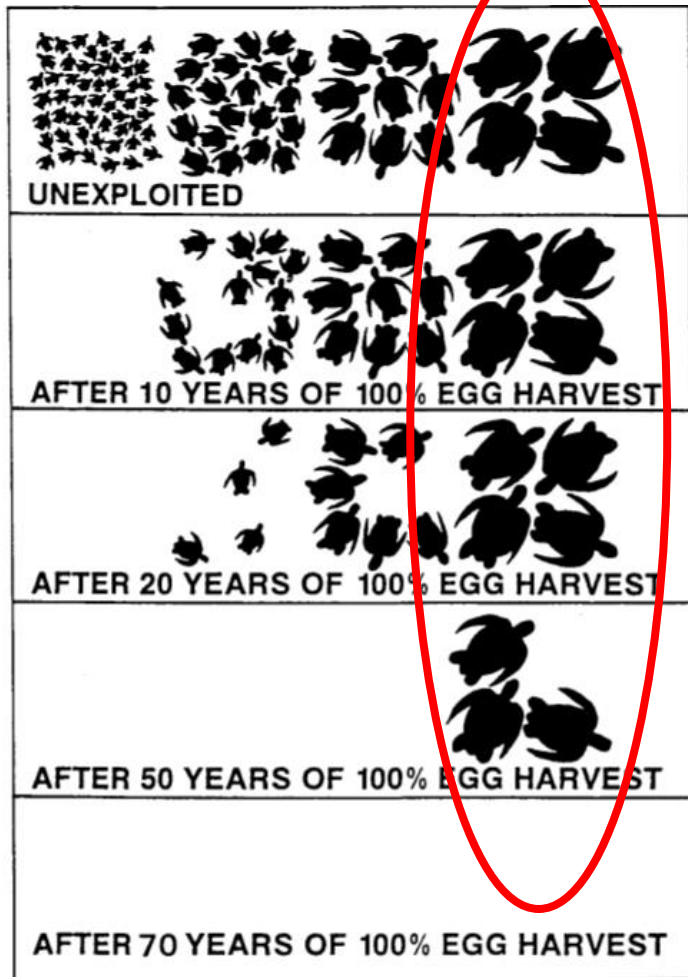
AFTER 70 YEARS OF 100% EGG HARVEST

TEACHING CRITICAL CONCEPTS FOR THE
CONSERVATION OF SEA TURTLES

**Most turtles are
juveniles**

Marine Turtle Newsletter

Number 71 October 1995



TEACHING CRITICAL CONCEPTS FOR THE
CONSERVATION OF SEA TURTLES

**If our monitoring
focusses on adult
females only, we
may be in for a
shock!**



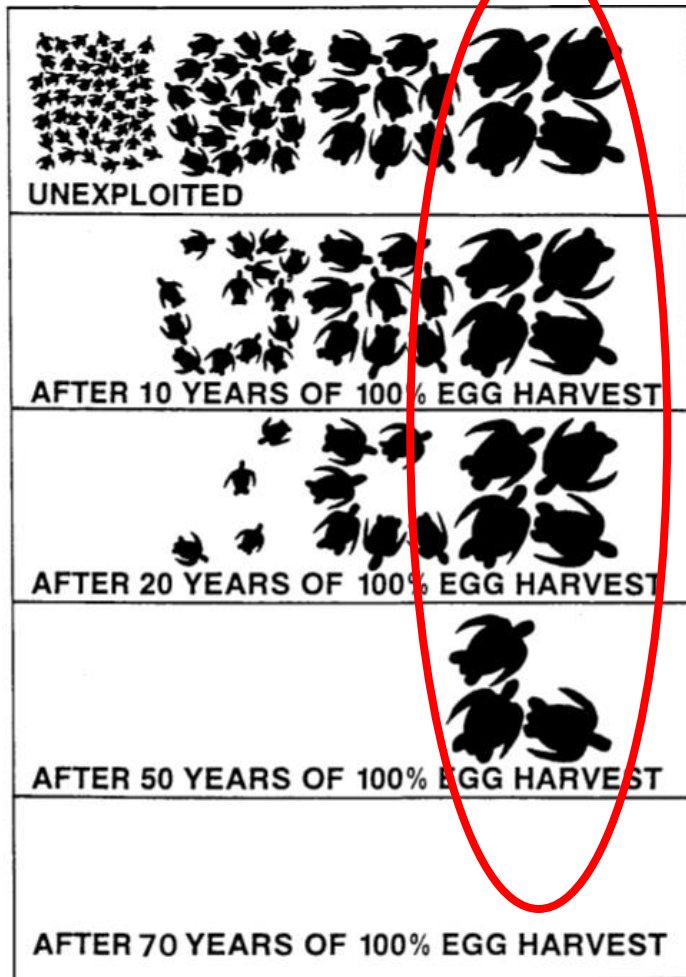
Photo: Maike Heidemeyer



Photo: Alejandro Fallabrino

Marine Turtle Newsletter

Number 71 October 1995



TEACHING CRITICAL CONCEPTS FOR THE
CONSERVATION OF SEA TURTLES

.....or it may be a
pleasant surprise!



Photo: Mathew Godfrey



More strandings can be good thing!

Photo: Mathew Godfrey



REVIEW

Informing research priorities for immature sea turtles through expert elicitation

Natalie E. Wildermann¹, Christian Gredzens¹, Larisa Avens, Héctor A. Barrios-Garrido¹, Ian Bell, Janice Blumenthal, Alan B. Bolten, Joanne Braun McNeill, Paolo Casale, Maikon Di Domenico, Camila Domit, Sheryan P. Epperly, Matthew H. Godfrey, Brendan J. Godley, Victoria González-Carman, Mark Hamann, Kristen M. Hart, Takashi Ishihara, Kate L. Mansfield, Tasha L. Metz, Jeffrey D. Miller, Nicolas J. Pilcher, Mark A. Read, Christopher Sasso, Jeffrey A. Seminoff, Erin E. Seney, Amanda Southwood Williard, Jesús Tomás, Gabriela M. Vélez-Rubio, Matthew Ware¹, Jessica L. Williams, Jeanette Wyneken, Mariana M. P. B. Fuentes^{1,*}

¹Turtle Research, Ecology and Conservation Group, Department of Earth, Ocean and Atmospheric Science, Florida State University, Tallahassee, FL 32306, USA

Addresses for other authors are given in the Supplement at www.int-res.com/articles/suppl/n037p055_supp.pdf



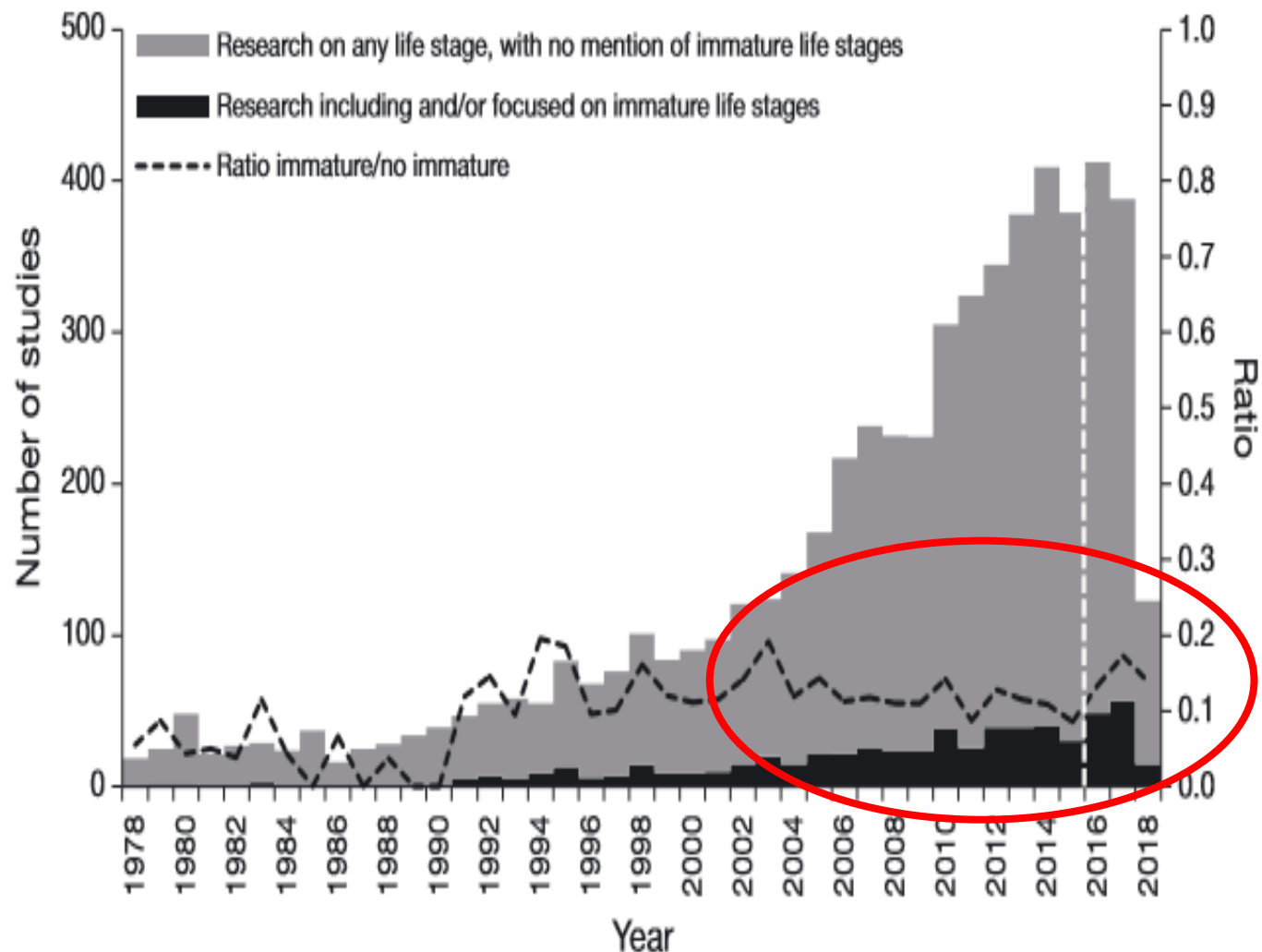


Fig. 1. Count (number of studies) and ratio of sea turtle research publications from 1978 to April 2018 from a Web of Science search using the search terms 'sea turtle' or 'marine turtle' for any life stage (gray bars) and for studies including or focused on immature turtles (black bars). White dashed line indicates end of sampling for literature review to identify experts. Prior to 1978, there were limited and temporally scattered studies on immature sea turtles; thus these studies were excluded from the search. From 1978 onwards, annual frequency of peer-reviewed studies on immature sea turtles started to increase

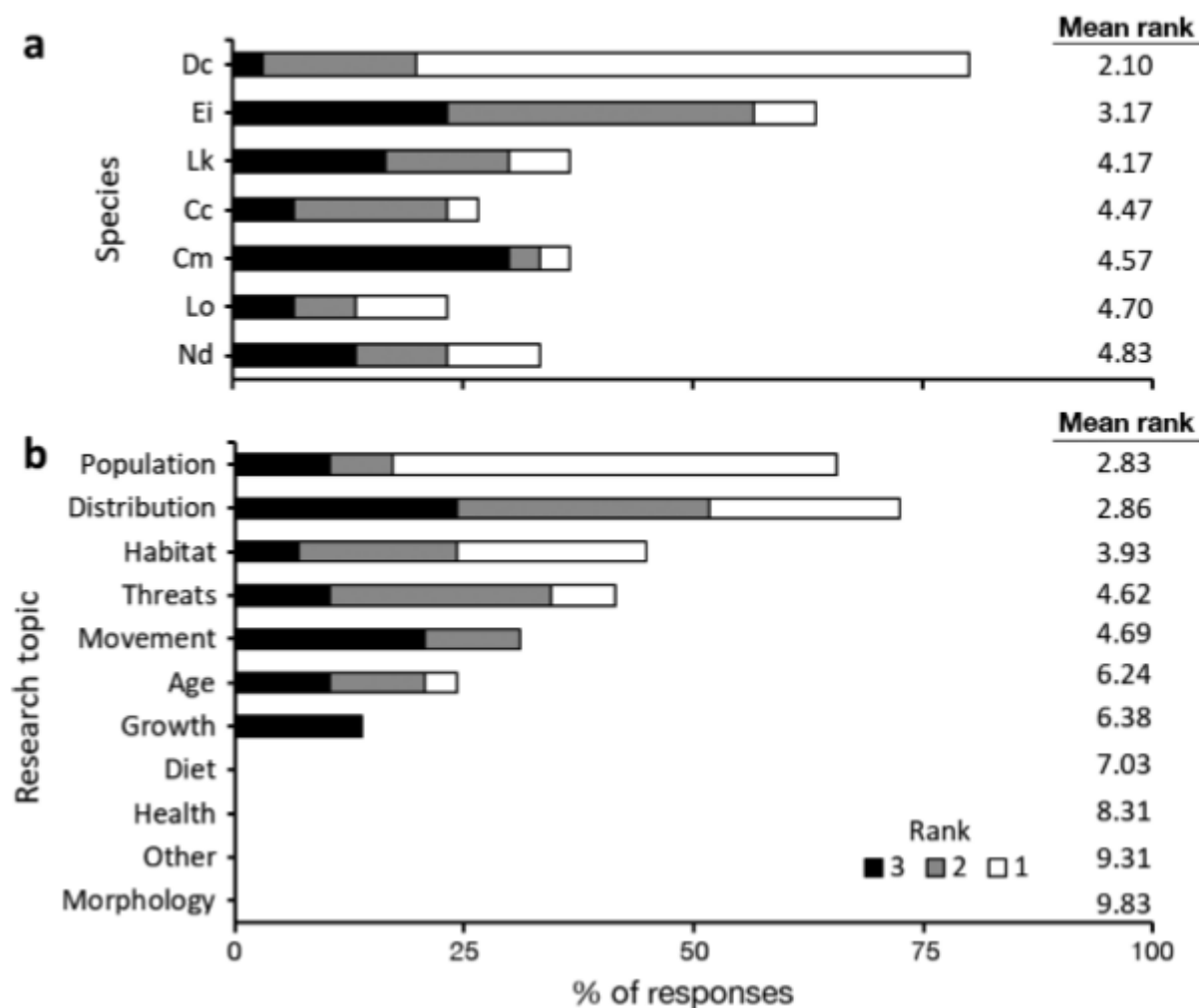
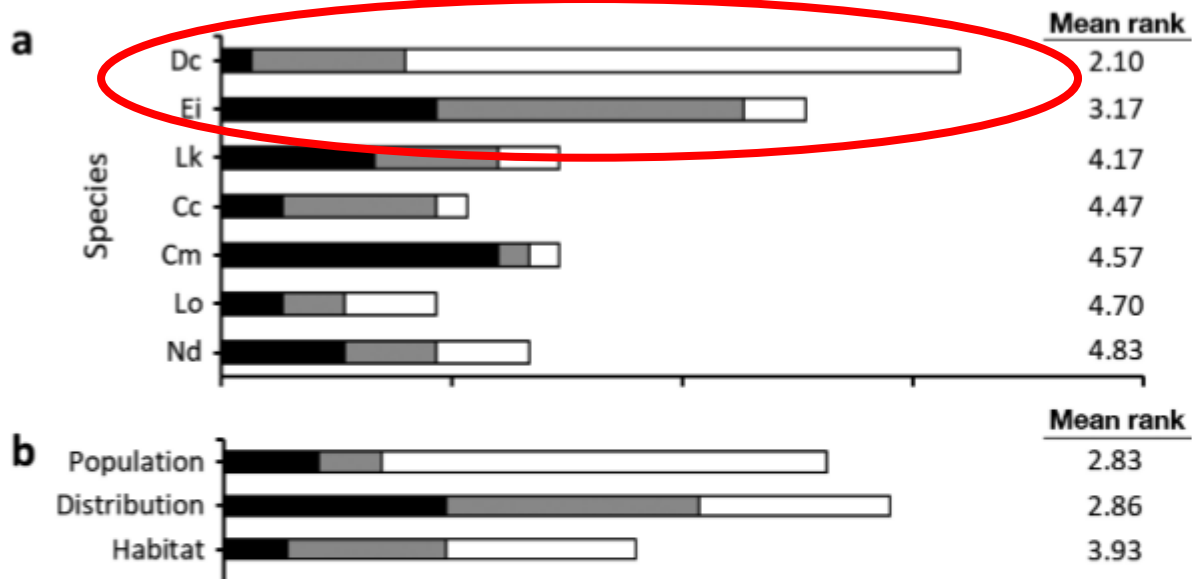


Fig. 4. Ranked immature sea turtle (a) priority species and (b) research topics as determined by expert opinion. Ranks ranged from 1 to 11, with lower ranks indicating the higher priority. Species abbreviations as in Fig. 2



□ 1



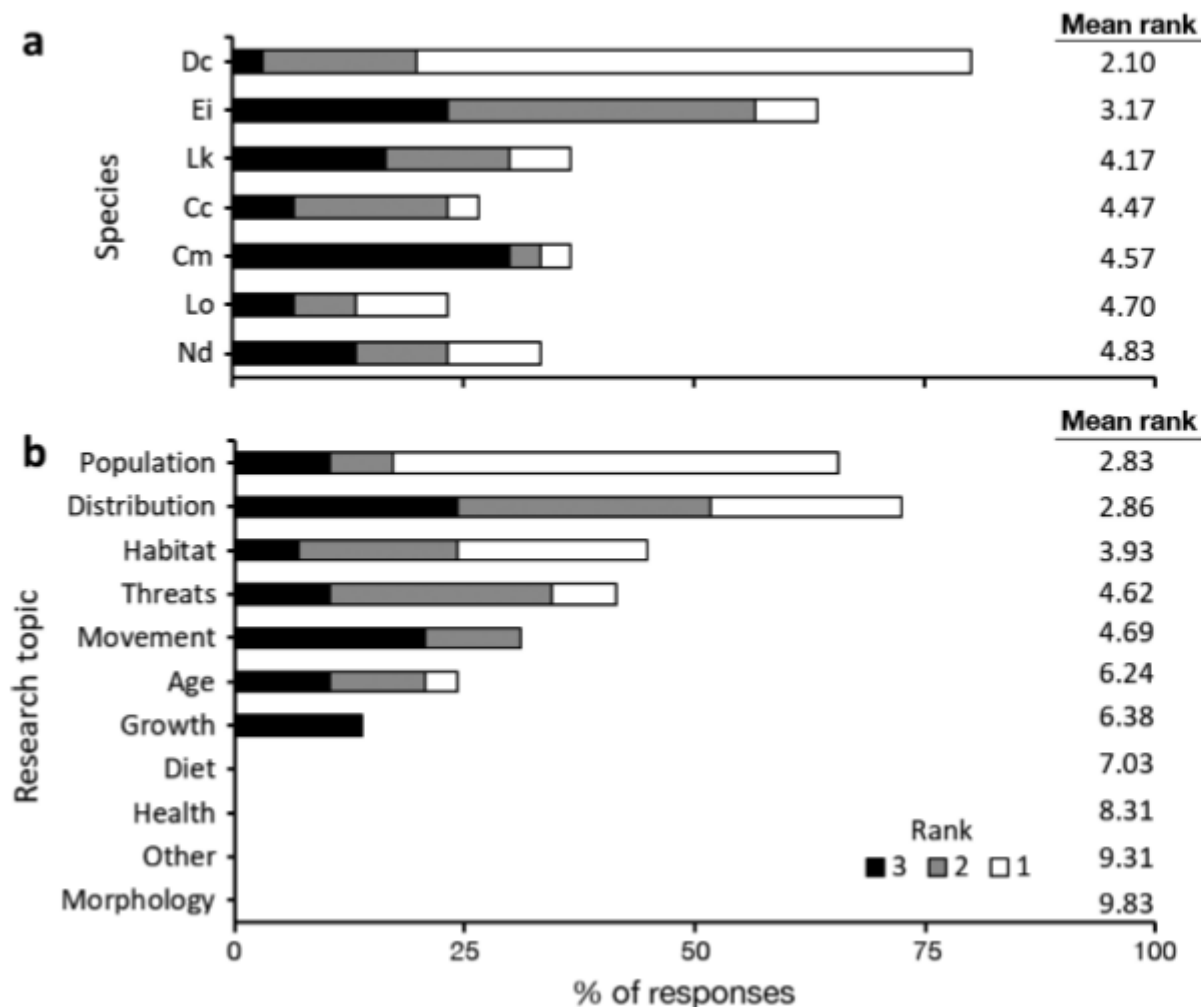


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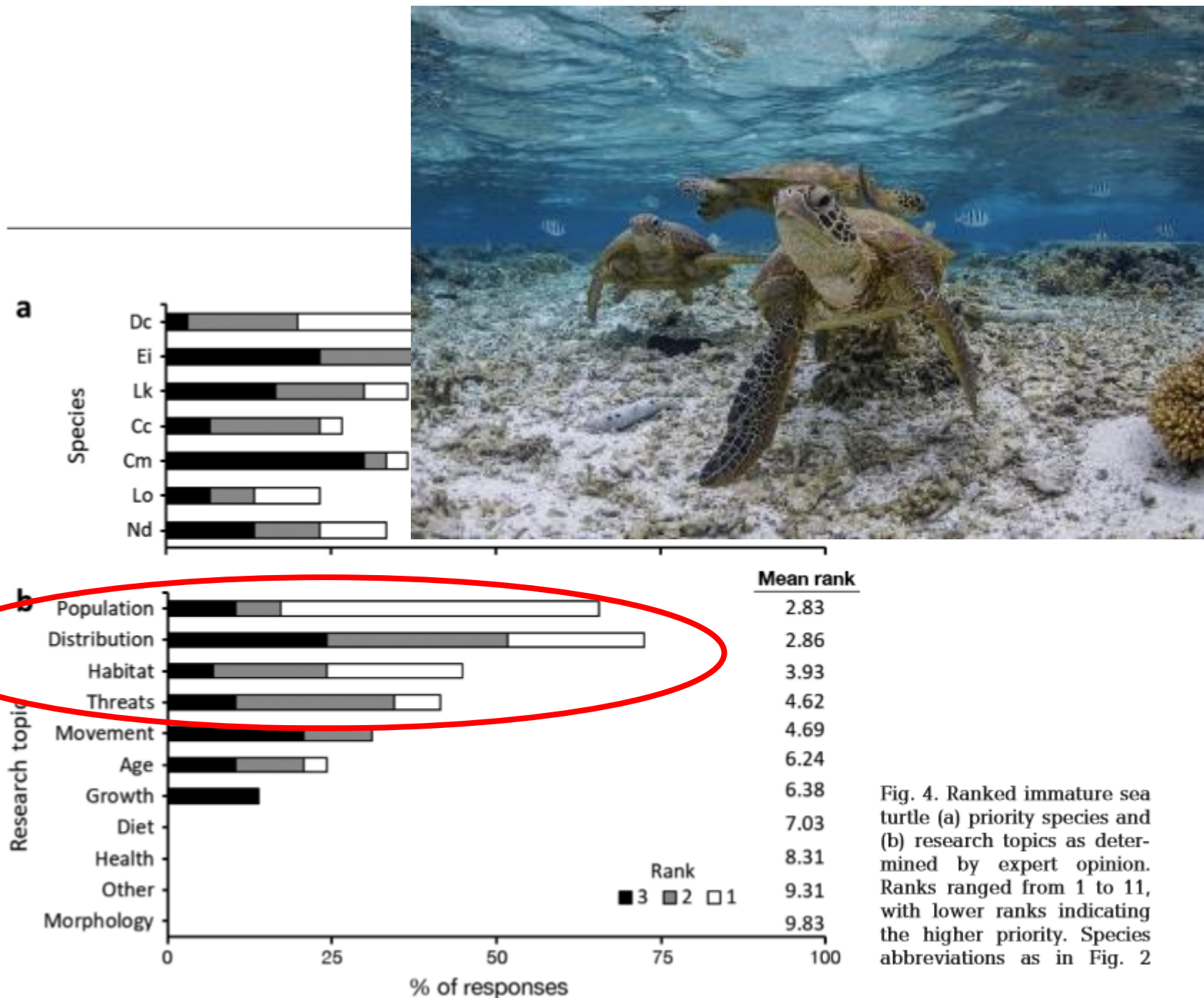


Fig. 4. Ranked immature sea turtle (a) priority species and (b) research topics as determined by expert opinion. Ranks ranged from 1 to 11, with lower ranks indicating the higher priority. Species abbreviations as in Fig. 2

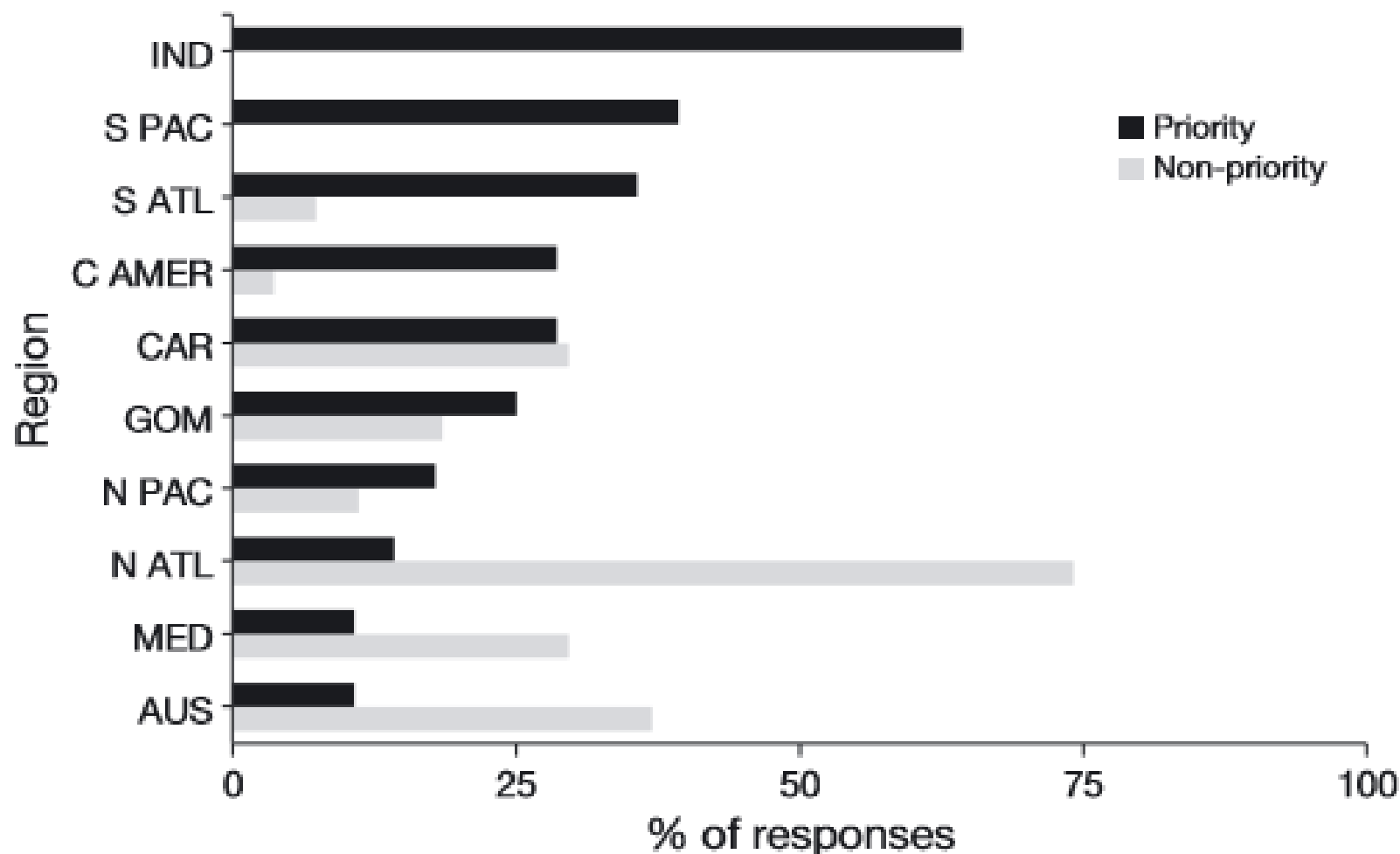


Fig. 5. Perceived priority and non-priority regions for immature sea turtle research, conservation, and management. IND: Indian Ocean, S PAC: South Pacific, S ATL: South Atlantic, C AMER: Central America, CAR: Caribbean, GOM: Gulf of Mexico, N PAC: North Pacific, N ATL: North Atlantic, MED: Mediterranean, AUS: Australia. Respondents could provide up to 3 regions for both priority and non-priority areas

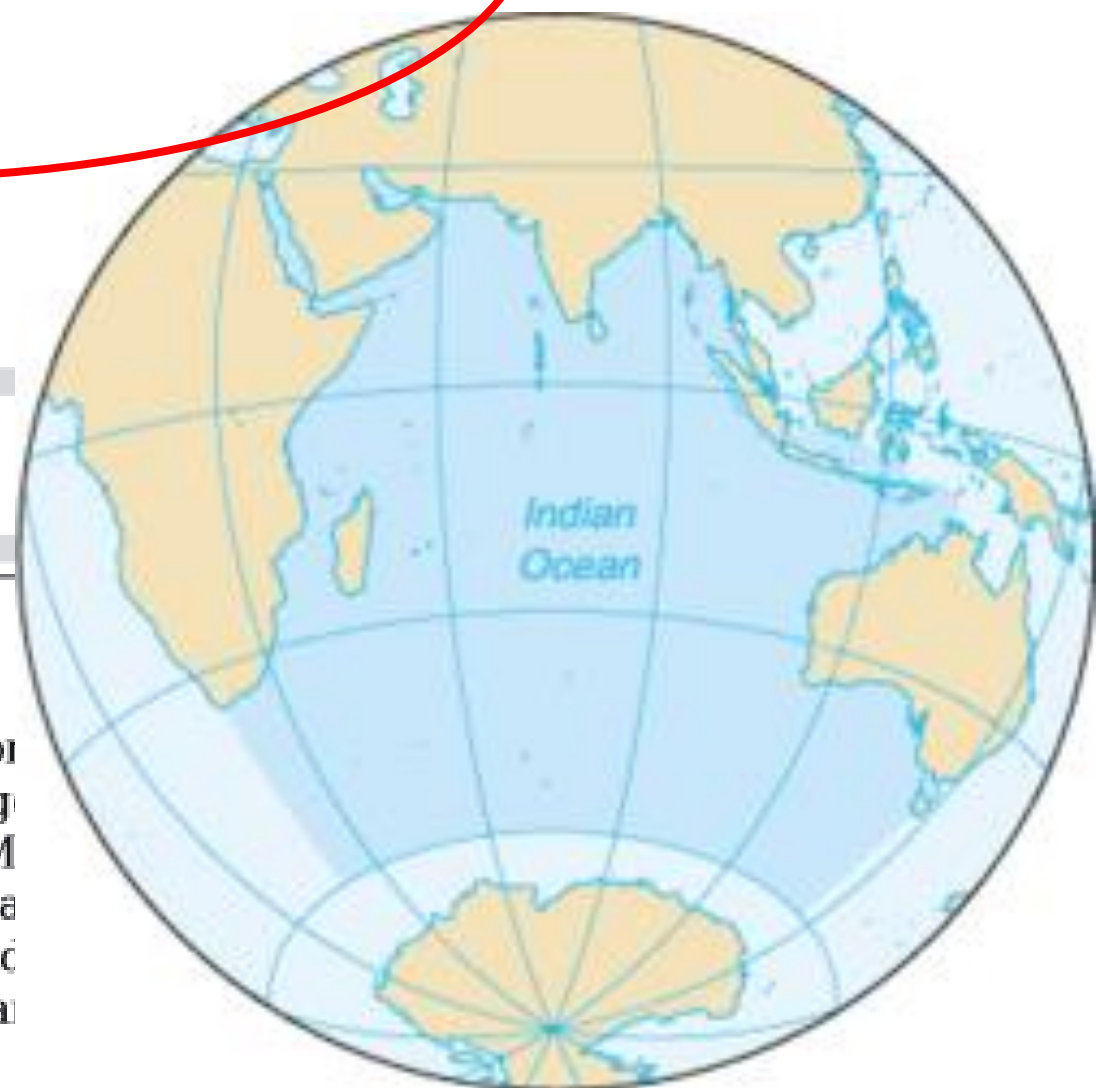


Fig. 5. Perceived priority and non-priority for search, conservation, and management of marine biodiversity. IND: Indian Ocean, S PAC: South Pacific, S ATL: South Atlantic, C AMER: Caribbean, GOM: Gulf of Mexico, N PAC: North Pacific, N ATL: North Atlantic, MED: Mediterranean, AUS: Australia. Respondents ranked priority and non-priority areas.

1 Population ecology

- 1.1 What is the survivorship of each stage/age-class and minimum threshold to maintain healthy populations?
- 1.2 What influences survivorship and abundances, both locally and globally?
- 1.3 What is the age and size at maturity?
- 1.4 What is the population size of juveniles?
- 1.5 What is the genetic and geographic origin of individuals in developmental habitats, and which RMUs do they belong to?

2 Habitat use and behavior

- 2.1 What is the distribution and movement of immature turtles?
- 2.2 What type of habitat is needed and which types are preferred?
- 2.3 What are the drivers of habitat selection or recruitment from pelagic post-hatchling foraging?
- 2.4 How do the distribution of habitat and food items correlate with juvenile densities and distributions?
- 2.5 How consistent is the distribution of juveniles, both spatially and temporally?

3 Threats

- 3.1 What are the key threats to juveniles in their developmental habitats, where are the threats hotspots and how can threats be mitigated?
- 3.2 What are the cumulative and synergetic impacts of threats?
- 3.3 What are the individual and population level impacts of various threats? What is the level of impact of fisheries on juveniles and developmental habitat?
- 3.4 How will climate change impact individuals and their habitats?
- 3.5 Which genetic stocks are being threatened during the immature stage?

4 Management

- 4.1 What are the best conservation measures to mitigate threats and monitor population responses, both globally and site specifically?
- 4.2 What is the minimum number of populations to monitor to effectively manage and conserve juveniles of each species?
- 4.3 What is the minimum number of key areas needed for effectively managing RMUs and promoting population growth?
- 4.4 Which management strategies can be implemented to protect vulnerable populations and developmental habitats temporarily?
- 4.5 Are there seasonal patterns in juvenile distribution and abundance which allow for targeted management approaches?

2. We need to be integrating multiple techniques





CMR, genetics, sexing, field ecology, novel methods



Tracking past, present & future; advanced modelling

ARRIBADA

 *initiative*



The Potential of Unmanned Aerial Systems for Sea Turtle Research and Conservation: a Review and Future Directions

Alan F. Rees, Larisa Avens, Katia Ballorain, Elizabeth Bevan, Annette C. Broderick, Raymond R. Carthy, Marjolijn J. A. Christianen, Gwénaél Duclos, Michael R. Helthaus, David W. Johnston, Jeffrey C. Mangel, Frank Paladino, Kellie Pendoley, Richard D. Reina, Nathan J. Robinson, Robert Ryan, Seth T. Sykora-Bodie, Dominic Tilley, Miguel R. Varela, Elizabeth R. Whitman, Paul A. Whittock, Thane Wibbels, Brendan J. Godley

Correspondence: a.f.rees@exeter.ac.uk

1

Using unmanned aerial vehicles (UAVs) in sea turtle research and conservation programmes has great potential



2

UAVs as research tools can save time and money and reduce risk to researchers in less accessible habitats



A nesting green turtle returns to the sea. As seen from above using a UAV-based thermal camera.

3

We present the diverse ways in which UAVs can be used, the practicalities of their use and when and where other methods remain more appropriate

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OCEANOGRAPHIC TURTLES

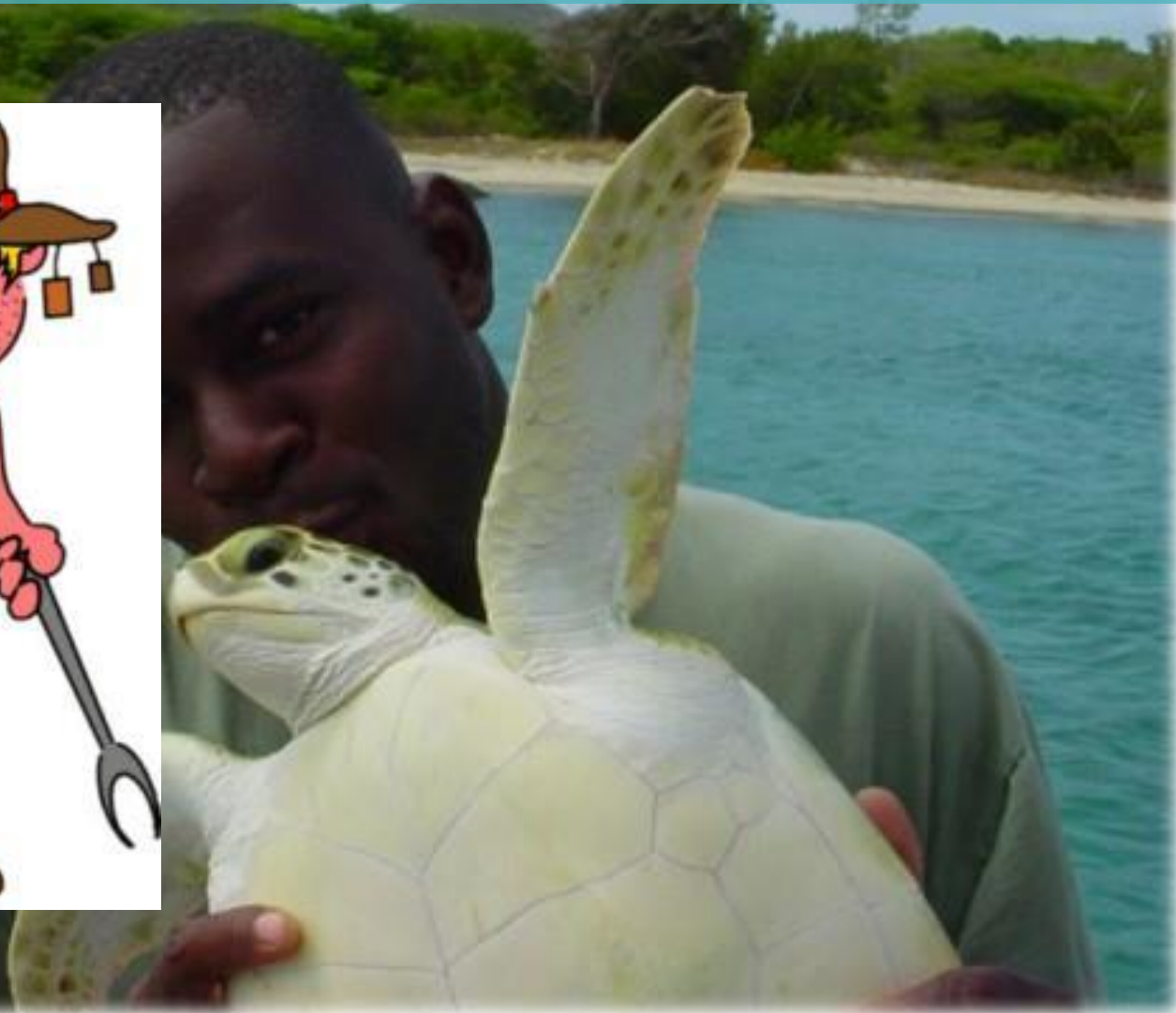
Ocean monitoring platforms for conservation and
dynamic ocean management

3. Need for widescale longterm studies



3. Need for widescale longterm studies

Be more like the Australians



3. Need for widescale longterm studies

Be more like the Australians



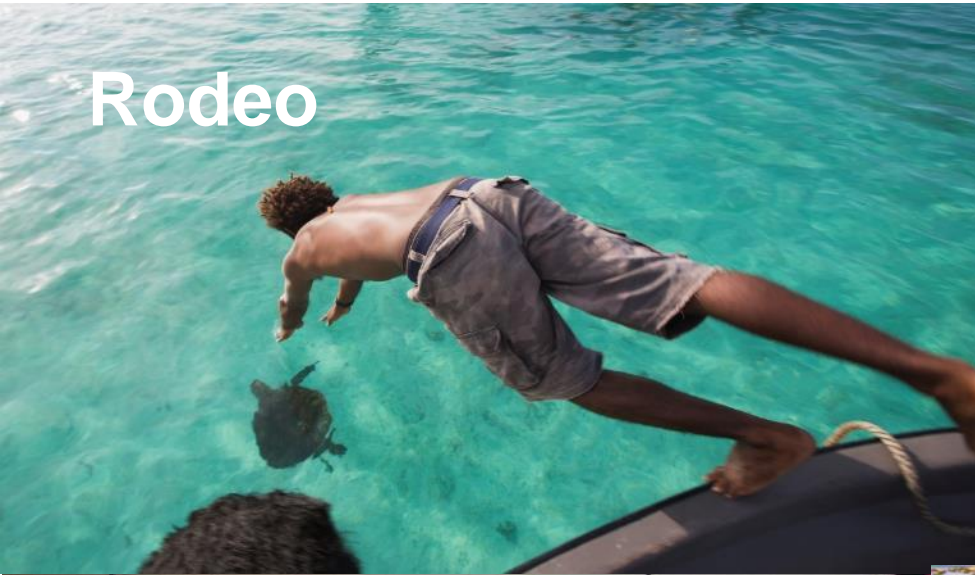
Environmental Warming and Feminization of One of the Largest Sea Turtle Populations in the World

Current Biology
Report



Michael P. Jensen,^{1,6,7,*} Camryn D. Allen,^{1,2,6} Tomoharu Eguchi,¹ Ian P. Bell,³ Erin L. LaCasella,¹ William A. Hilton,⁴ Christine A.M. Hof,⁵ and Peter H. Dutton¹

Rodeo



Genetics



Endoscopy



Beach Temperature

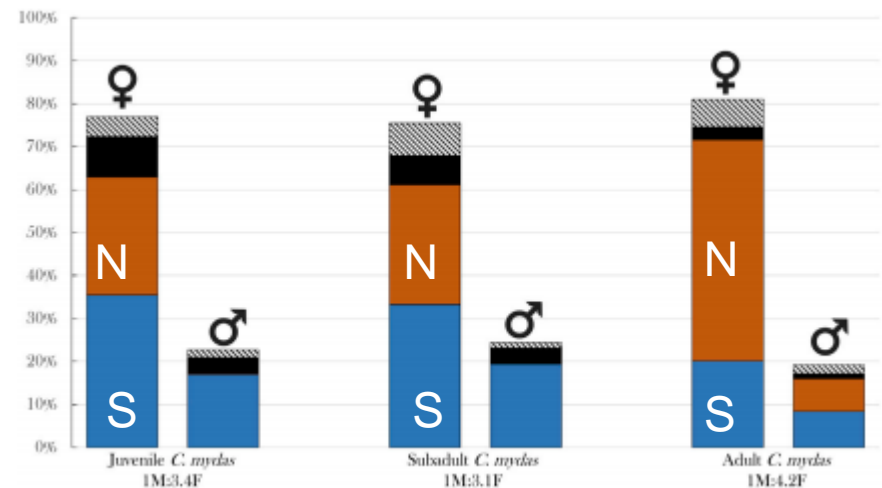
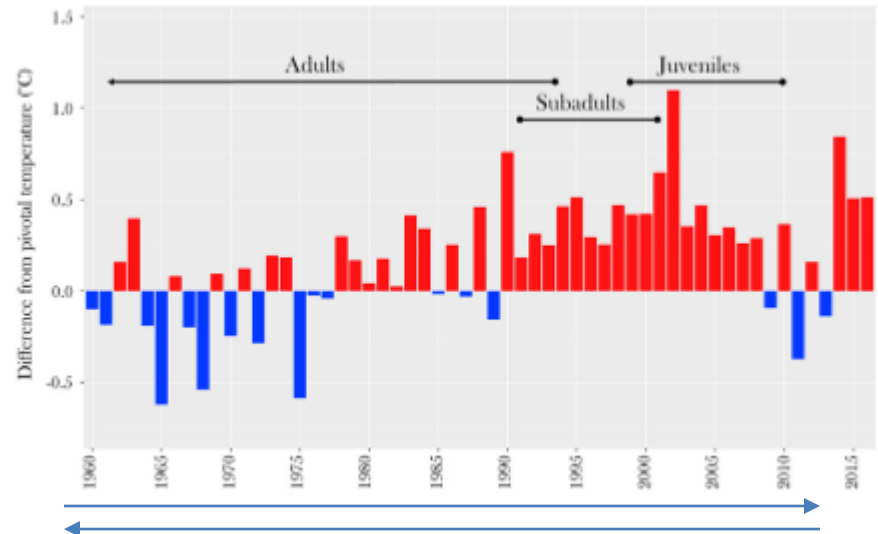
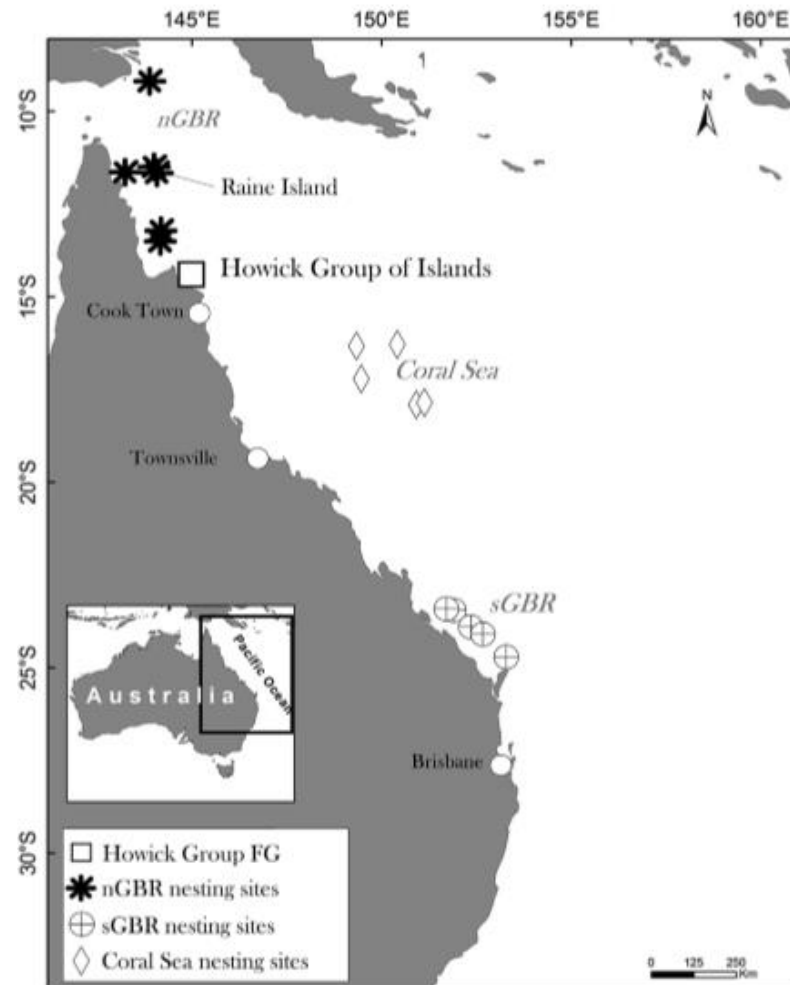


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4. Working with (artisanal) fishers





Fisheries: In many cases the single greatest concern for sea turtle conservation





Fisheries: Food and employment for millions; some the poorest people on earth



Working with fishers **has** to be key to
successful marine turtle conservation

Fishers own and can handle boats



If you work with the right guys, you can catch a lot of turtles...fast!





British Virgin Islands





In a 2.5 years:

- Large marked populations of two species
- Morphometrics/growth/genetics/sexing (hormones)
- Tracking and diving studies

Bonuses:

- Field missions without “the scientists”
- Deeper understanding of culture/economics
- Community engagement
- Many, many smiles!!



Down but not out: marine turtles of the British Virgin Islands

A. McGowan¹, A. C. Broderick¹, G. Frett², S. Gore², M. Hastings², A. Pickering², D. Wheatley³, J. White³, M. J. Witt¹ & B. J. Godley¹

¹ Marine Turtle Research Group, Centre for Ecology and Conservation, School of Biological Sciences, University of Exeter, Cornwall Campus, Penryn, UK

² BVI Conservation and Fisheries Department, Tortola, British Virgin Islands

³ The Settlement, Anegada, British Virgin Islands

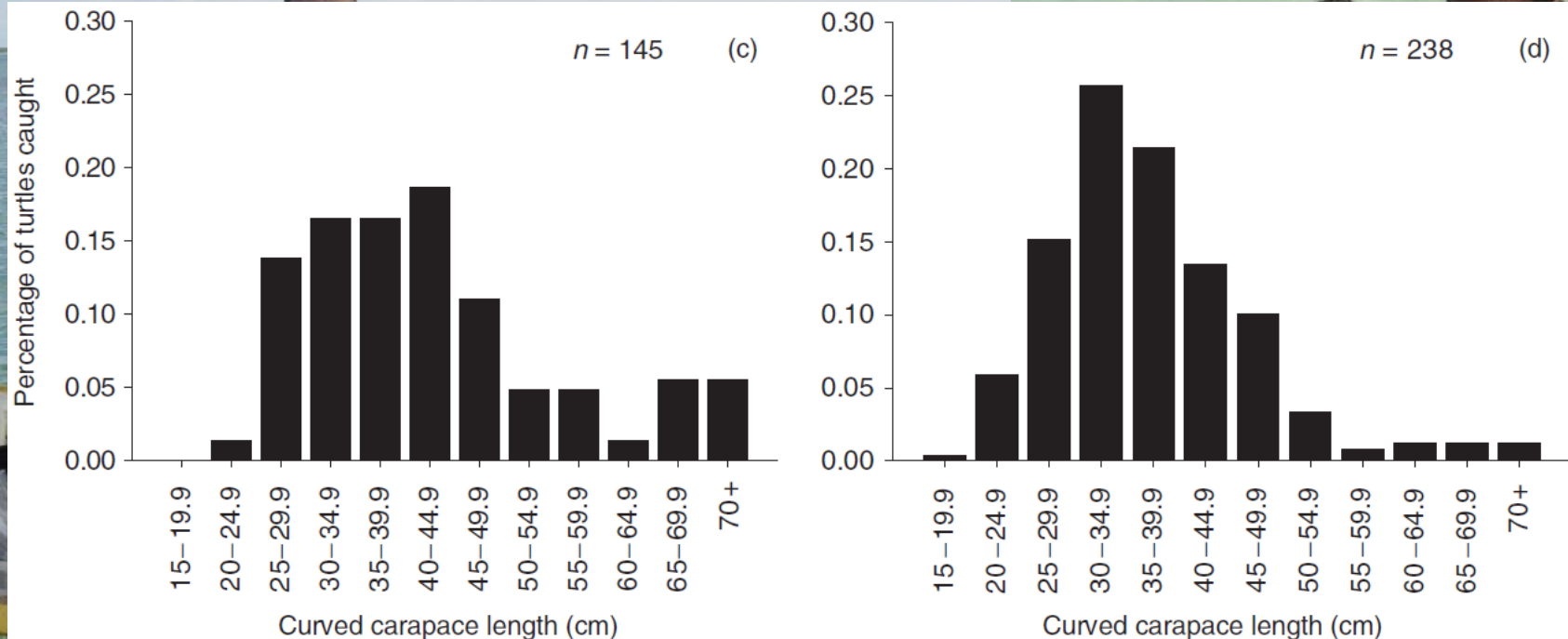


Figure 6 Size class distribution of captured (a) green turtles *Chelonia mydas* from Tortolan-based efforts; (b) hawksbill turtles *Eretmochelys imbricata* from Tortolan-based efforts; (c) green turtles from Anegada and (d) hawksbill turtles from Anegada.

Turks and Caicos Islands



Second largest turtle fishery in the Caribbean



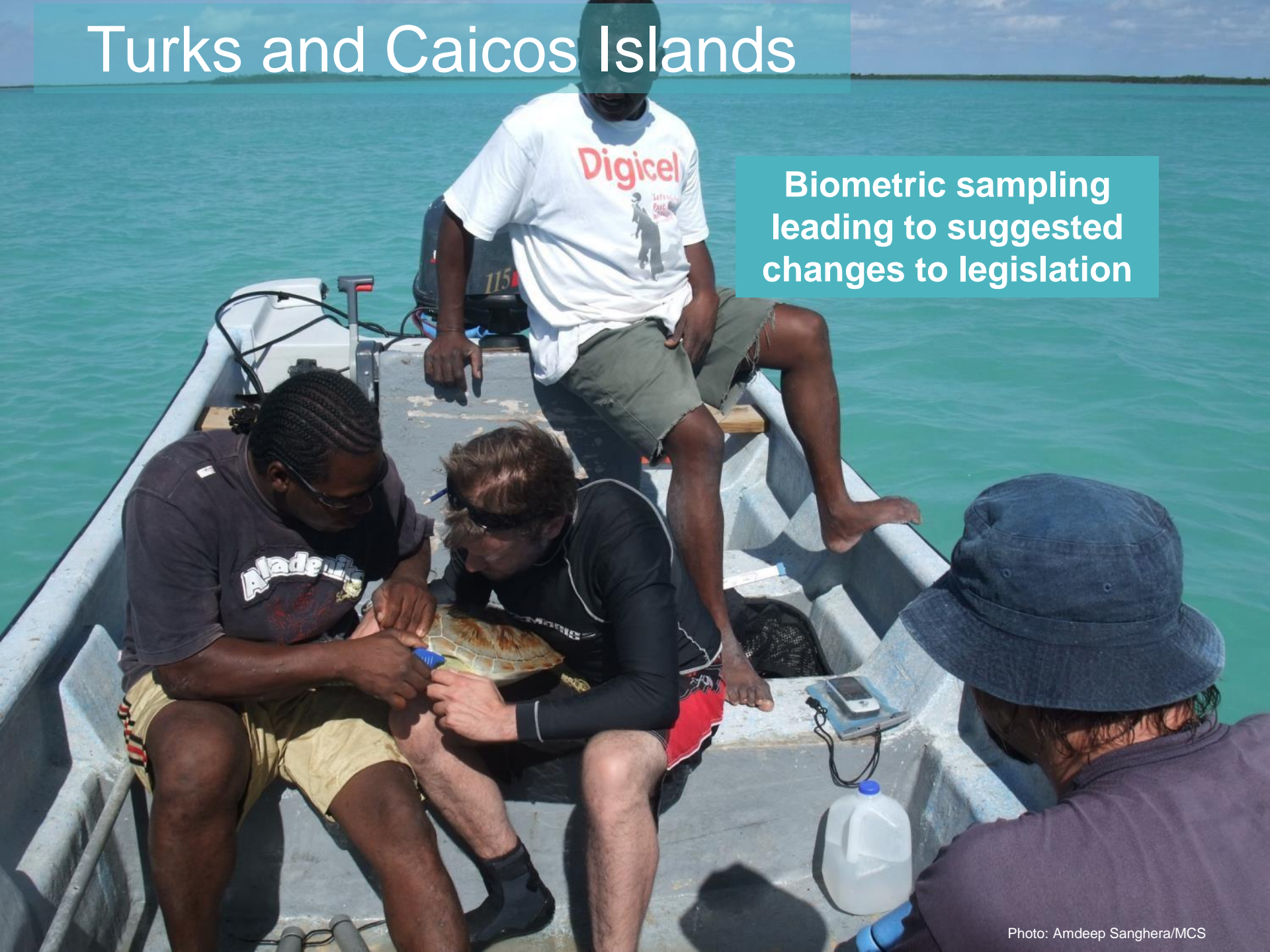
Turks and Caicos Islands

... sampling turtle stocks at fishing sites in partnership with local fishermen.



Turks and Caicos Islands

**Biometric sampling
leading to suggested
changes to legislation**



Turks and Caicos Islands



Contents lists available at SciVerse ScienceDirect

Ocean & Coastal Management

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

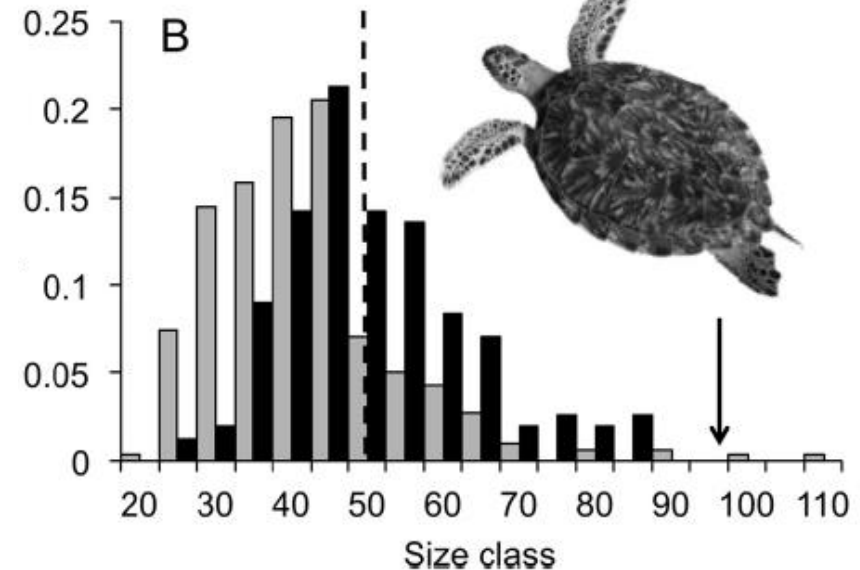
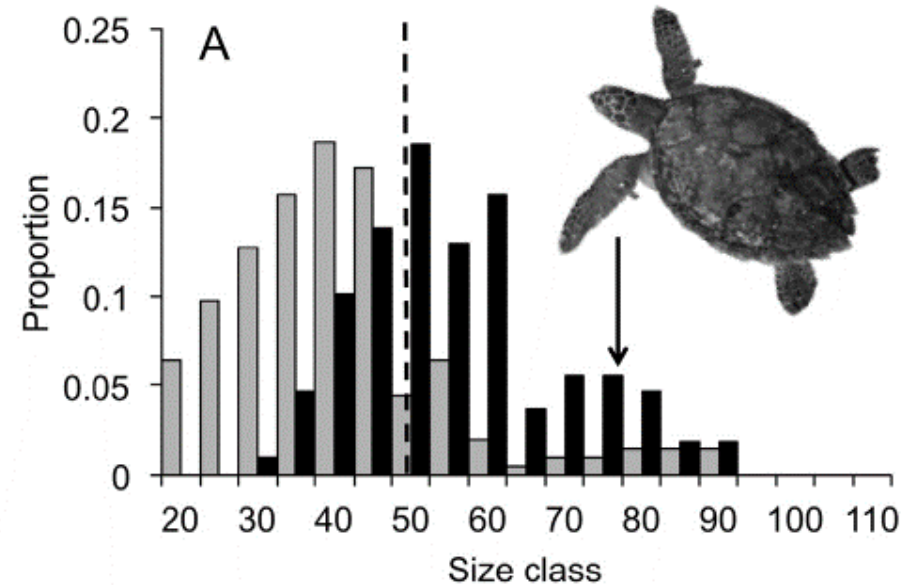


d
on

Marine turtle harvest in a mixed small-scale fishery: Evidence for revised management measures



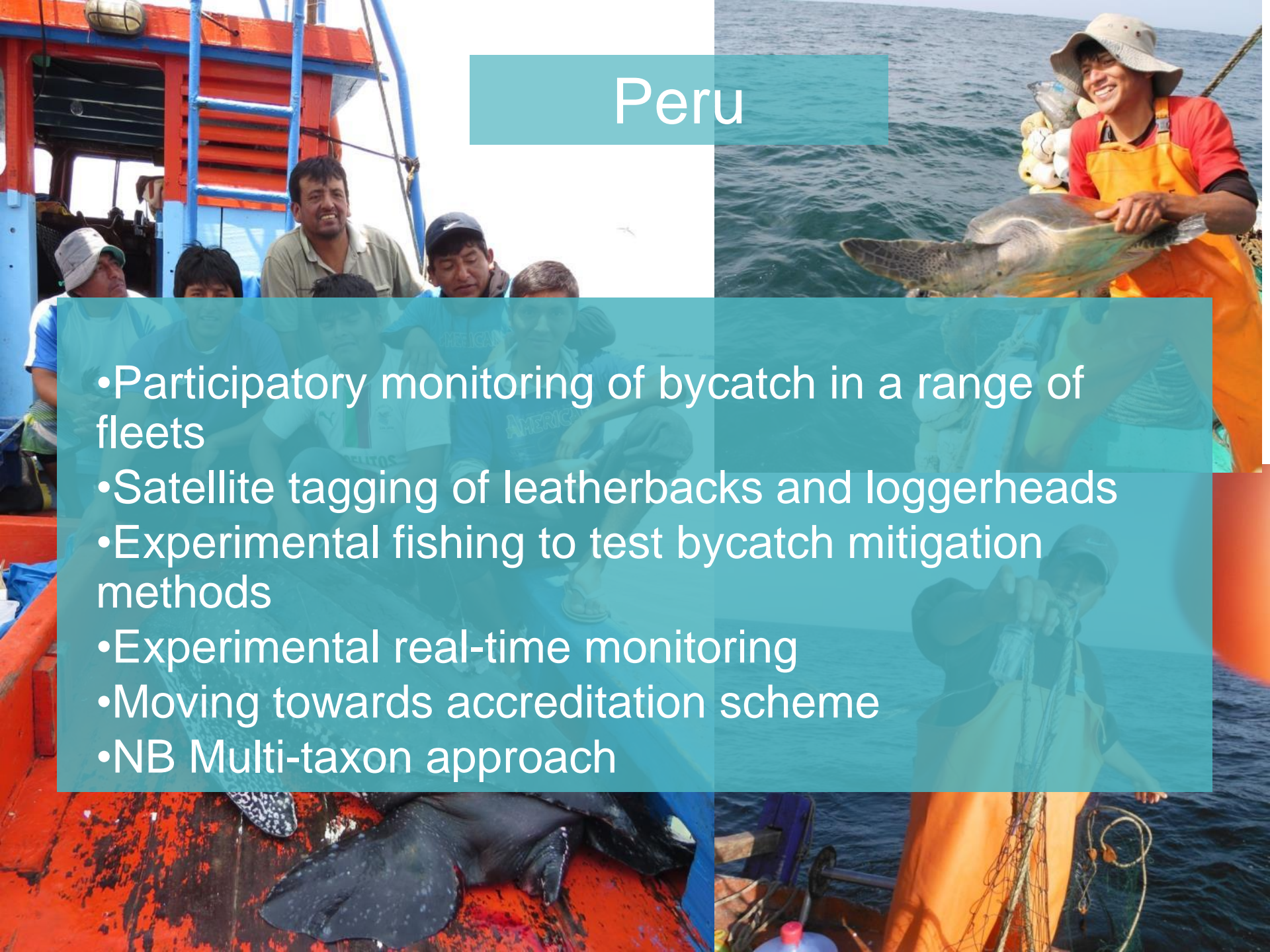
Thomas B. Stringell^a, Marta C. Calosso^b, John A.B. Claydon^b, Wesley Clerveaux^c,
Brendan J. Godley^a, Kathy J. Lockhart^c, Quinton Phillips^c, Susan Ranger^{a,d},
Peter B. Richardson^{a,d}, Amdeep Sanghera^d, Annette C. Broderick^{a,*}





Peru

- Participatory monitoring of bycatch in a range of fleets
- Satellite tagging of leatherbacks and loggerheads
- Experimental fishing to test bycatch mitigation methods
- Experimental real-time monitoring
- Moving towards accreditation scheme
- NB Multi-taxon approach



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

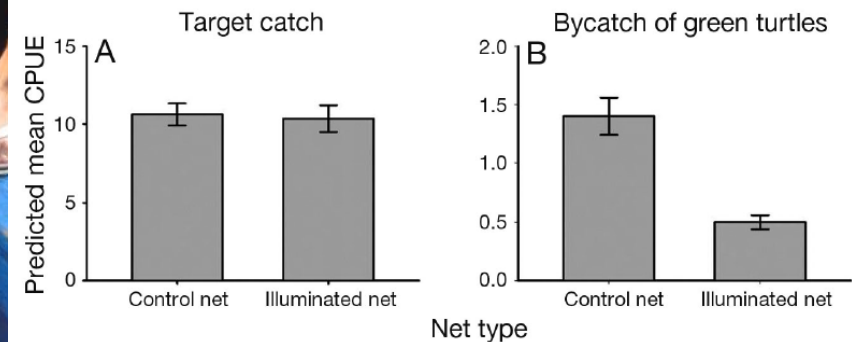
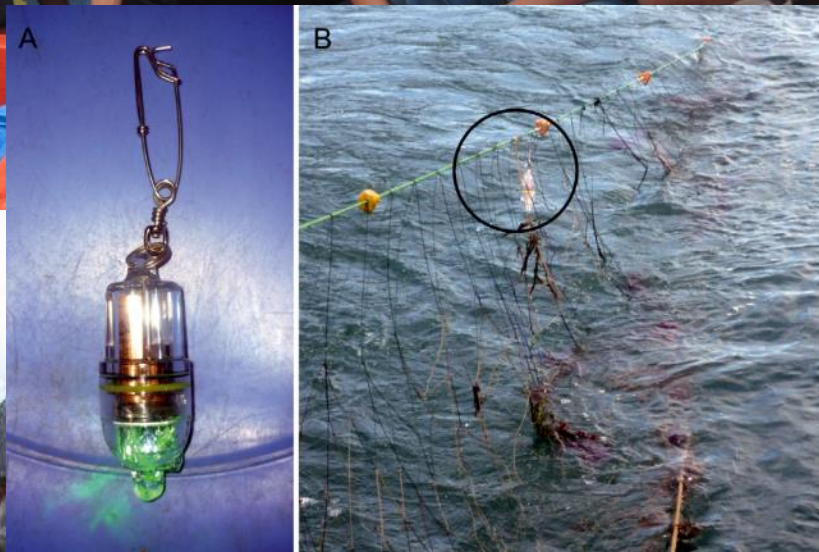


Fig. 3. (A) Comparison of the predicted mean CPUE (no. [km × 24 h]⁻¹) of target species between control (without LED illumination) and illuminated (with LED illumination) nets showing no significant difference. (B) Comparison of the predicted mean CPUE of green turtles between control and illuminated nets showing a significant 63.9% decrease in illuminated nets. Data are mean ± SE

Working with fishers has to be key to successful marine turtle conservation

ADVANTAGES:

- Skills
- Traditional knowledge
- Multi-dimensional insight (Social, cultural and economic)
- Project credibility
- Community ownership
- Likely long-term impact
- Very enjoyable!!!
- Not just for sea turtles



Working with fishers has to be key to successful marine turtle conservation

ADVANTAGES:

- Skills
- Traditional knowledge
- Multi-dimensional insight (Social, cultural and economic)
- Project credibility
- Community ownership
- Likely long-term impact
- Very enjoyable!!!
- Not just for sea turtles

CHALLENGES:

- Gaining trust
- Cultural differences
- Continuity/funding

This list is much shorter
so we should clearly be
doing much more of this!

(d) **5. There will be emerging themes**



26 years ago





Getting worse, people care, we can fix.
Flagship issue for marine conservation?

Plastic Pollution



Necropsy



**Content
Sorting**



Classification



Classification



Type

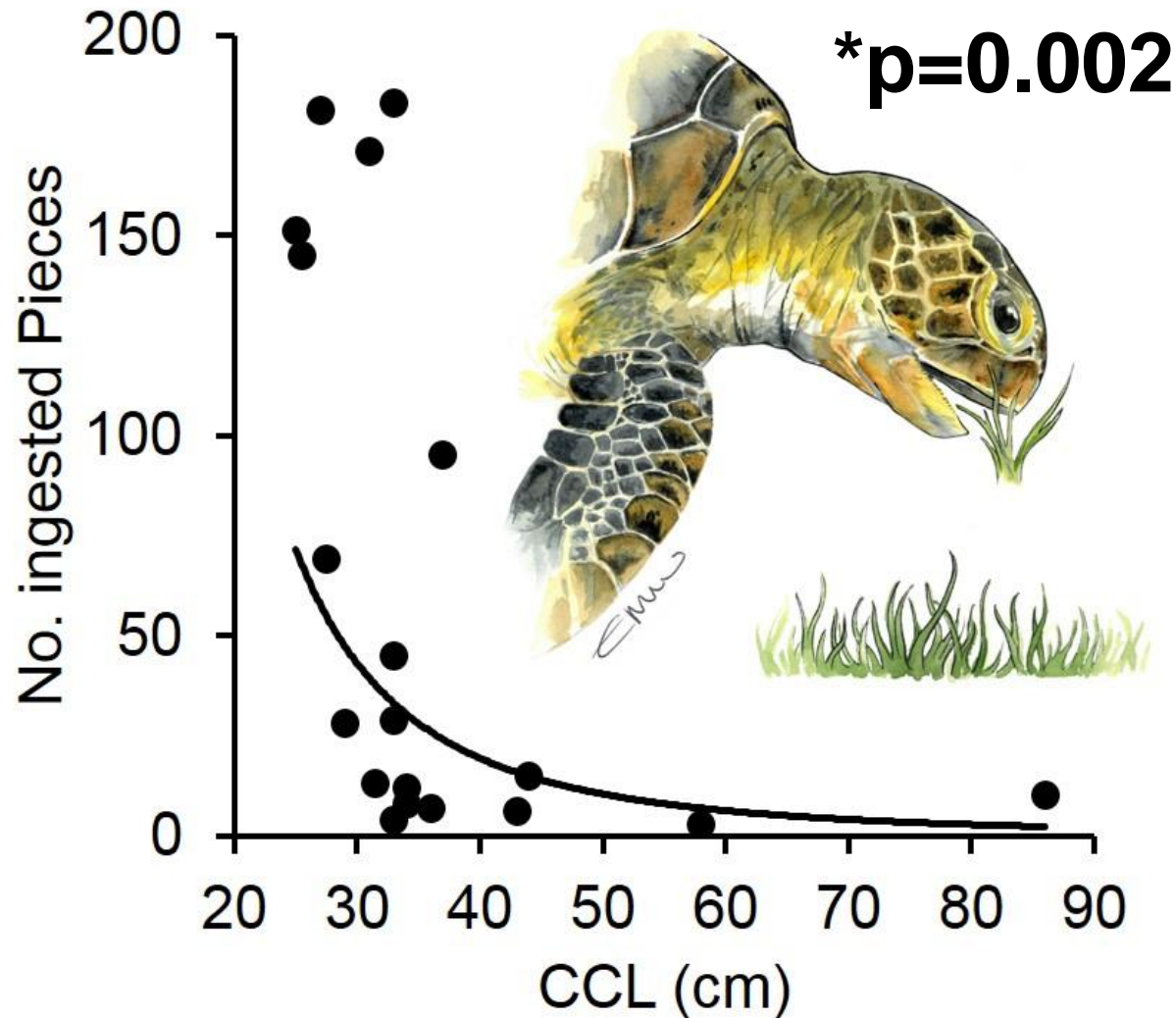
Shape



Dimension

Colour

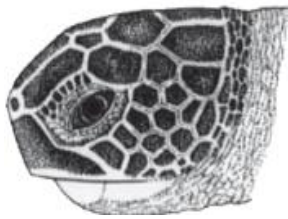
Size & Ingestion



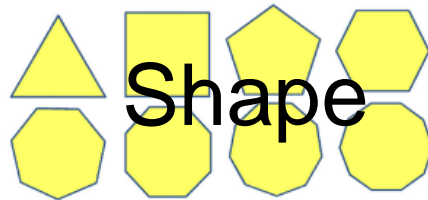
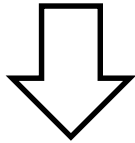
Diet-related Selectivity



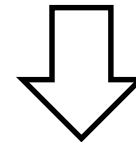
Ingested Plastic



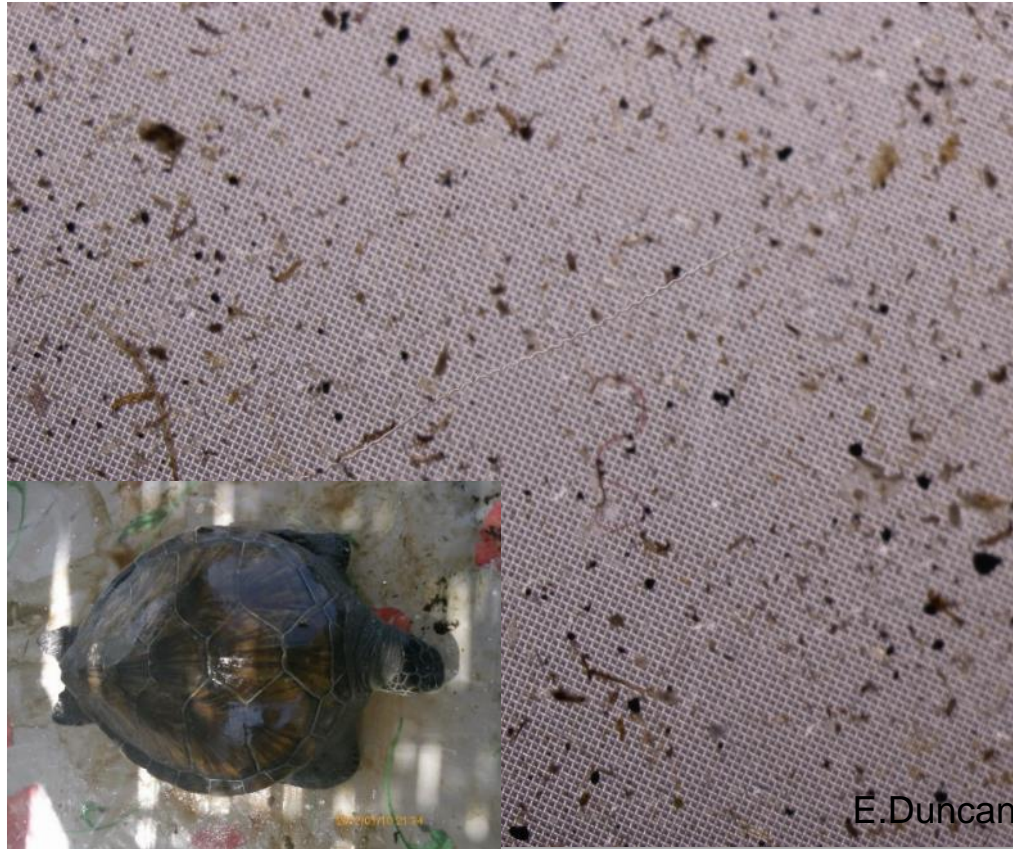
Dietary Relation



Seagrass



Microplastic Isolation

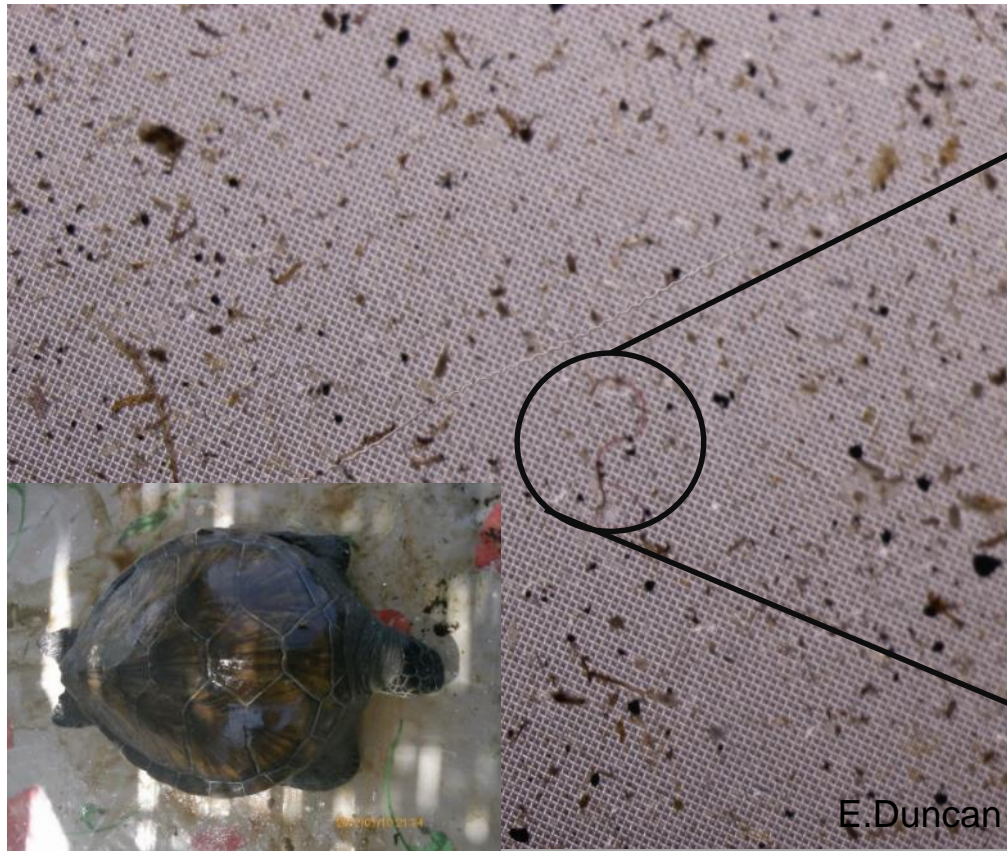


Enzymatic digestion
(Cole et al. 2014)

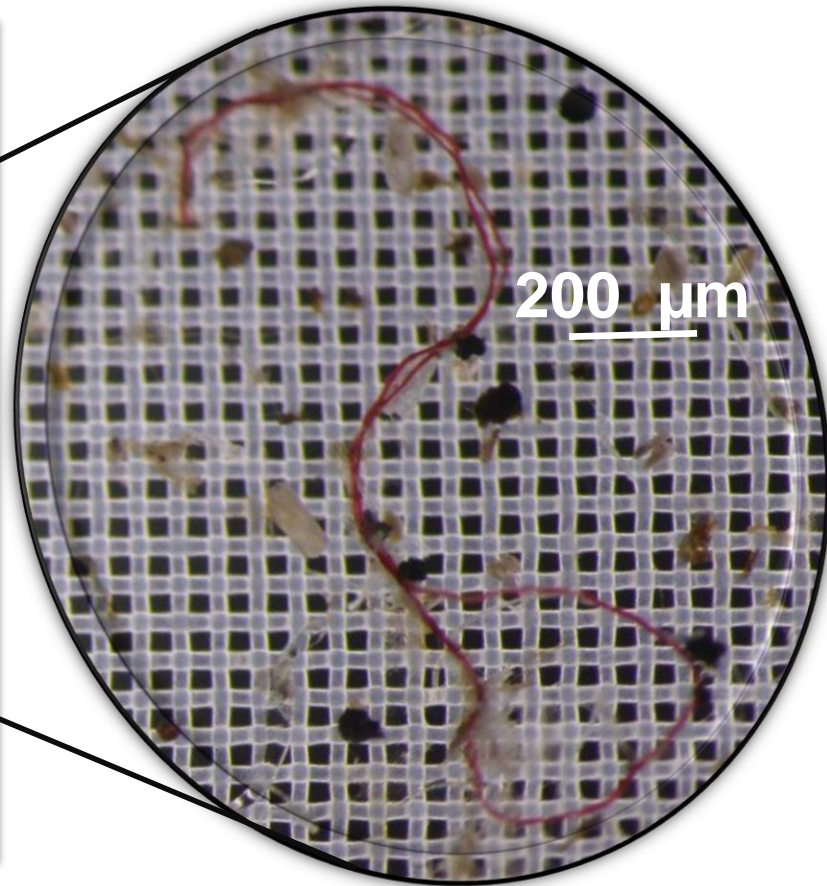
Removal of
biological material
from sample

Fourier transform
infrared
spectroscopy (FT-IR)

Enzymatic Digestion



E. Duncan



Classification



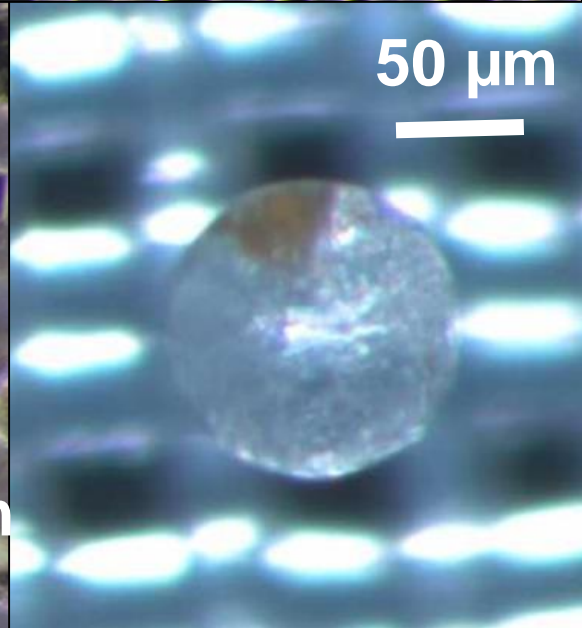
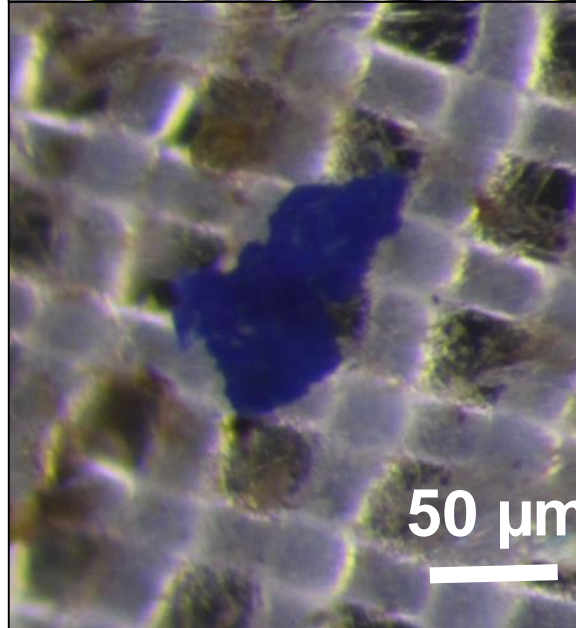
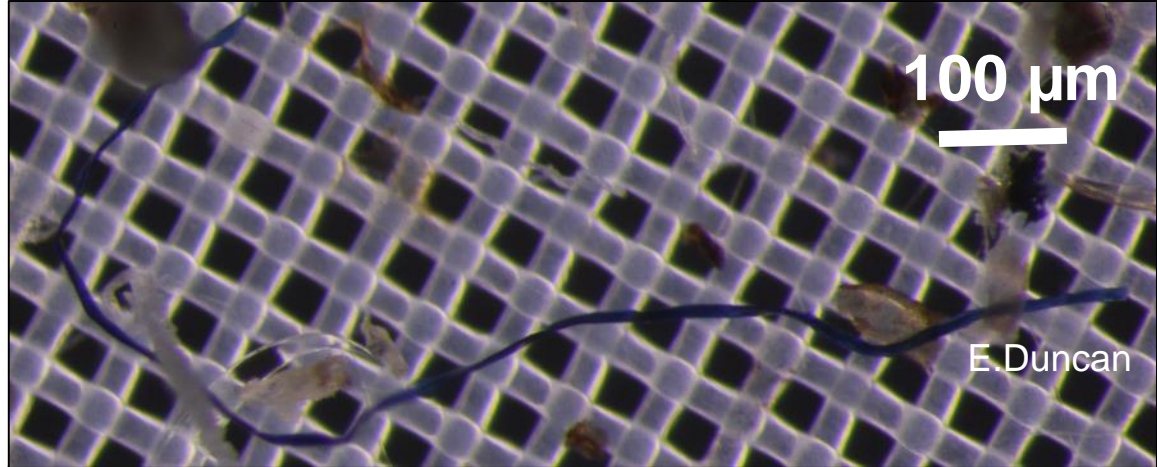
Type:

- Fibres
- Fragments
- Beads

All turtles!

All species!

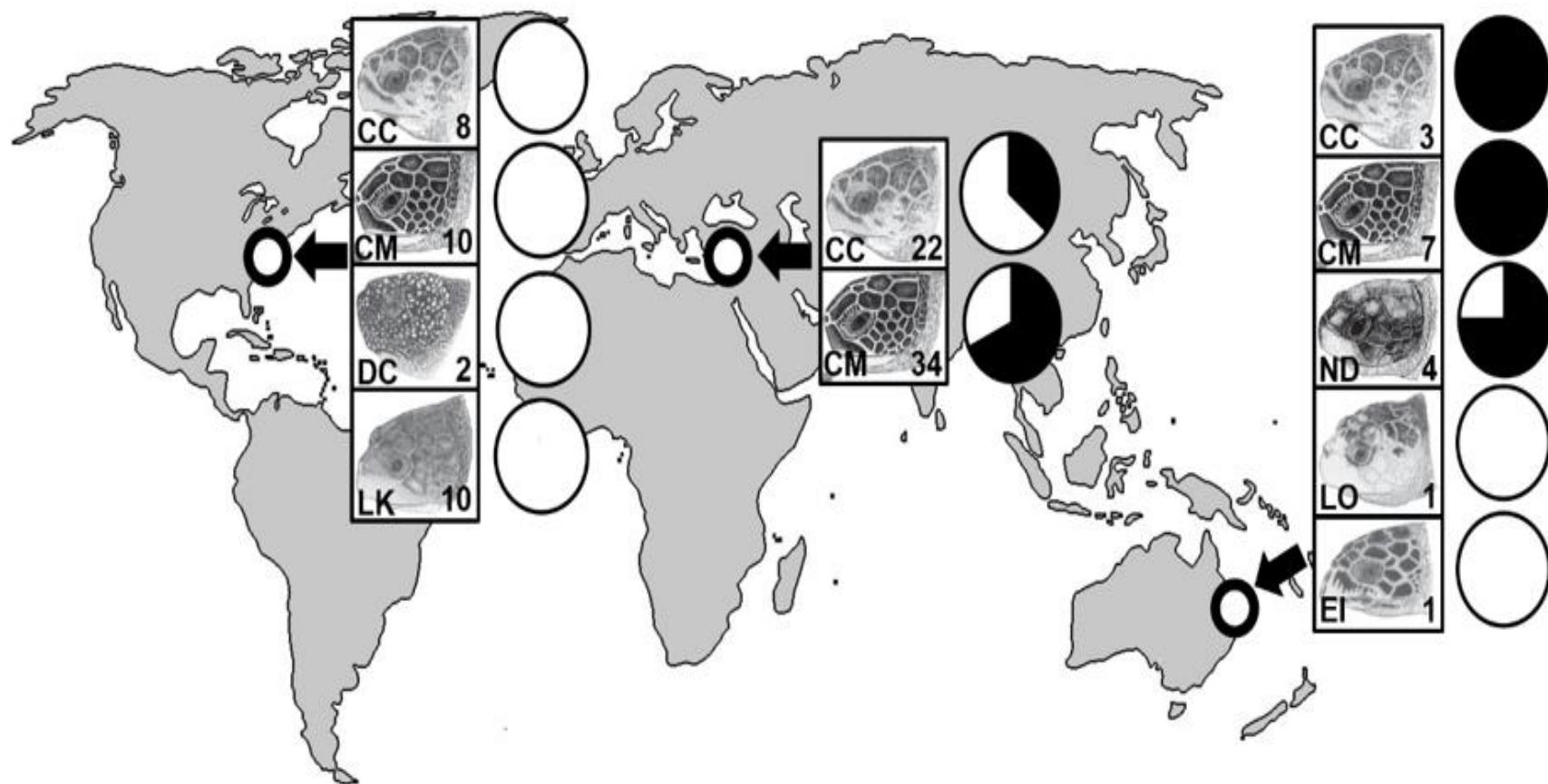
Three oceans!

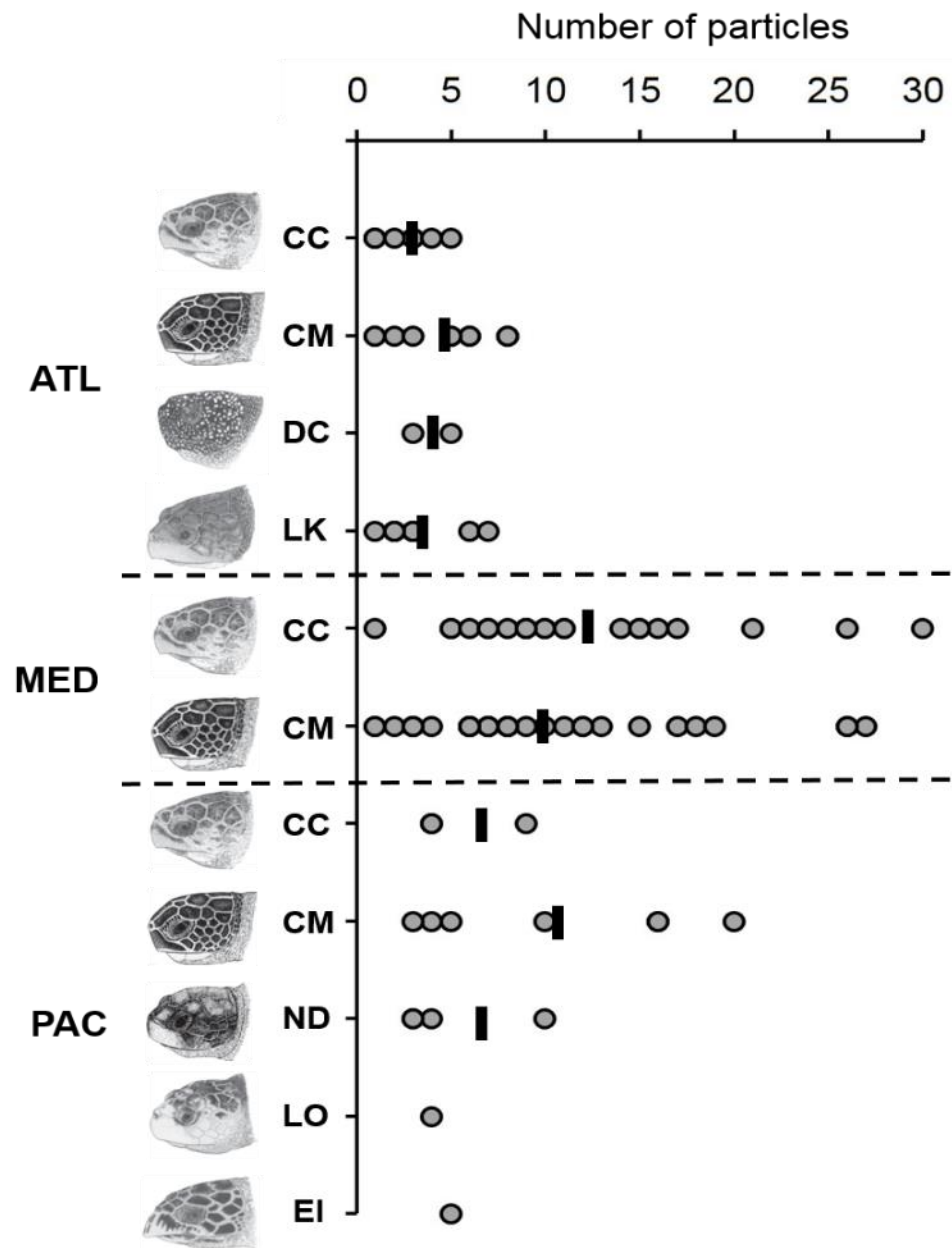


ATL

MED

PAC





1 **Title:** Microplastic ingestion ubiquitous in marine turtles

2 **IN PRESS:** *Global Change Biology*

3 Emily M. Duncan ^{1, 2, 3}, Annette C. Broderick¹, Wayne J. Fuller^{1,4,5}, Tamara S. Galloway²,

4 Matthew H. Godfrey⁶, Mark Hamann⁷, Colin J. Limpus⁸, Penelope K. Lindeque³, Andrew G.

5 Mayes⁹, Lucy C. M. Omeyer¹, David Santillo¹⁰, Robin T. E. Snape^{1,5}, Brendan J. Godley¹





● N 87881



A juvenile sea turtle is swimming in clear, deep blue water. The turtle is positioned in the center-right of the frame, facing towards the right. Its head is slightly above the water surface, and its front flipper is extended forward. The turtle's shell is dark with a pattern of lighter, brownish-yellow scutes. The water is a vibrant blue with some ripples on the surface. The overall scene is peaceful and captures a moment of the turtle's natural habitat.

1. More of us need to work on juveniles

Photo: Nick Pilcher



1. More of us need to work on juveniles
2. It will need to be with multiple techniques
(some of them we don't have yet!)



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5. We need to be open to emerging themes

Photo: Nick Pilcher

Sarah Nelms

Kate Nelms

Le conte de
la Tortue et la
Méduse en Plastique



www.issuu.com - Search "tortue"

Thank you for listening!



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Photo: Peter Richardson