SEA TURTLES AS INDICATORS OF PLASTIC MARINE DEBRIS QUANTITIES AND TYPES IN THE CENTRAL PACIFIC

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Golden Honu Services of Oceania

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NOAA Pacific Islands Fisheries Science Center

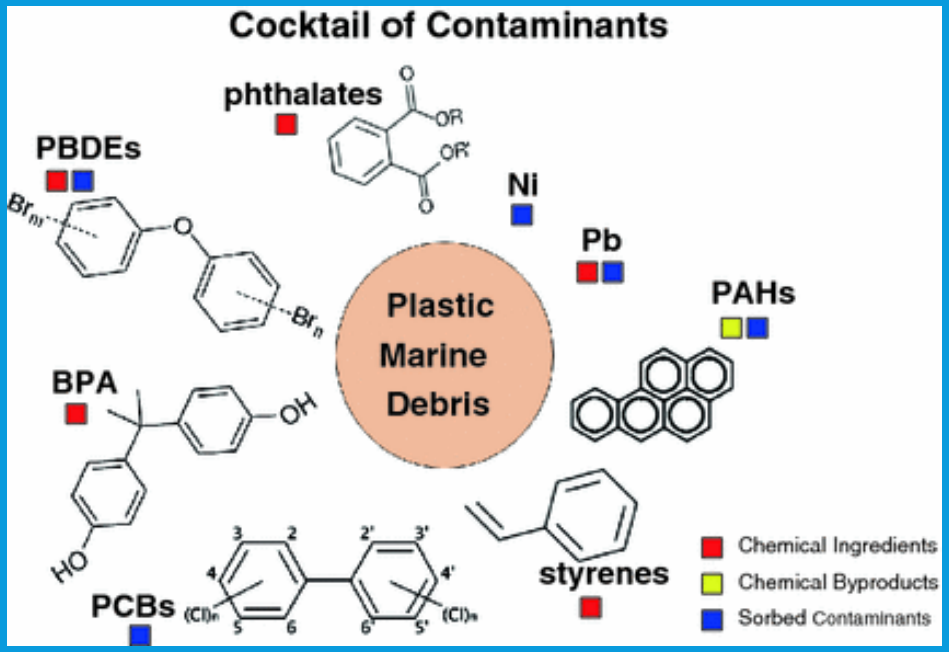
THE PROBLEM WITH PLASTIC

- Entanglement
- Habitat damage
- Ingestion

POTENTIAL EFFECTS OF INGESTION

Sublethal:

-Exposure to harmful chemicals (Rochman et al., 2013)
-Dilution of nutrients (McCauley & Bjorndal, 1999)



Lethal:

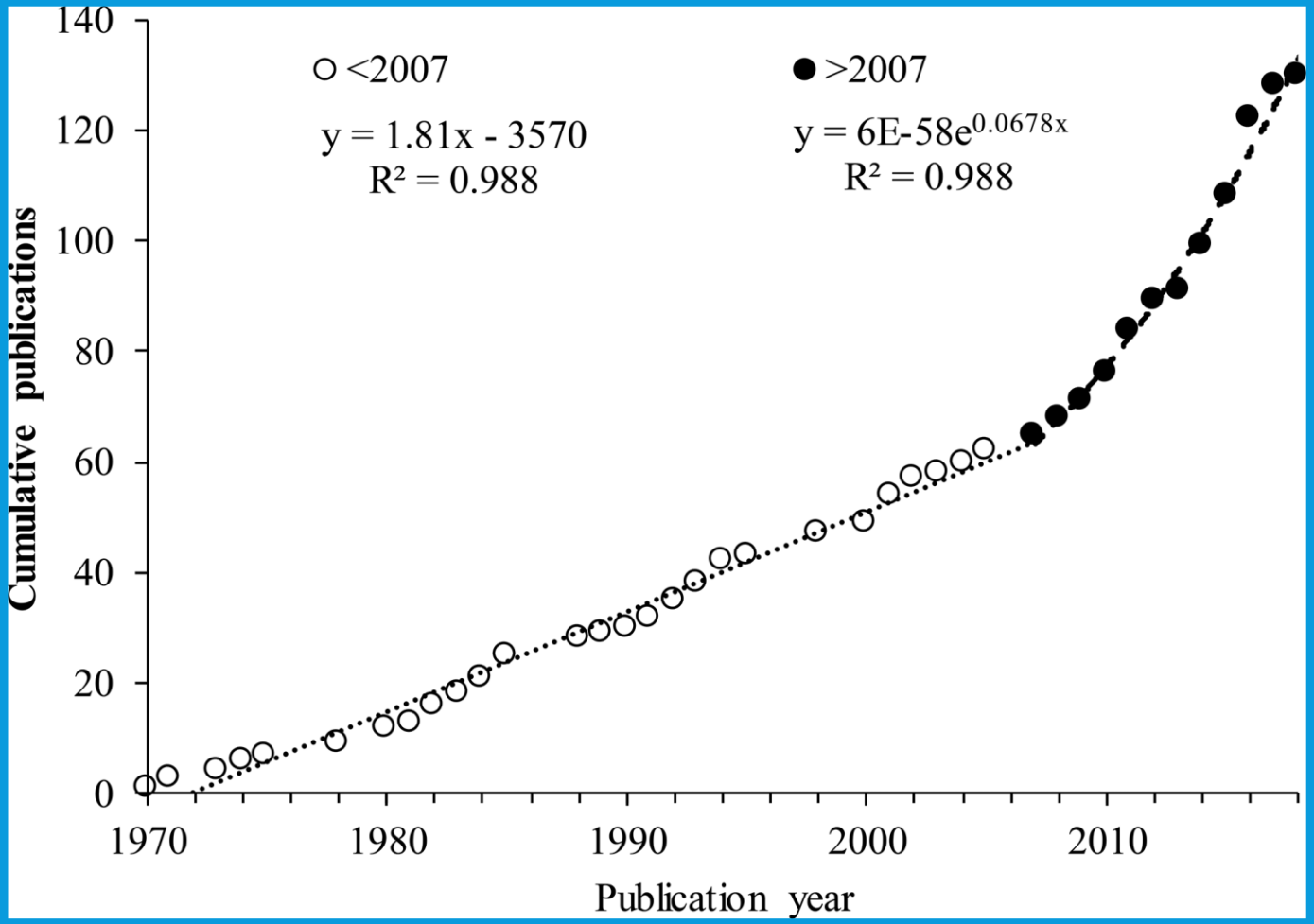
-Obstruction (Balazs, 1985)
-Perforation (Mascarenhas et al., 2004)
-Plications

Rochman, 2015

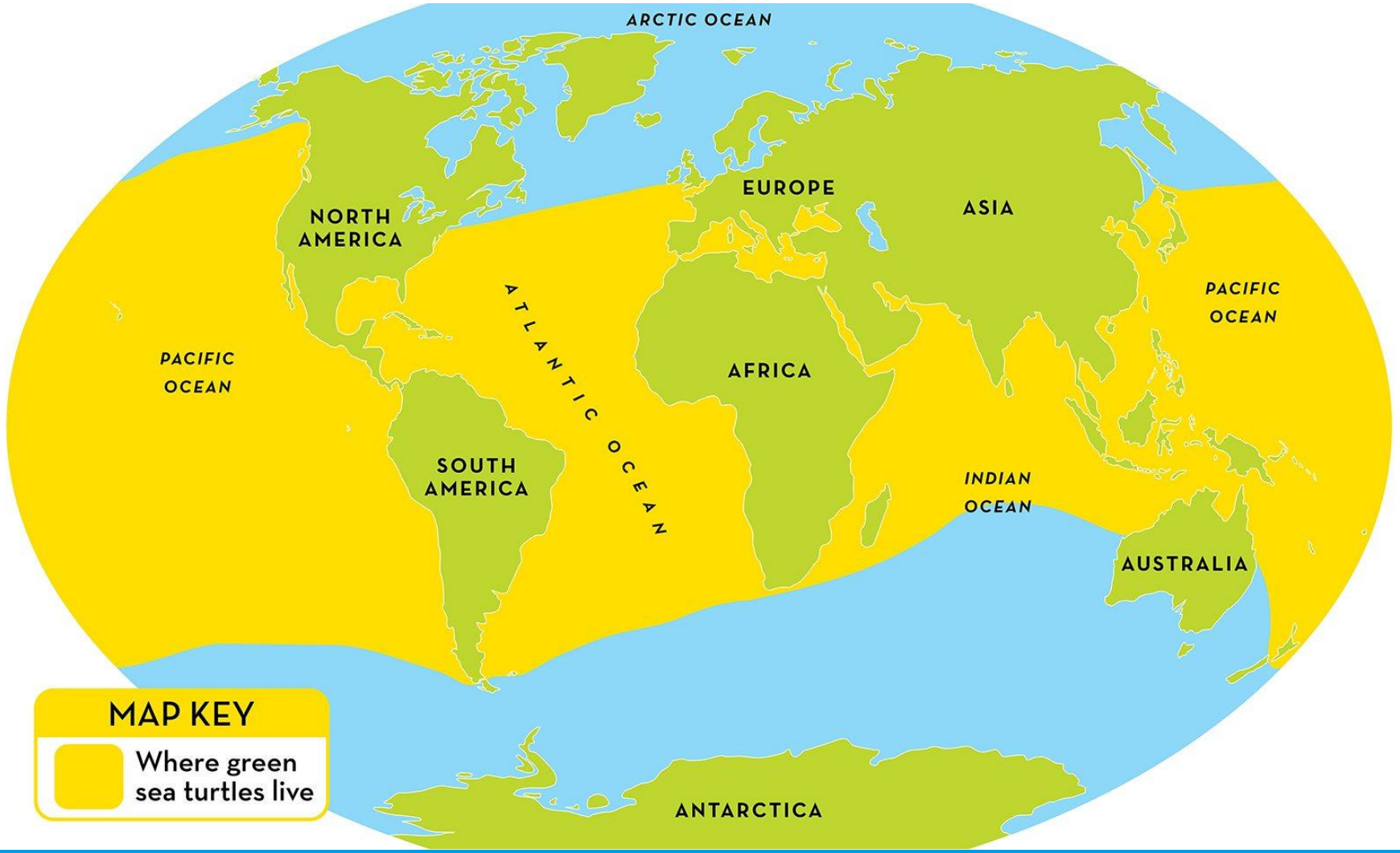
PLASTIC INGESTION BY SEA TURTLES

First report in the late 1950's

Archie Carr (reported in Balazs 1985)



SEA TURTLES MAKE GOOD INDICATORS



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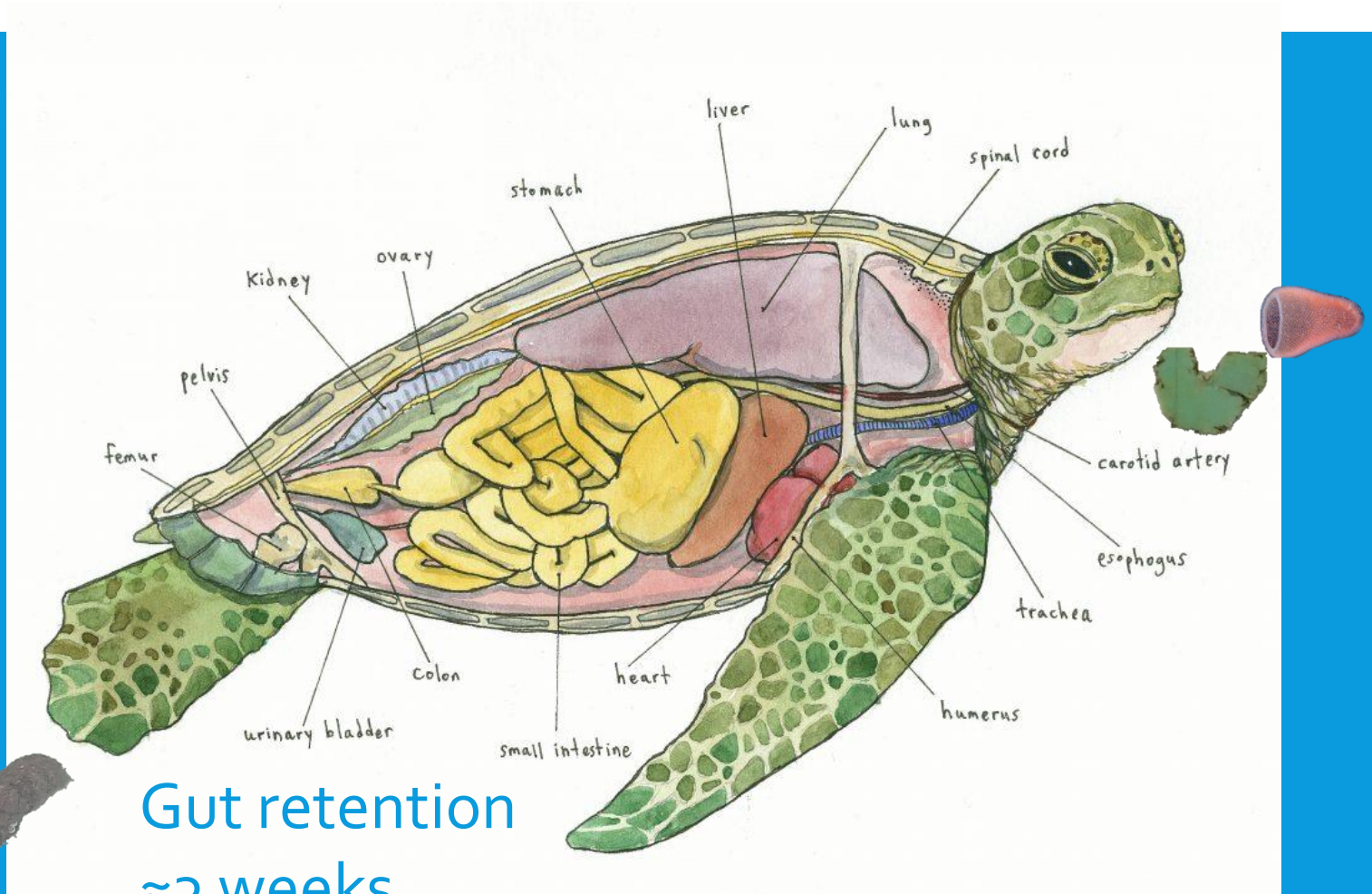


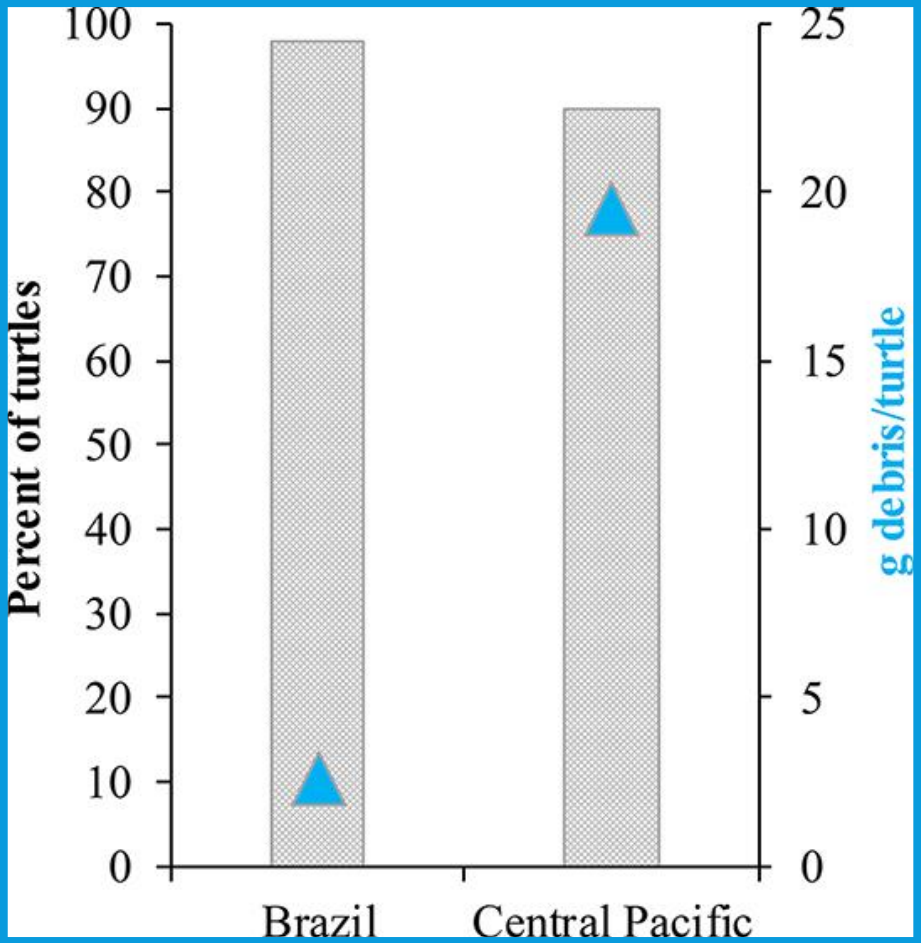
Gut retention
≈3 weeks

SEA TURTLES INGEST A LOT OF PLASTIC

Clukey et al. 2017 Mar Pollut Bull

BEST REPORTING UNITS

- Quantities are better than percent occurrence
- Include non-detects
- Report particle counts, size, and mass of polymers
- g/kg is best unit for biota



Lynch 2018 ES&T

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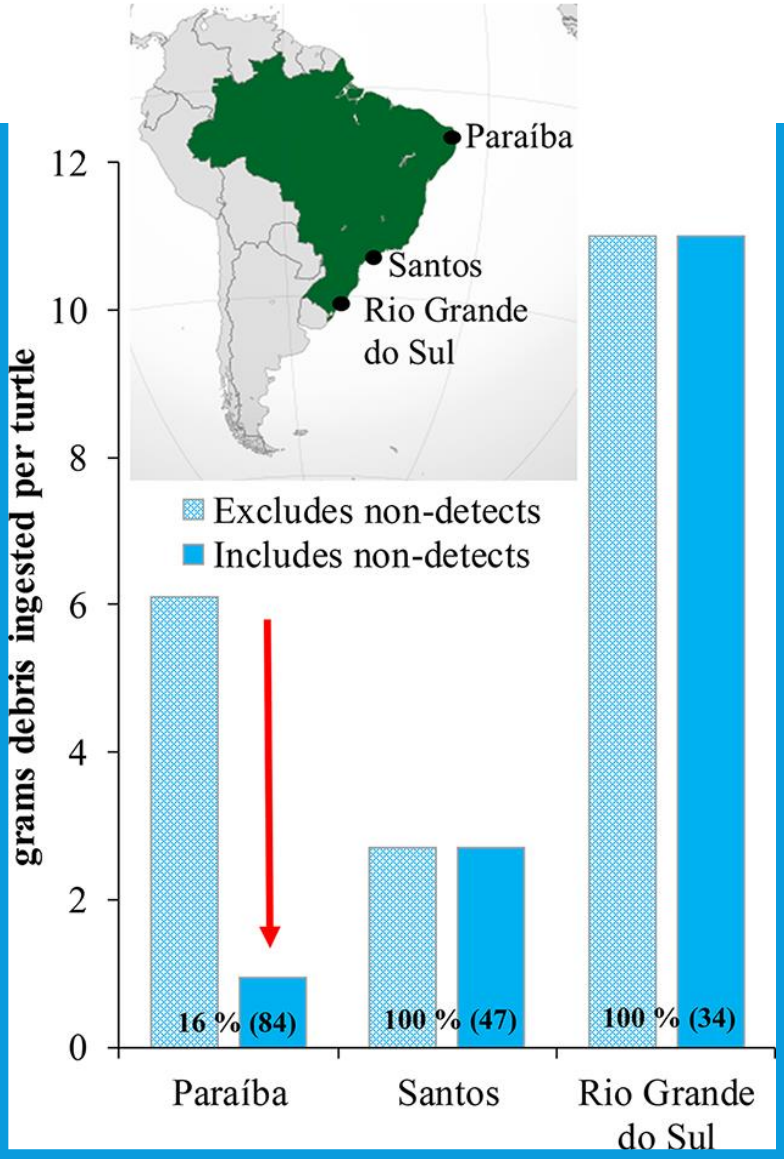

Lynch 2018 ES&T

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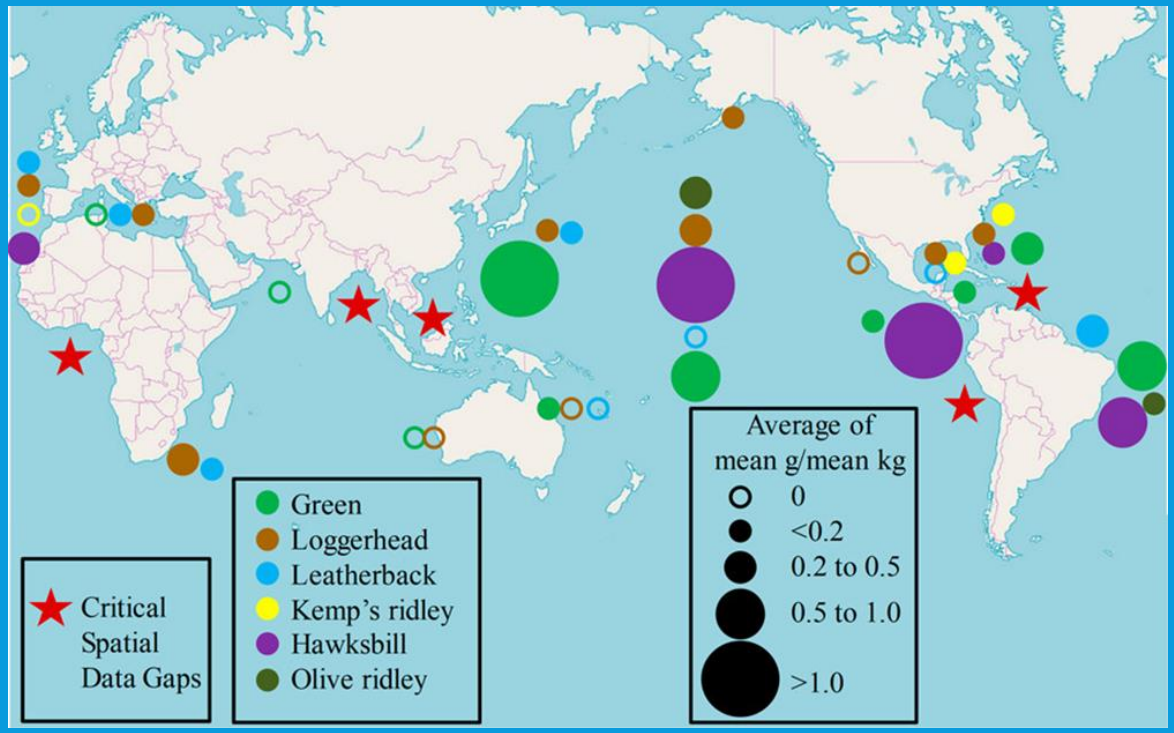
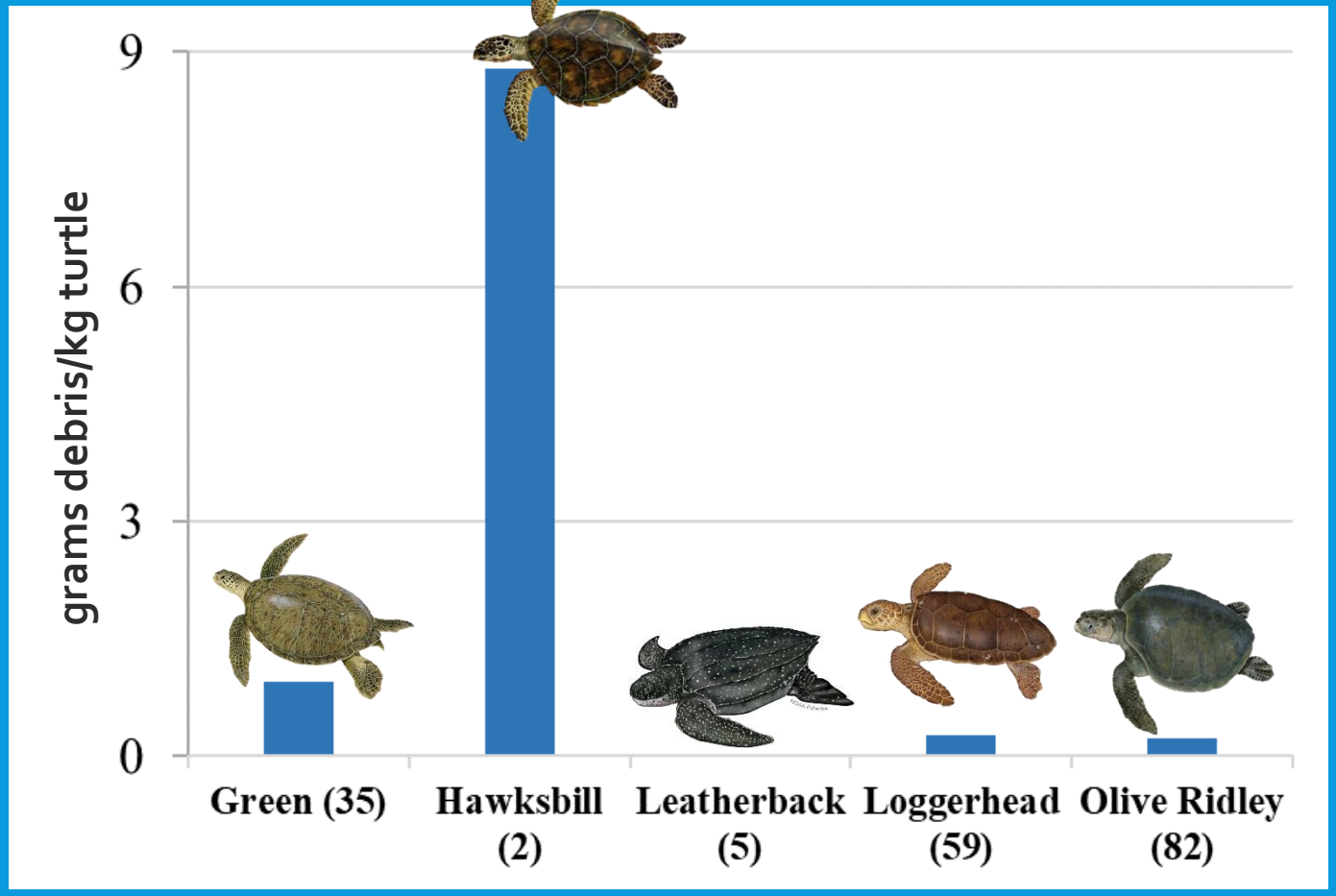


Lynch 2018 ES&T

HAWKSBILLS IN CENTRAL PACIFIC



Lynch 2018 ES&T

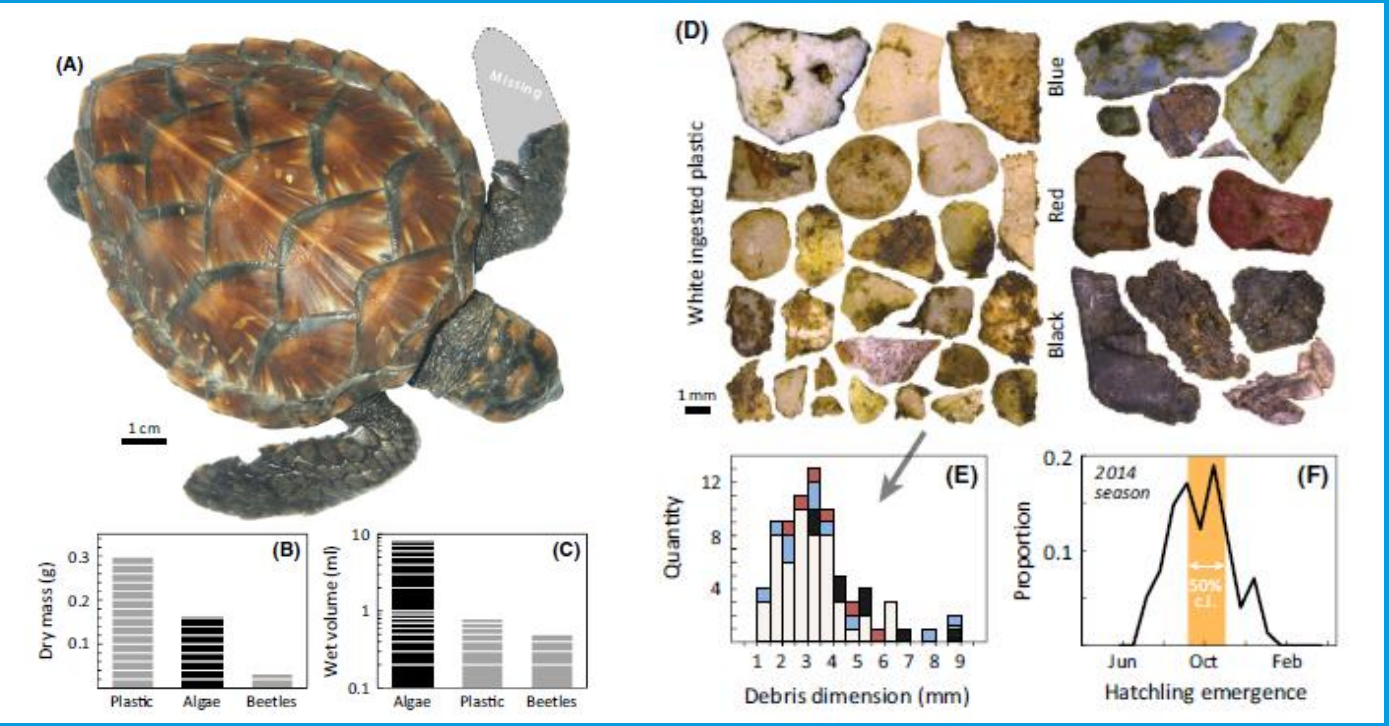
HAWKSBILL FROM OAHU 1984

5.4 kg turtle with ≈741 pieces or 116 grams of debris

21.5 g debris/kg

Balazs 1985

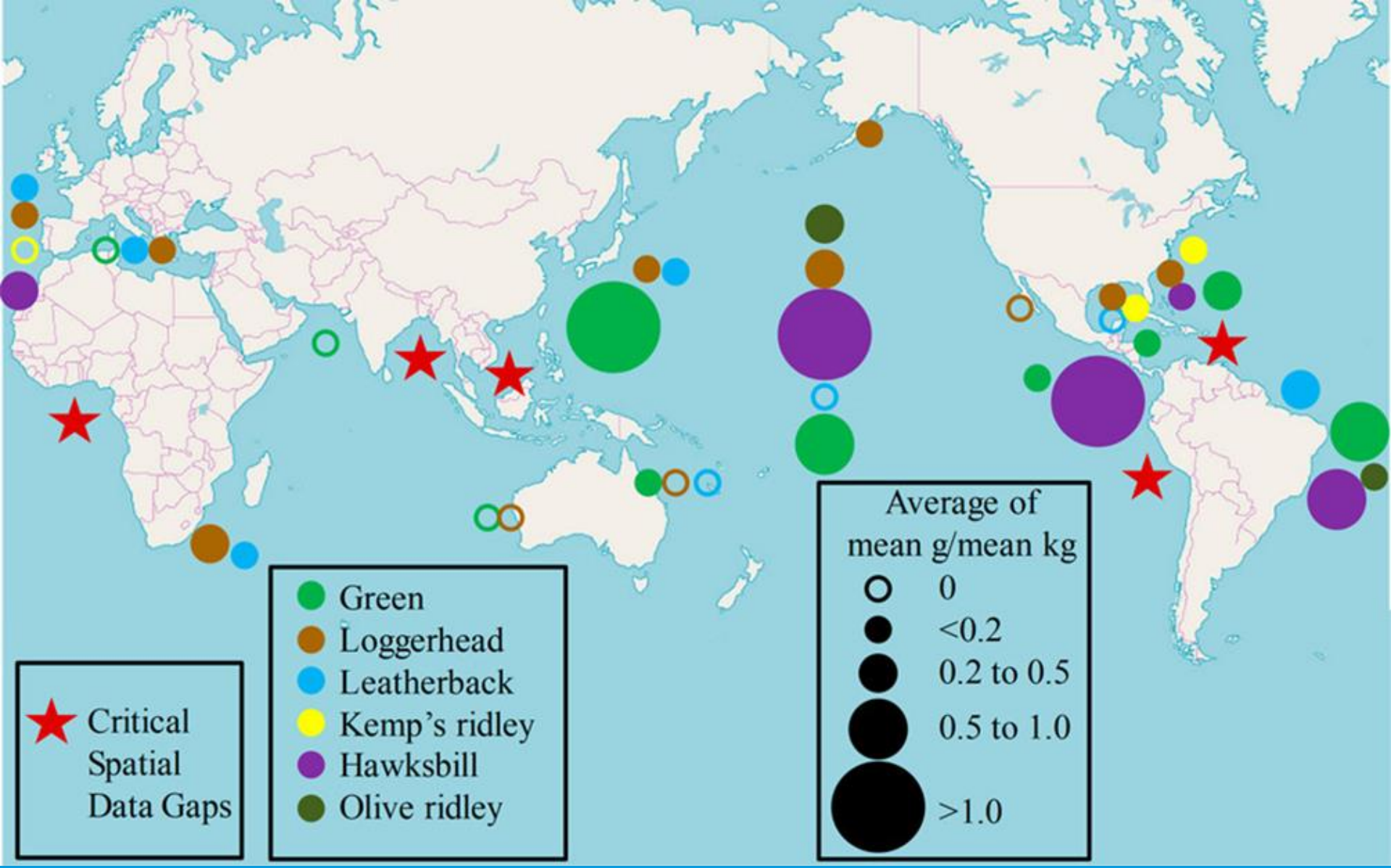
HAWKSBILL FROM KAUAI 2015



9.2 cm ≈0.096 kg turtle with 41 pieces or 0.3 grams of debris

3.11 g/kg

Van Houtan et al., 2016

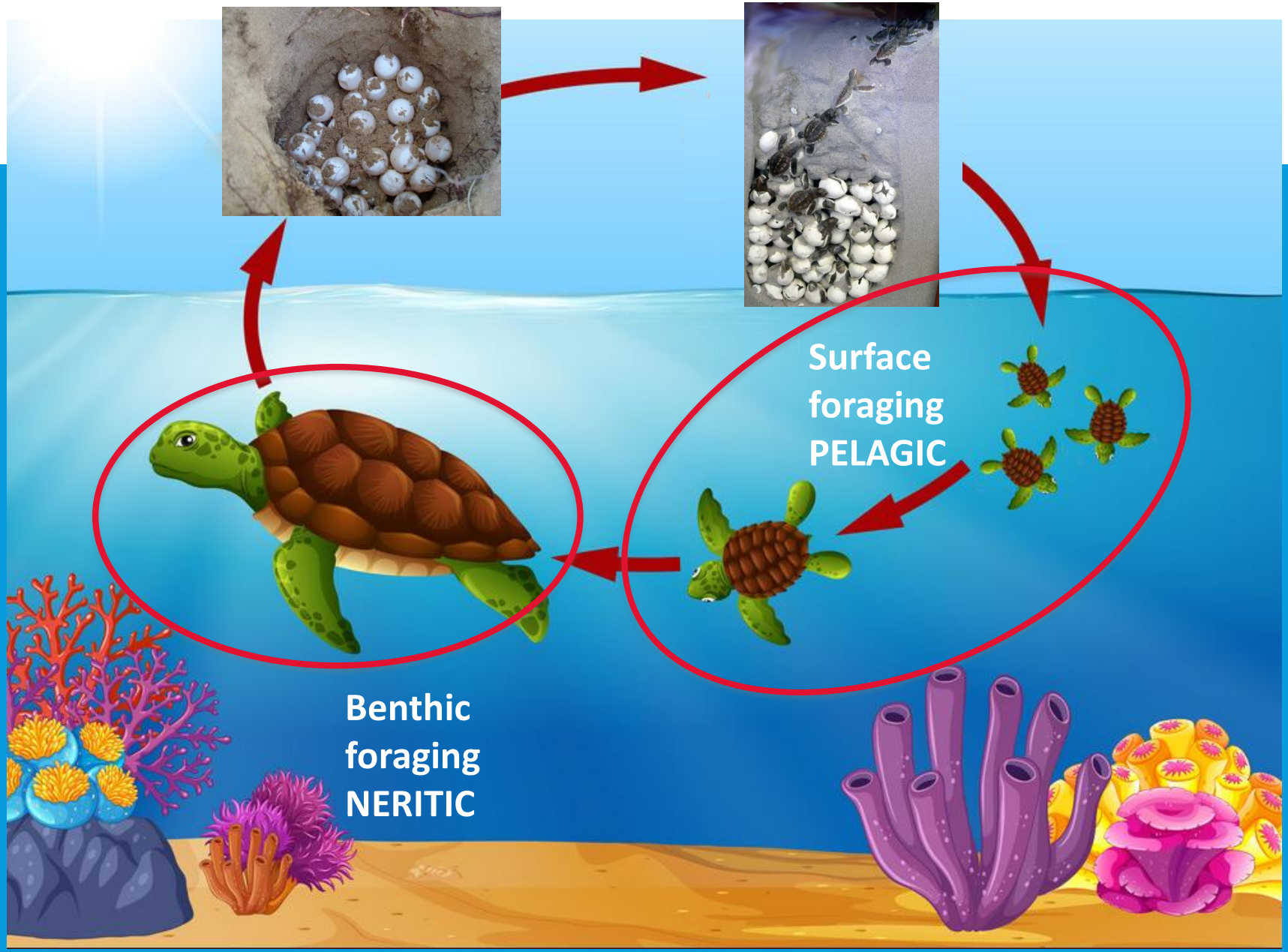


Lynch, J.M., 2018. Quantities of marine debris ingested by sea turtles: global meta-analysis highlights need for standardized data reporting methods and reveals relative risk. *Environmental Science & Technology*, *52*(21), pp.12026-12038.

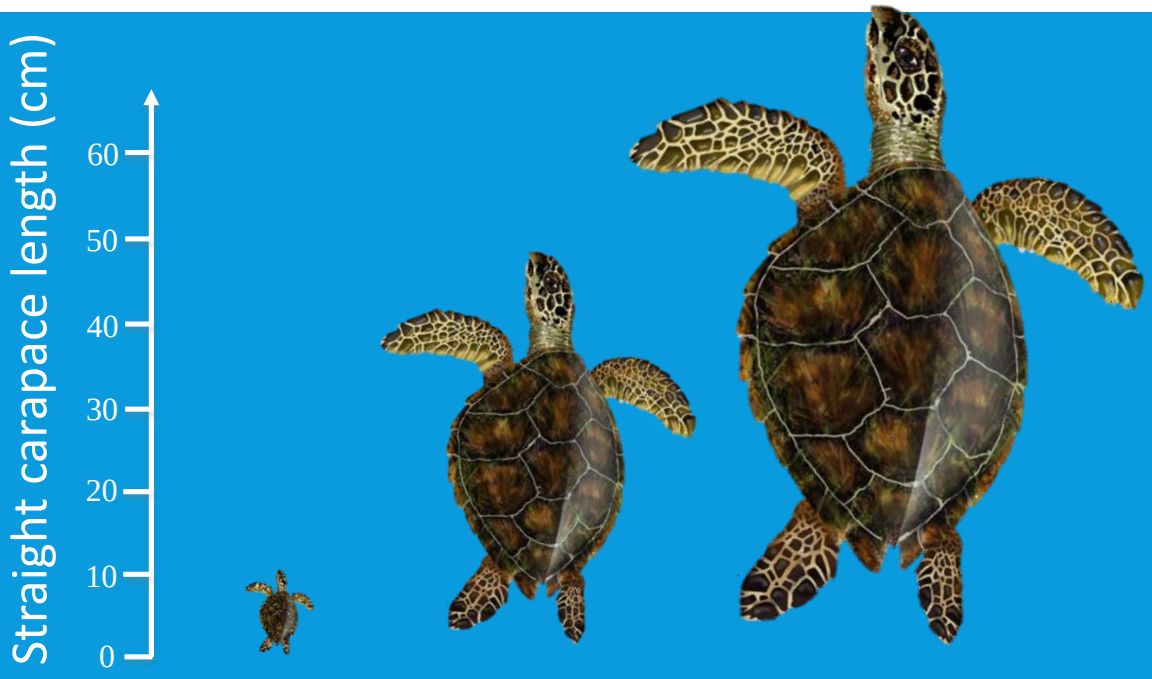
OBJECTIVE

Increase the sample size of hawksbills from the Central Pacific to assess size class differences and update species and spatial comparisons

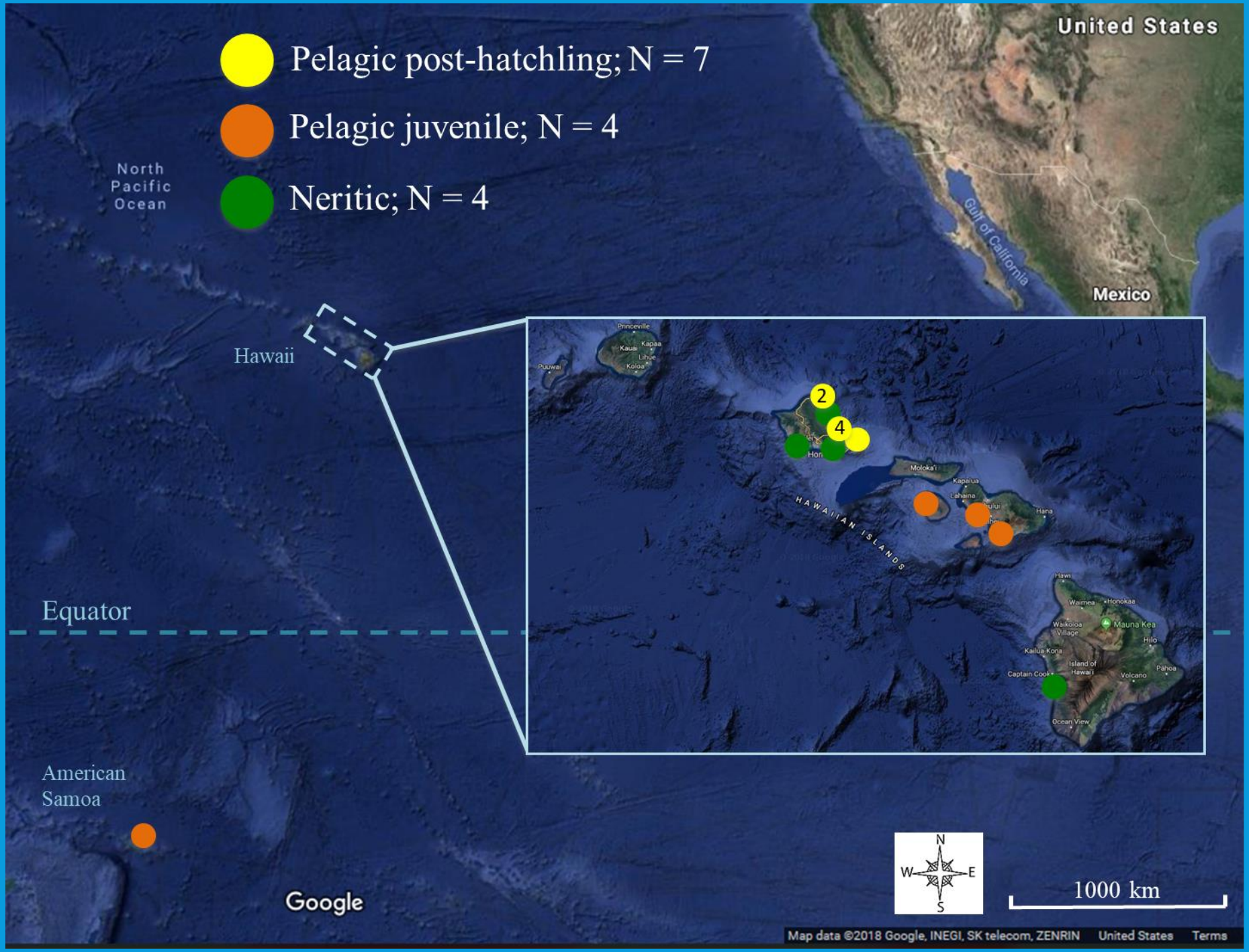
LIFE CYCLE OF SEA TURTLES



STAGE ESTIMATED BY SIZE

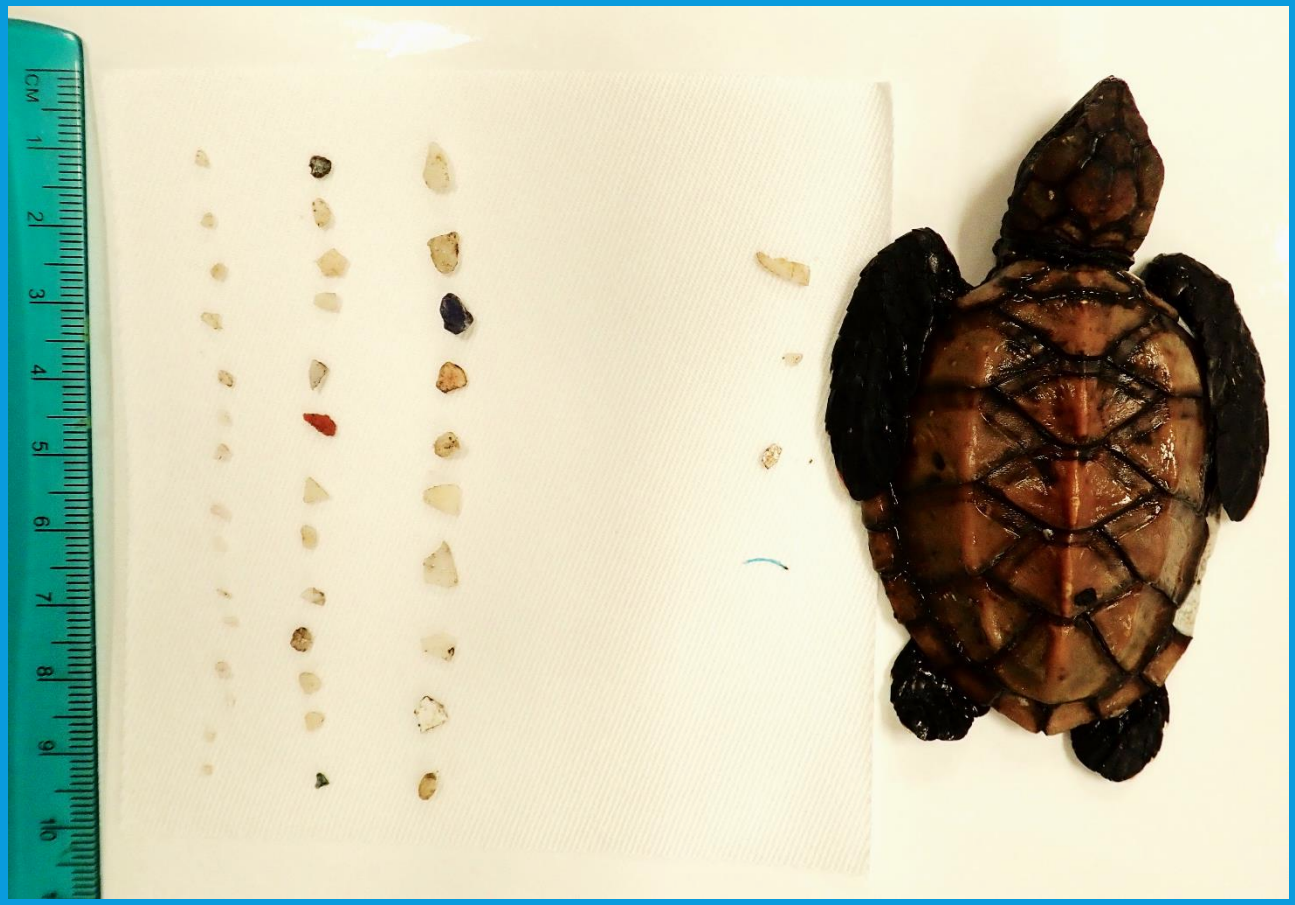


Pelagic post-hatchling (4-9 cm)	Pelagic juvenile (28-41 cm)	Neritic (46-71 cm)
N = 7(1)	4(1)	4

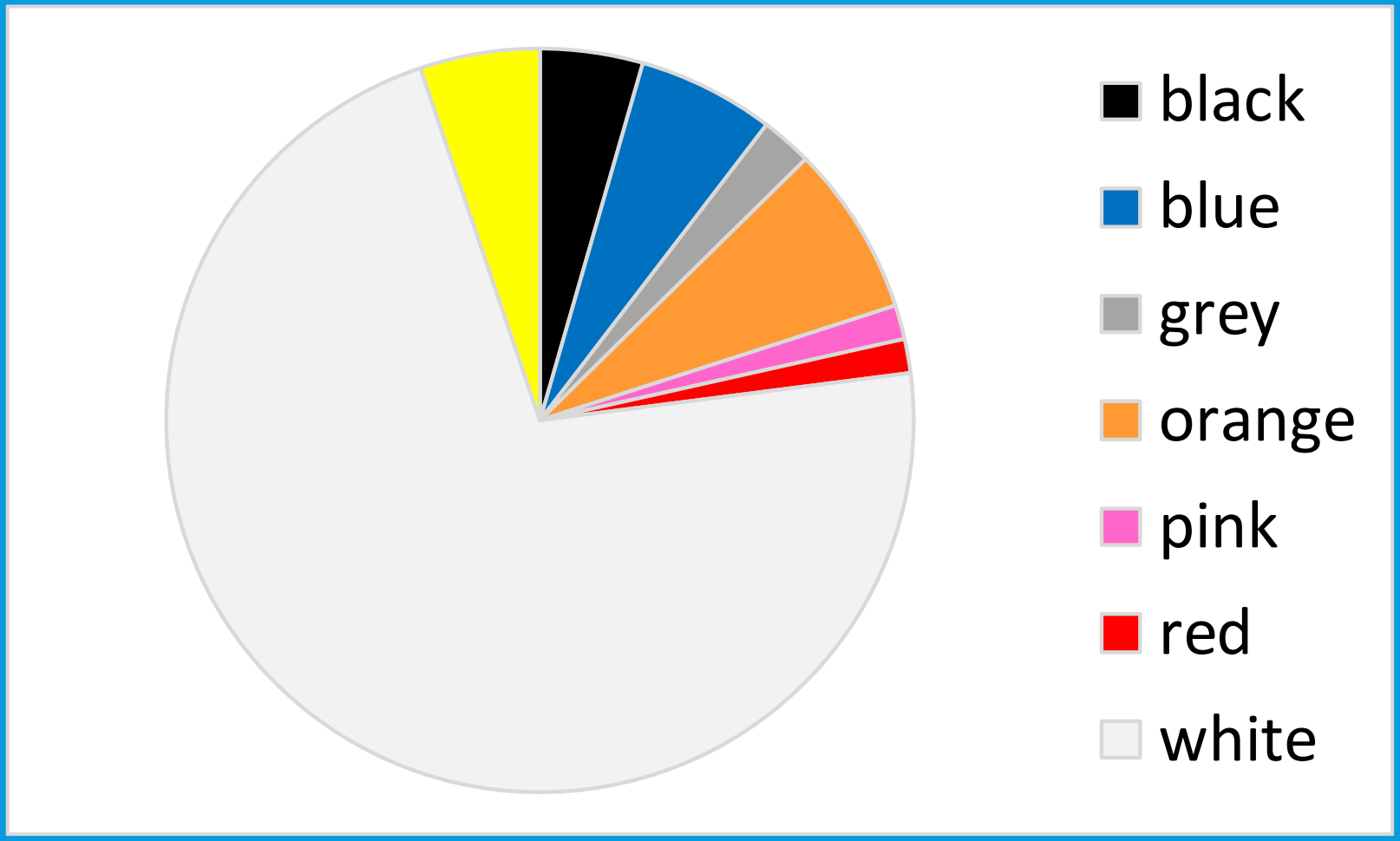

Pelagic post-hatchling; N = 7
Pelagic juvenile; N = 4
Neritic; N = 4
North Pacific Ocean
United States
Gulf of California
Mexico
Hawaii
Equator
American Samoa
HAWAIIAN ISLANDS
2
4
1000 km
Google
Map data ©2018 Google, INEGI, SK telecom, ZENRIN
United States
Terms

SAMPLE COLLECTION

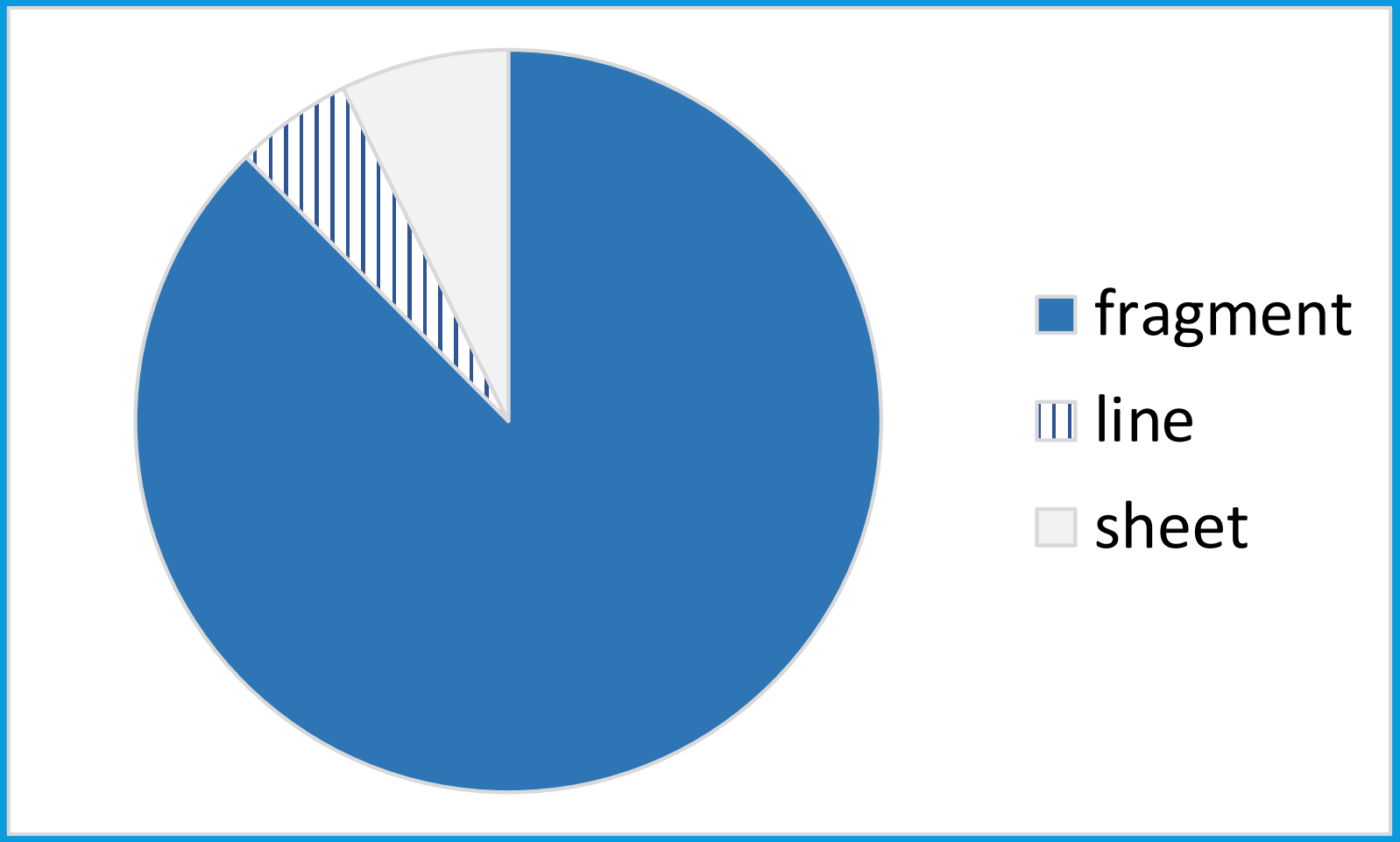
- Necropsy
- Examine entire GI tracts
- Record color, type, size, mass
- Store plastics and tissues in LN2 for future chemical analysis
- Calculate per turtle
  - # of pieces
  - mass
  - g/kg



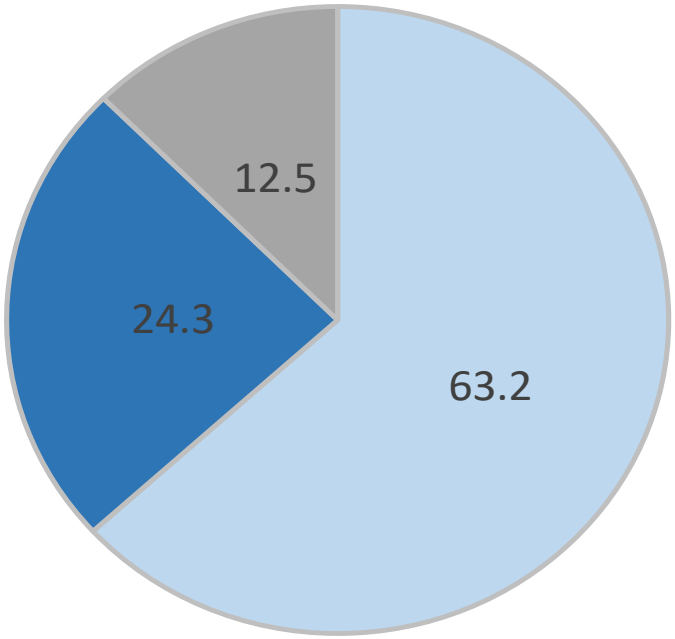
COLORS

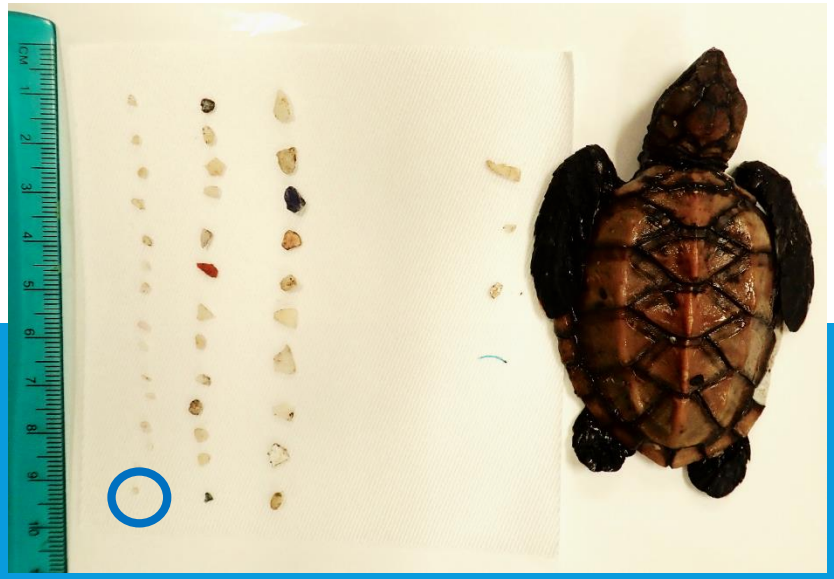


TYPES

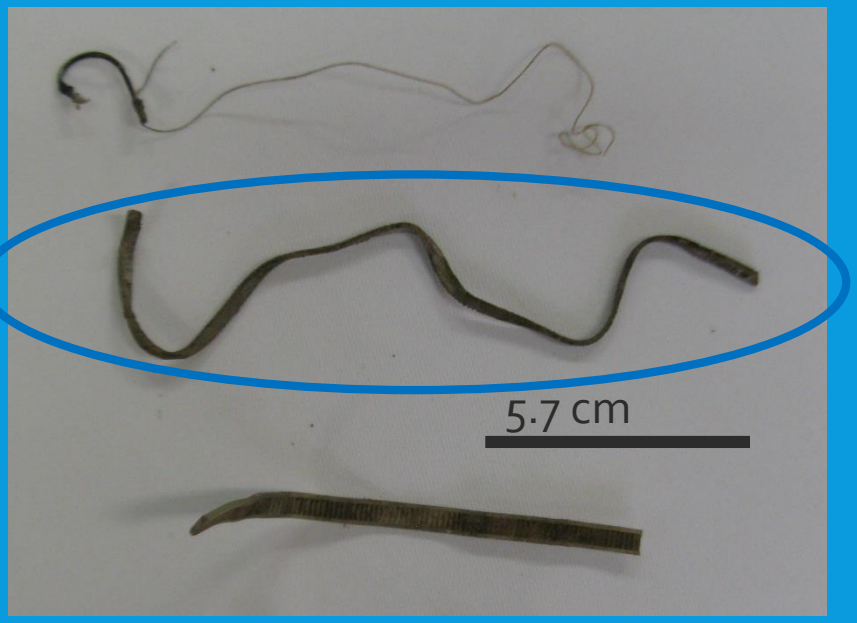


SIZES





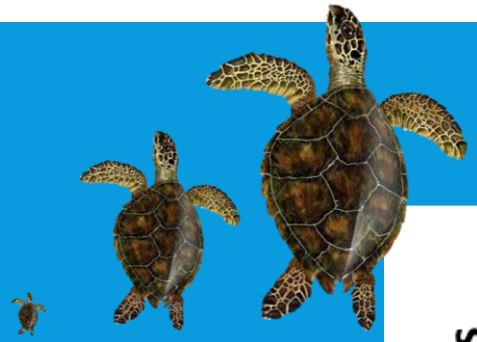
Minimum: 1 x 1 x 0.5 mm



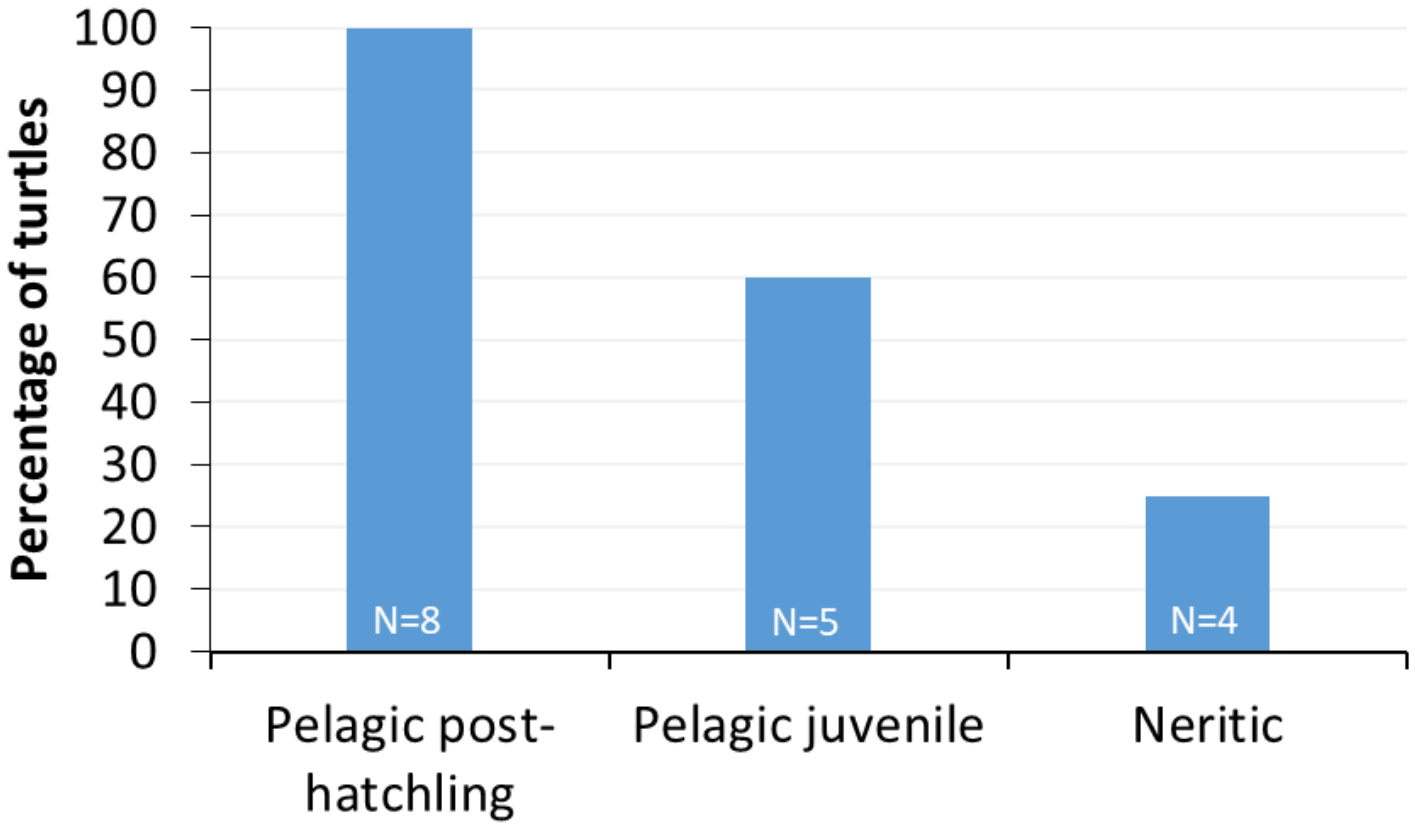
Mean: 1.13 cm SD: 1.90 cm

Maximum: 14 x 0.5 x 0.1 cm

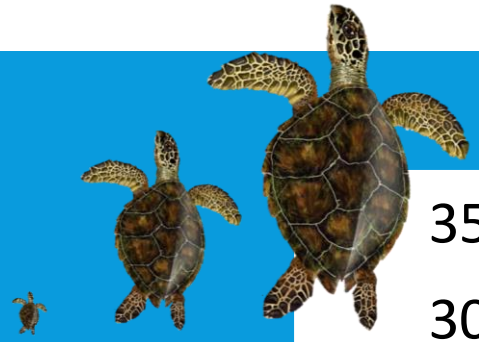
FREQUENCY OF OCCURRENCE

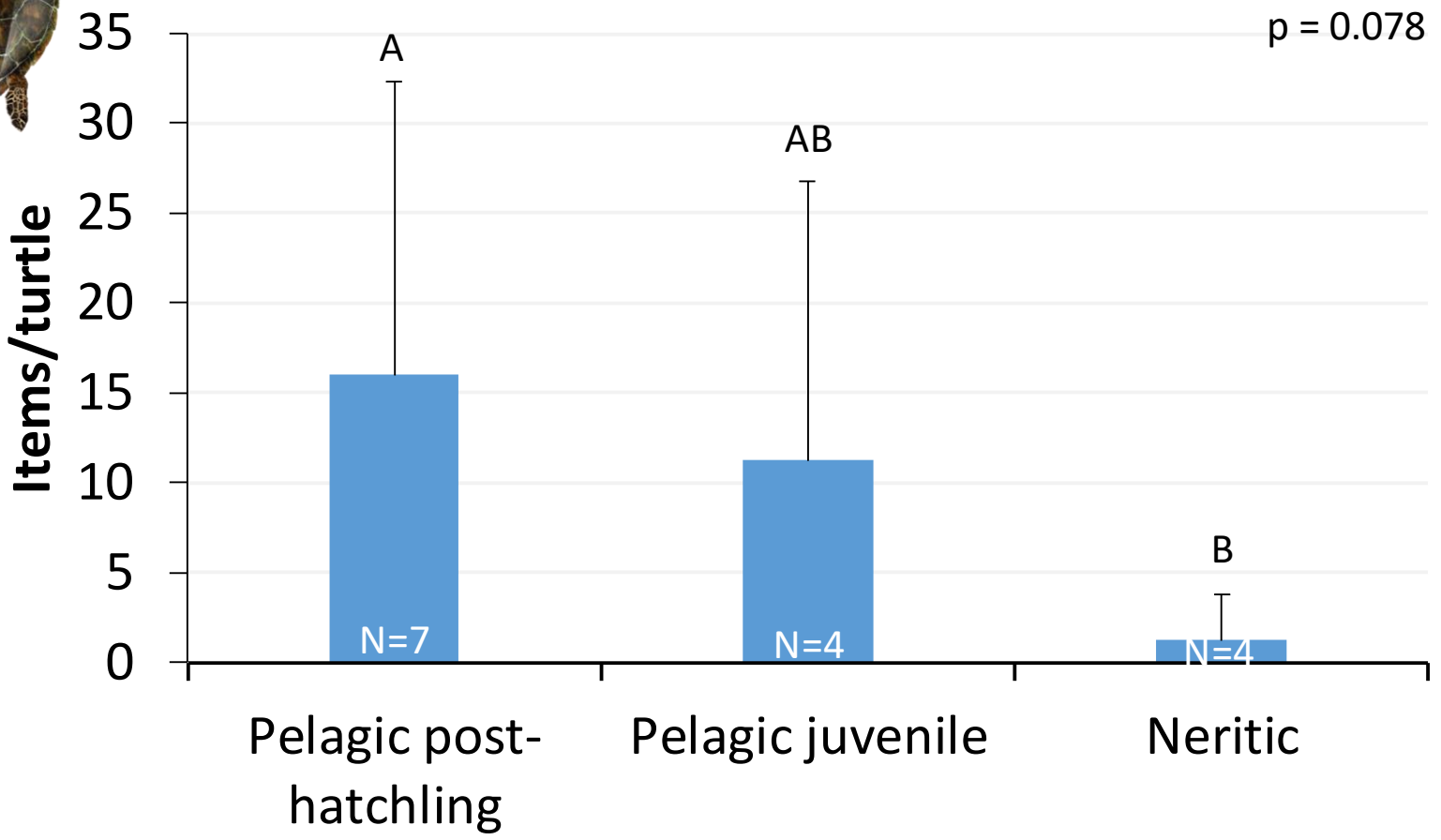


70.6 % N = 17

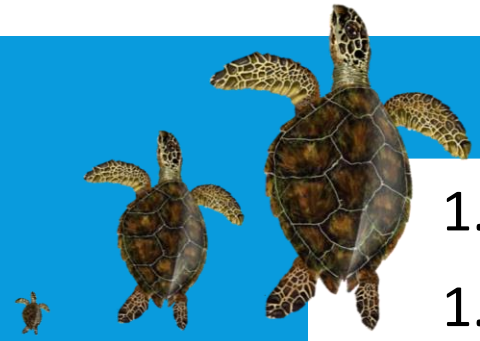


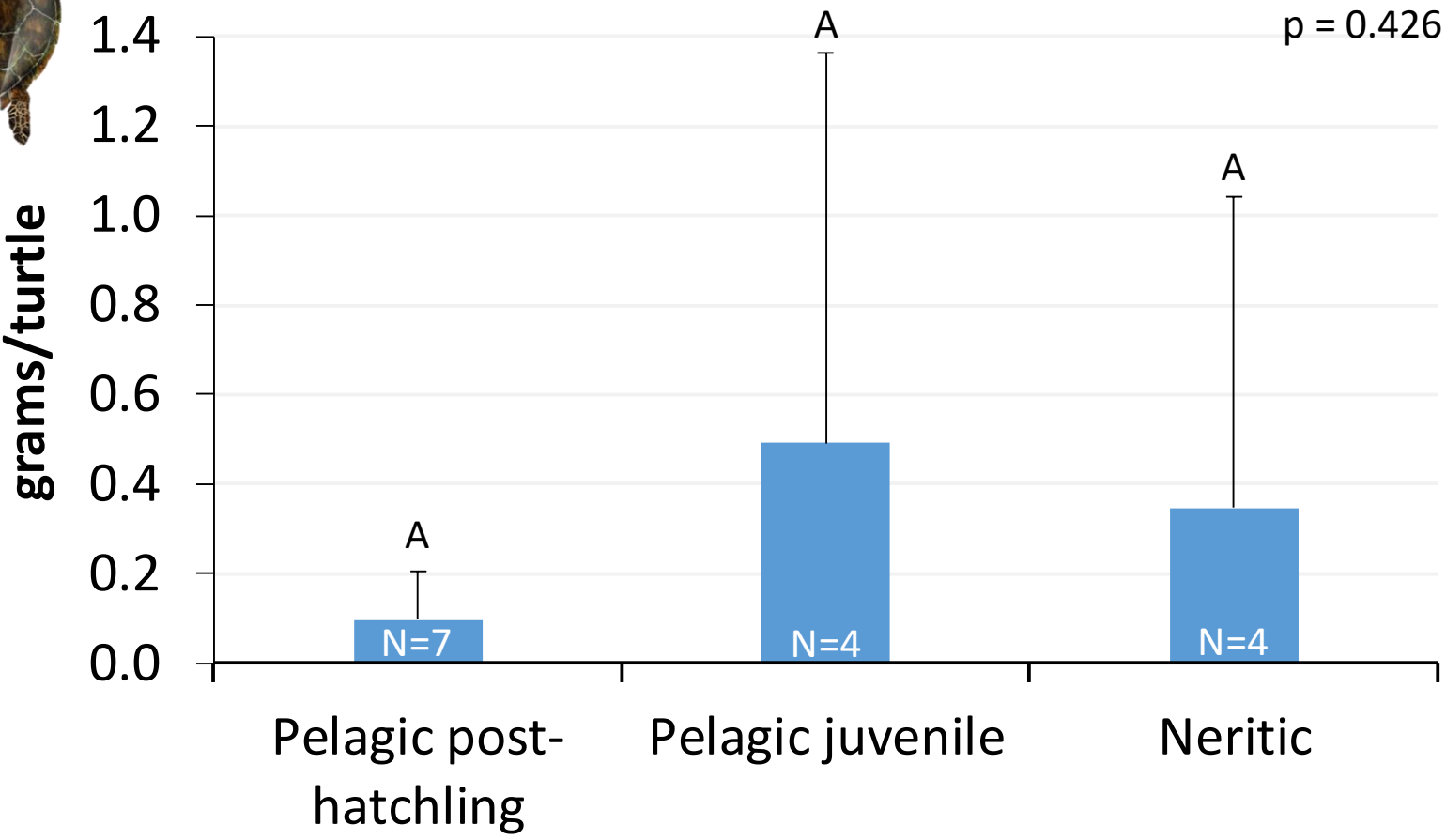
QUANTITIES: COUNT/TURTLE



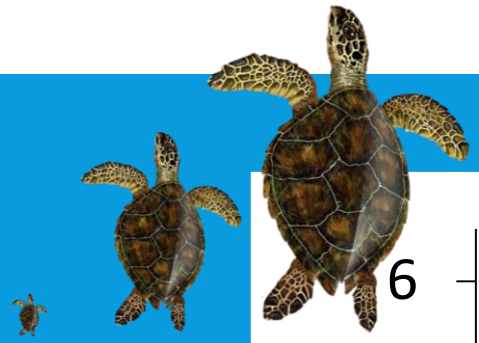


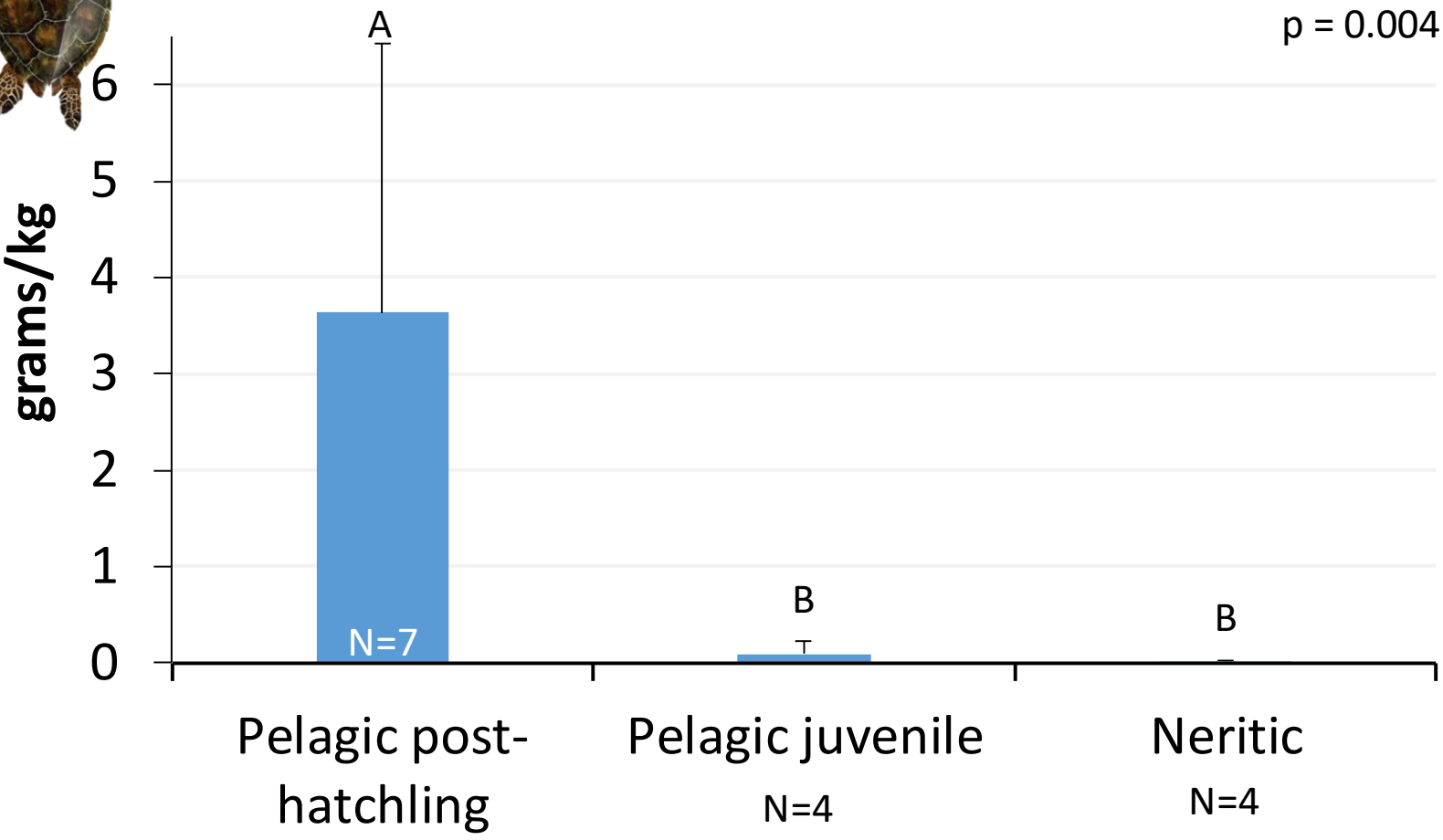
QUANTITIES: GRAMS/TURTLE



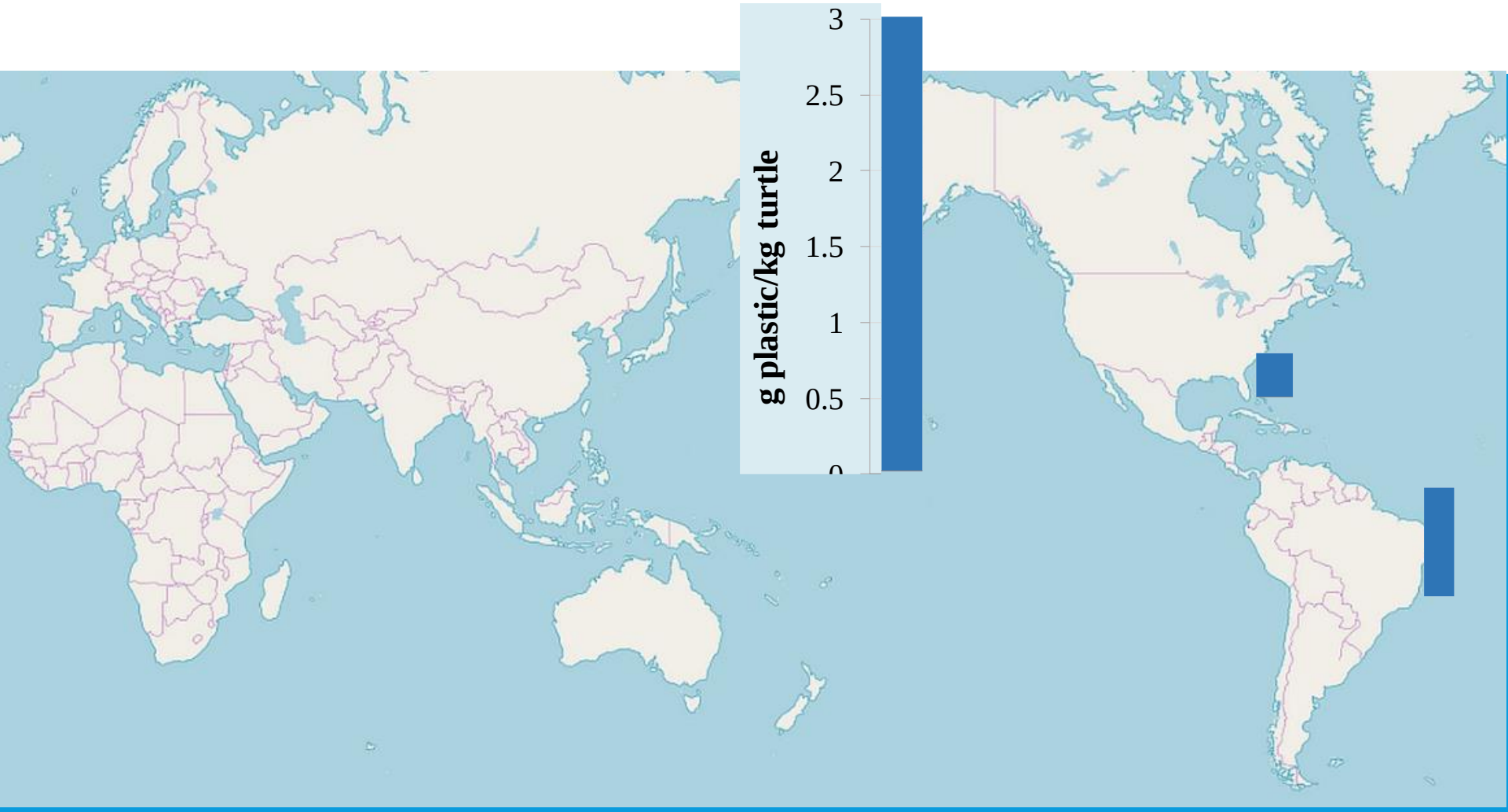


QUANTITIES: GRAMS/KG

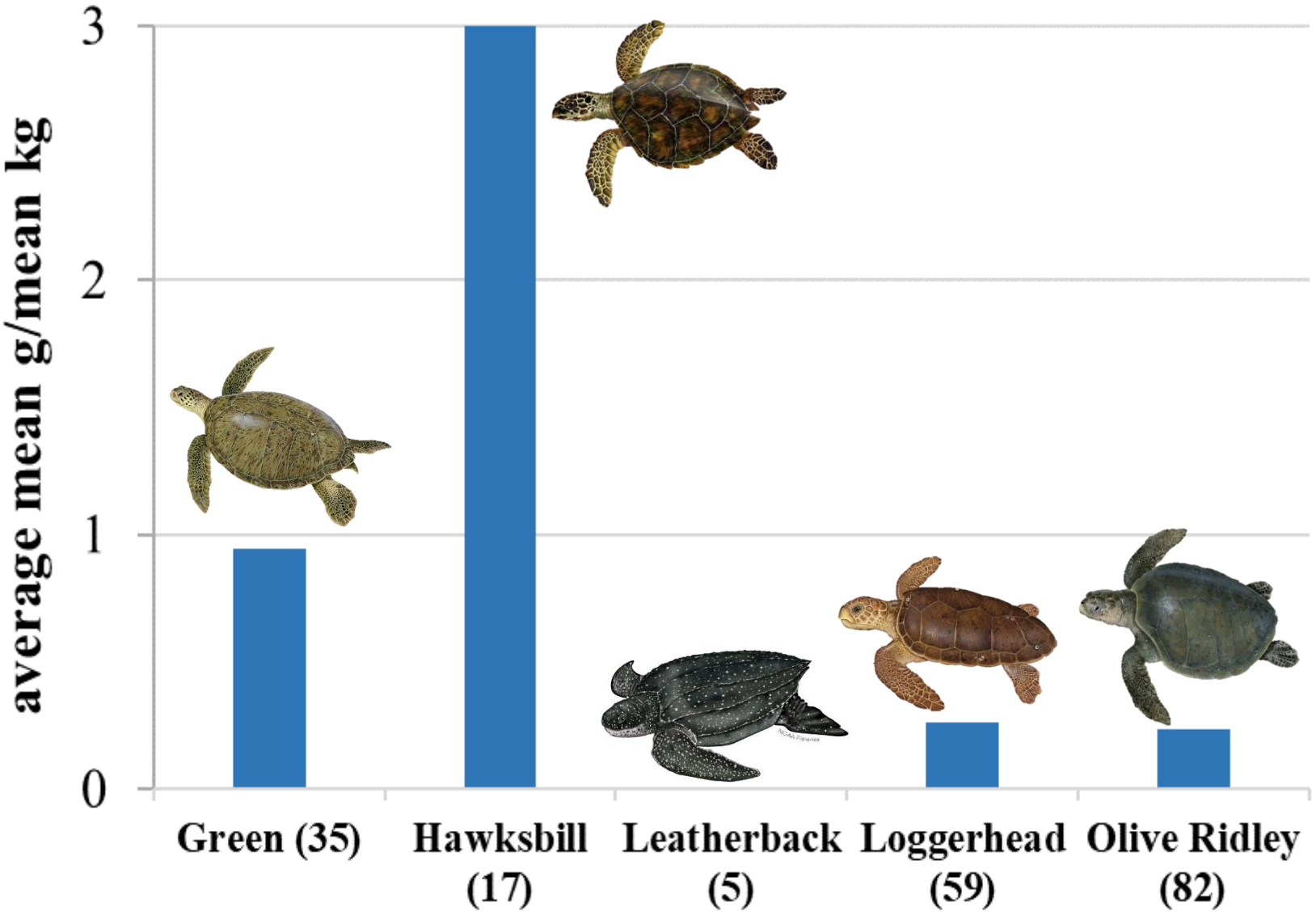




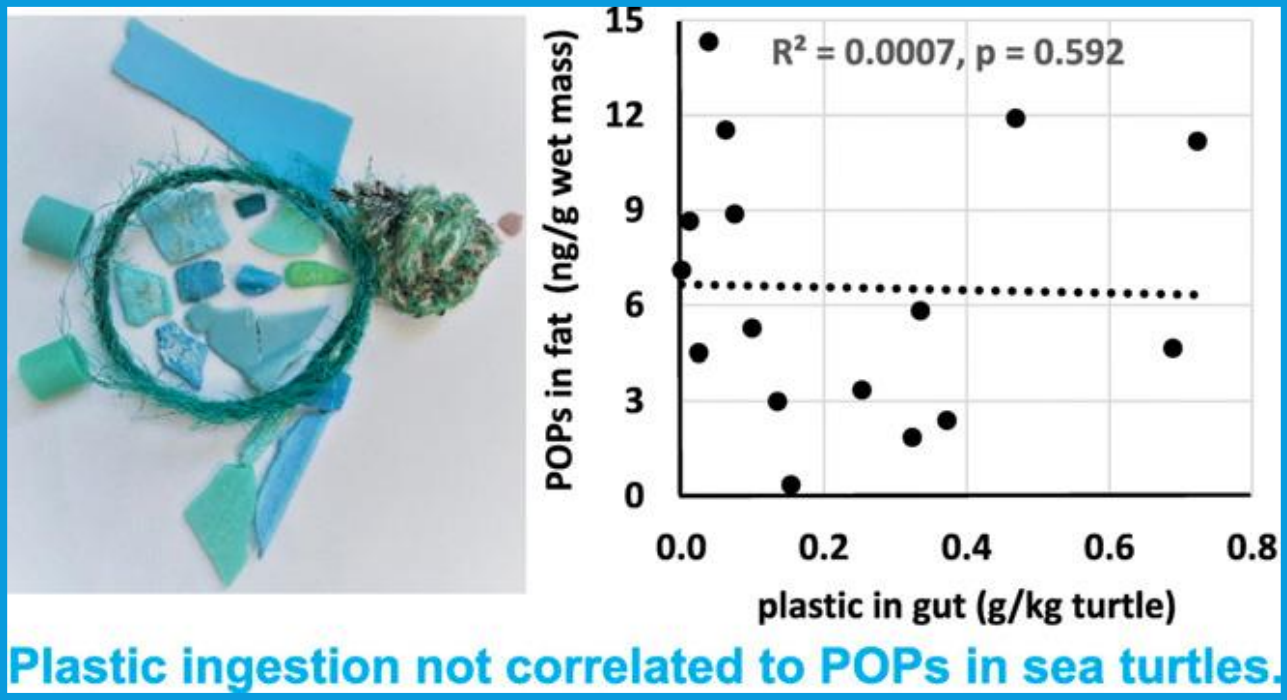
UPDATED HAWKSBILL GLOBAL COMPARISON



UPDATED SPECIES COMPARISON



EFFECTS OF PLASTIC INGESTION?



- No dietary dilution
- No gut obstructions, perforations, torsions
- Source of POP exposure is likely food>plastic

Clukey et al. 2018 Sci Total Environ

CONCLUSIONS

- Report data in multiple, proper units
- Focus on younger, pelagic-phase turtles in plastic polluted regions
- Investigate effects

THANK YOU!

- Paul Becker, John Kucklick, Rebecca Pugh, Katy Shaw

- Brenda Jensen, Kayla Brignac, Frannie Nilsen, Angela Hansen, Adam Kurtz, Elise Kohli, Jennette Vanderjagt

- Devon Francke, Wendy Marks, Irene Nurzia Hamburg

- Bob Rameyer, Renee Breeden

- Katharine Clukey

FOLLOW US

CENTER FOR MARINE DEBRIS RESEARCH

Website: www.hpu.edu/cncs/cmdr

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@debrisresearch

@company/center-for-marine-debris-research

CENTER FOR MARINE DEBRIS RESEARCH

MISSION:

The Center for Marine Debris Research develops and applies optimal methods to investigate the sources, transport, fate, and impacts of plastic marine debris. The Center also disseminates this knowledge to inform management and stimulate ocean stewardship.

VISION:

The ultimate goal of all activities of the Center for Marine Debris Research is a trash-free ocean.

WHERE?

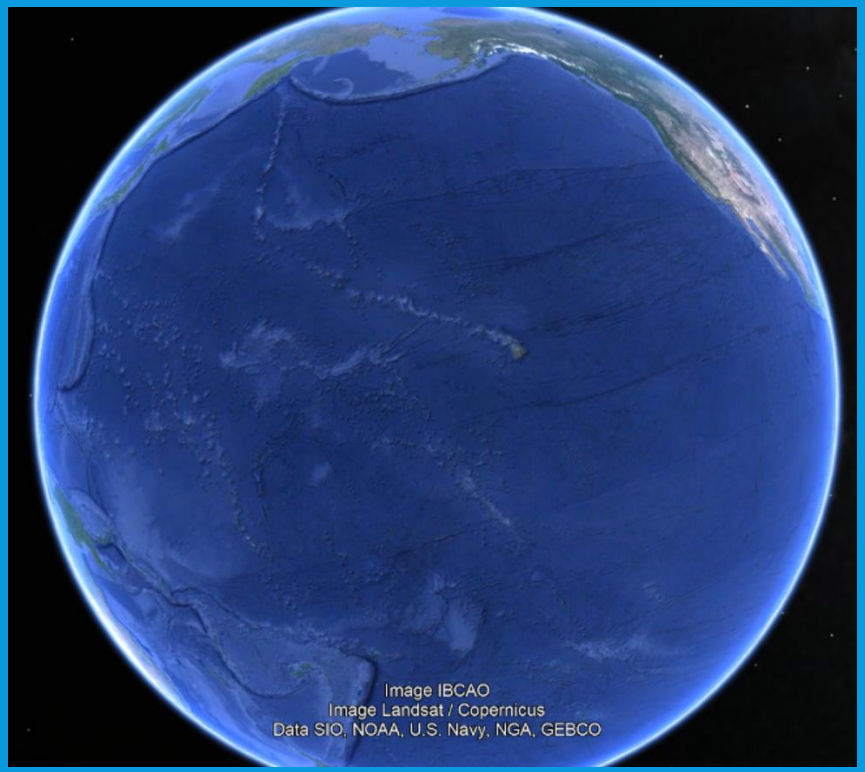
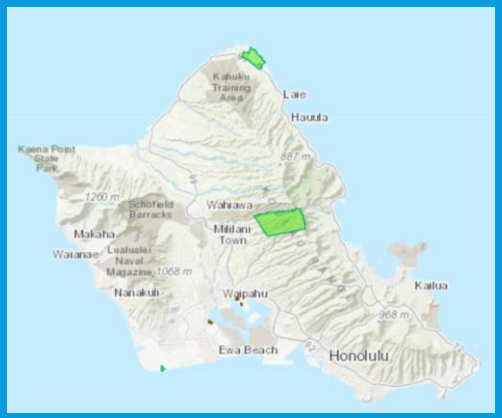


Image IBCAO
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

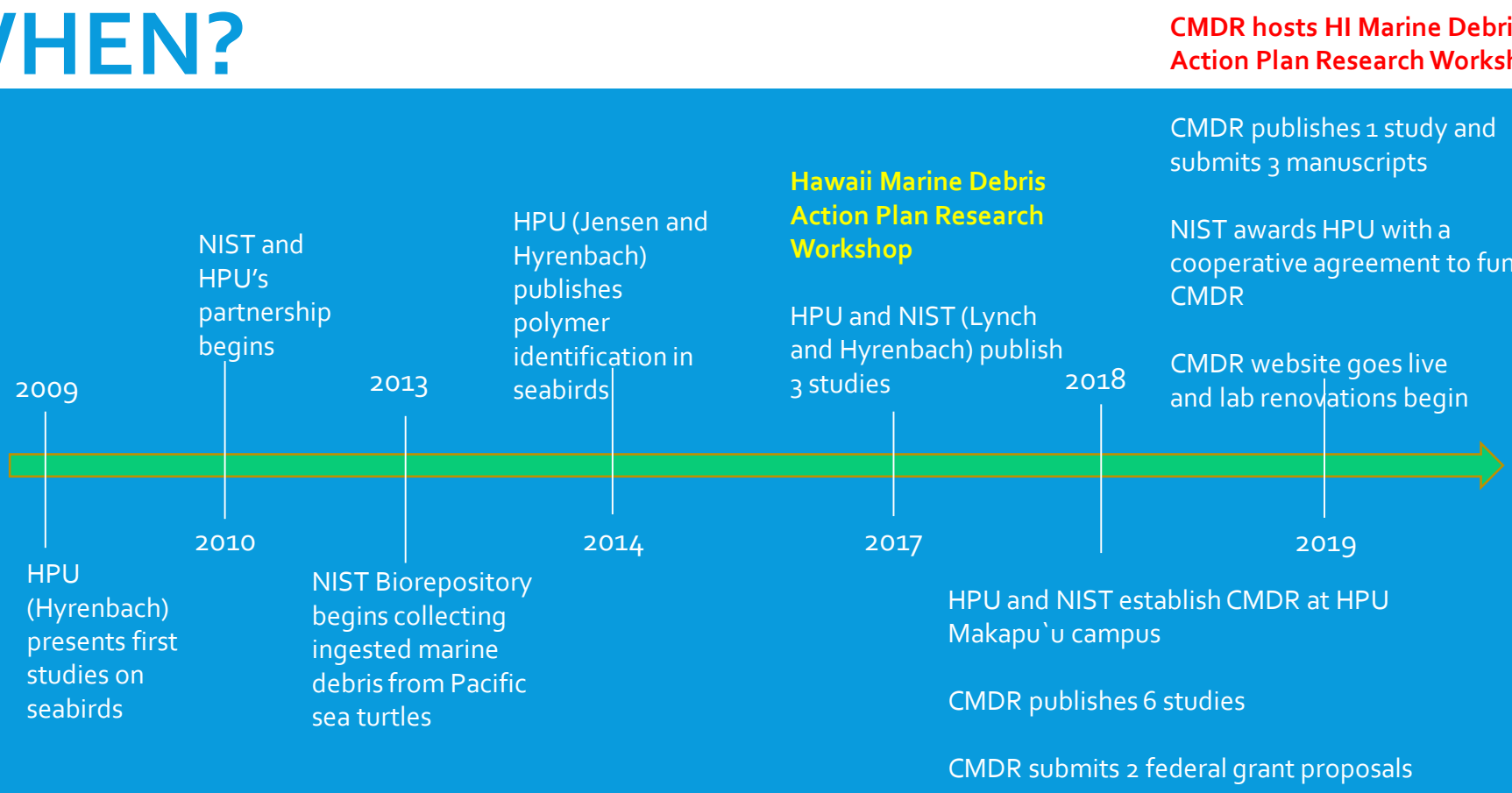
WHY?

James Campbell National Wildlife Refuge
Oahu, Hawaii, 21 Aug 2019

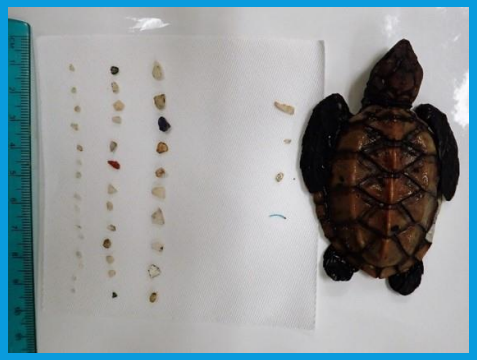


WHO?

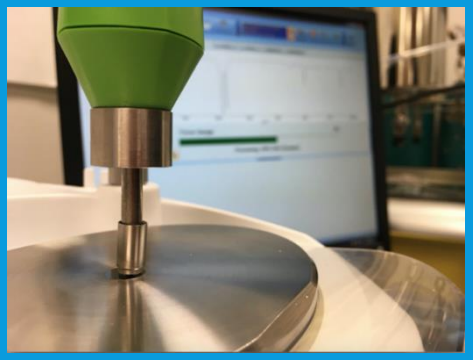
WHEN?


2009
HPU (Hyrenbach) presents first studies on seabirds
2010
NIST and HPU's partnership begins
2013
NIST Biorepository begins collecting ingested marine debris from Pacific sea turtles
2014
HPU (Jensen and Hyrenbach) publishes polymer identification in seabirds
2017
Hawaii Marine Debris Action Plan Research Workshop
HPU and NIST (Lynch and Hyrenbach) publish 3 studies
2018
HPU and NIST establish CMDR at HPU Makapu`u campus
CMDR publishes 6 studies
CMDR submits 2 federal grant proposals
2019
CMDR hosts HI Marine Debris Action Plan Research Workshop
CMDR publishes 1 study and submits 3 manuscripts
NIST awards HPU with a cooperative agreement to fund CMDR
CMDR website goes live and lab renovations begin

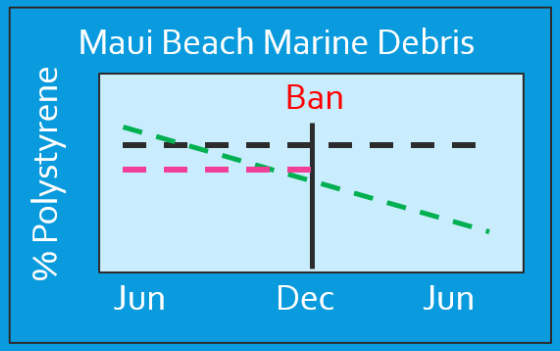
WHAT?



Biology

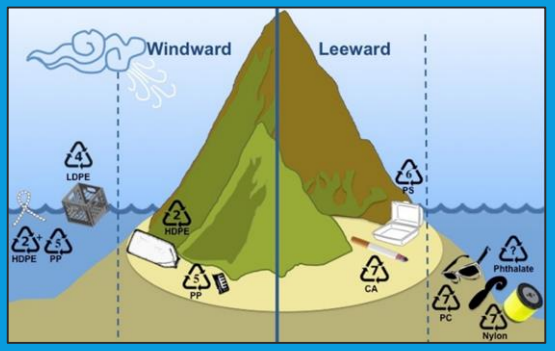


Chemistry



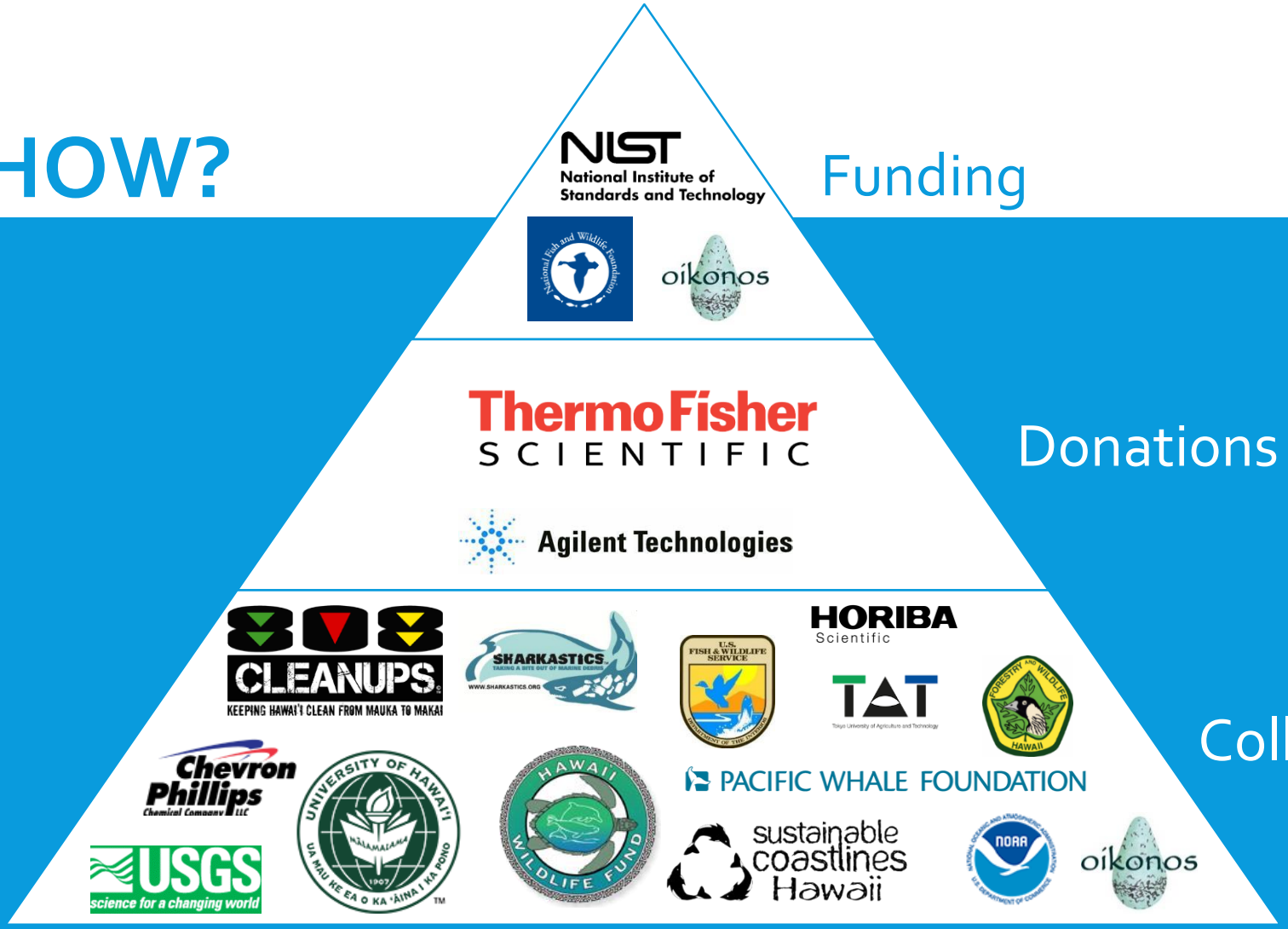
Policy and Economics

Engineering



Physics

HOW?



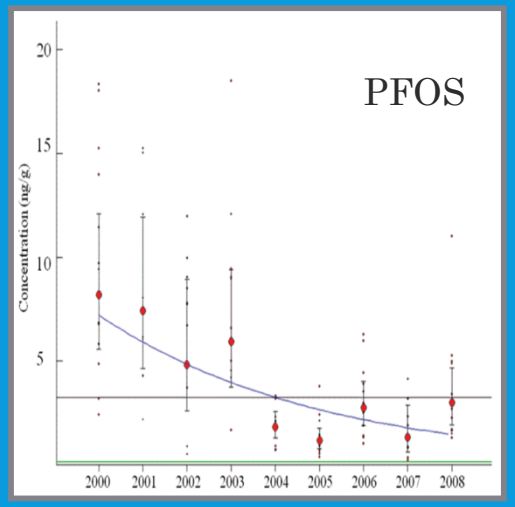
Funding

Donations

Collaborations

Biological and Environmental Monitoring and Archival of Sea Turtle Tissues (BEMAST) Project

Biological and Environmental Monitoring and Archival of Sea Turtle Tissues (BEMAST) Project



Mission: Archive tissues from prioritized sea turtle species and locations in a world class specimen bank for real-time and retrospective contaminant and health-related research studies

Sample types

- Necropsy
  - Fat
  - Liver
  - Scute
  - Muscle
  - Bile
  - Ingested plastics
- Live capture
- Nesting beach

SAMPLE ARCHIVE

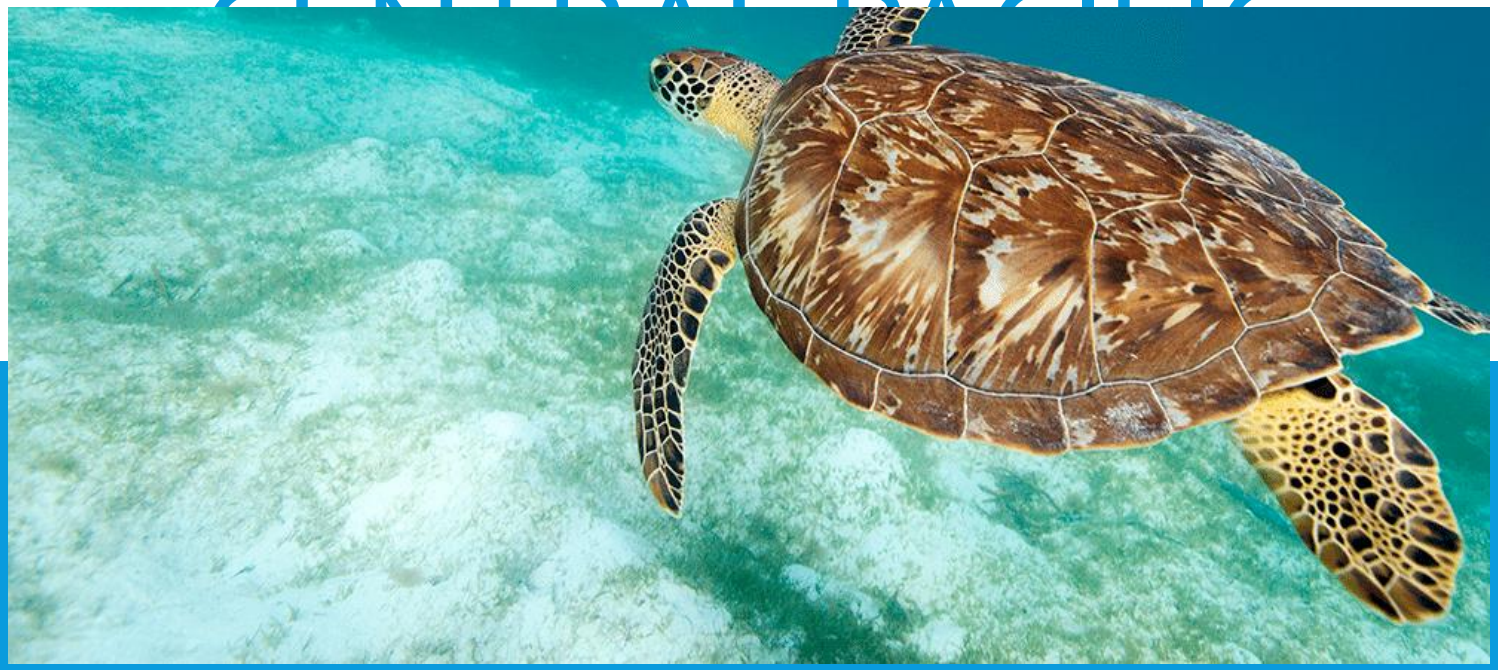
- NIST Internal Report 7996
- All 5 species in US Pacific Islands Region
- 851 samples
  - 285 turtles
  - 38 nests

Species	Capture Method	Location	FP Tumor Status	No. of Animals (Sample Type)	Collection Date
Green	Live capture	Kailua Bay, Oahu	0%	20 (blood, scute)	Mar 2011
Green	Live capture	Kiholo Bay, Hawaii	0	20 (blood, scute)	May 2011
Green	Live capture	Kapoho Bay, Hawaii	34%	22 (blood, scute)	Nov 2011
Green	Live capture	Kailua Bay, Oahu	0.05	21 (blood, scute)	Jul 2012
Green	Live capture	Palmyra Atoll	0%	20 (blood, scute)	Jul 2012
Green	Live capture	Palmyra Atoll	0	22 (blood, scute, mouth algae)	Jun-Jul 2013
Green	Live capture	San Diego, CA	0%	4 (blood)	Jun-Aug 2013
Green	Live capture	Kailua Bay, Oahu	0.05	20 (blood, scute, mouth algae)	Jul 2013
Green	Live capture	Kiholo Bay, Hawaii	0%	21 (blood, scute, mouth algae)	Dec 2013
Green	Live capture	Saipan & Tinian, CNMI	0%	20 (blood, mouth algae)	Dec 2013
Green	Live strandings euthanized	Main Hawaiian Islands	100%	20 (blood, scute, fat, liver, FP lesion)	Jul 2011 – Jul 2012
Green	Longline caught	>200 km from American Samoa & Hawaiian Is.	0%	14 (scute, fat, muscle, bile, liver)	Mar 2011 - Jan 2014
Green	Dead stranding	Main Hawaiian Islands	0%	7 (scute)	May 2011 - May 2013
Green	Dead stranding	San Diego, CA	0%	1 (scute, fat, muscle, bile, liver)	Jan 2013
Green	Unhatched eggs	Main Hawaiian Islands	N/A	26 nests	Jan 2013 - Jan 2014
Olive Ridley	Longline caught	>200 km from American Samoa & Hawaiian Is.	0%	22 (scute, fat, muscle, bile, liver, GI tract)	Mar 2011 - Jan 2014
Olive ridley	Dead stranding	Main Hawaiian Islands	0%	4 (scute, fat, liver, muscle, bile, GI tract)	Nov 2011 - Jul 2013
Hawksbill	Live capture	Palmyra Atoll	0%	2 (blood, scute)	Jun-Jul 2013
Hawksbill	Live capture	Saipan & Tinian, CNMI	0%	4 (blood)	Dec 2013
Hawksbill	Dead stranding	Main Hawaiian Islands	0%	3 (scute, fat, muscle, bile, liver)	Nov 2011 - Jul 2013
Hawksbill	Unhatched eggs	Main Hawaiian Islands	N/A	12 nests	Dec 2012 - Jan 2014
Leatherback	Longline caught	>200 km from American Samoa & Hawaiian Is.	0%	4 (blubber, fat, skin, liver, muscle)	Mar 2011 - Jul 2013
Loggerhead	Longline caught	>200 km from American Samoa & Hawaiian Is.	0%	3 (scute, fat, muscle, bile, liver, GI tract)	Mar 2011 - Jan 2014

LOCATIONS


Asia
International Date Line
North America
Midway Island
Northern Mariana Islands
Wake Island
Hawaiian Islands
Guam
Johnston Island
Palmyra Atoll
Kingman Reef
Equator
Howland and Baker Islands
Jarvis Island
Long-line Fisheries
American Samoa

CENTRAL PACIFIC



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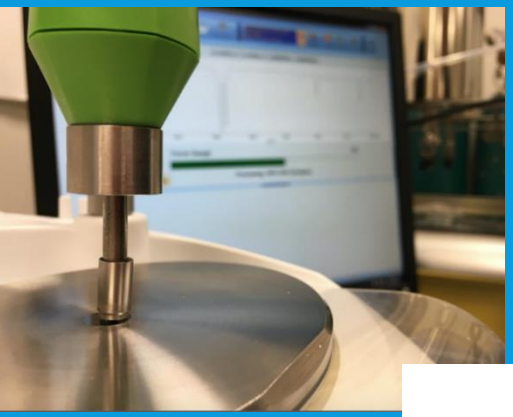
POLYMER IDENTIFICATION METHODS



Marine Pollution Bulletin 127 (2018) 704–716

Contents lists available at ScienceDirect

Marine Pollution Bulletin

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

Validation of ATR FT-IR to identify polymers of plastic marine debris, including those ingested by marine organisms

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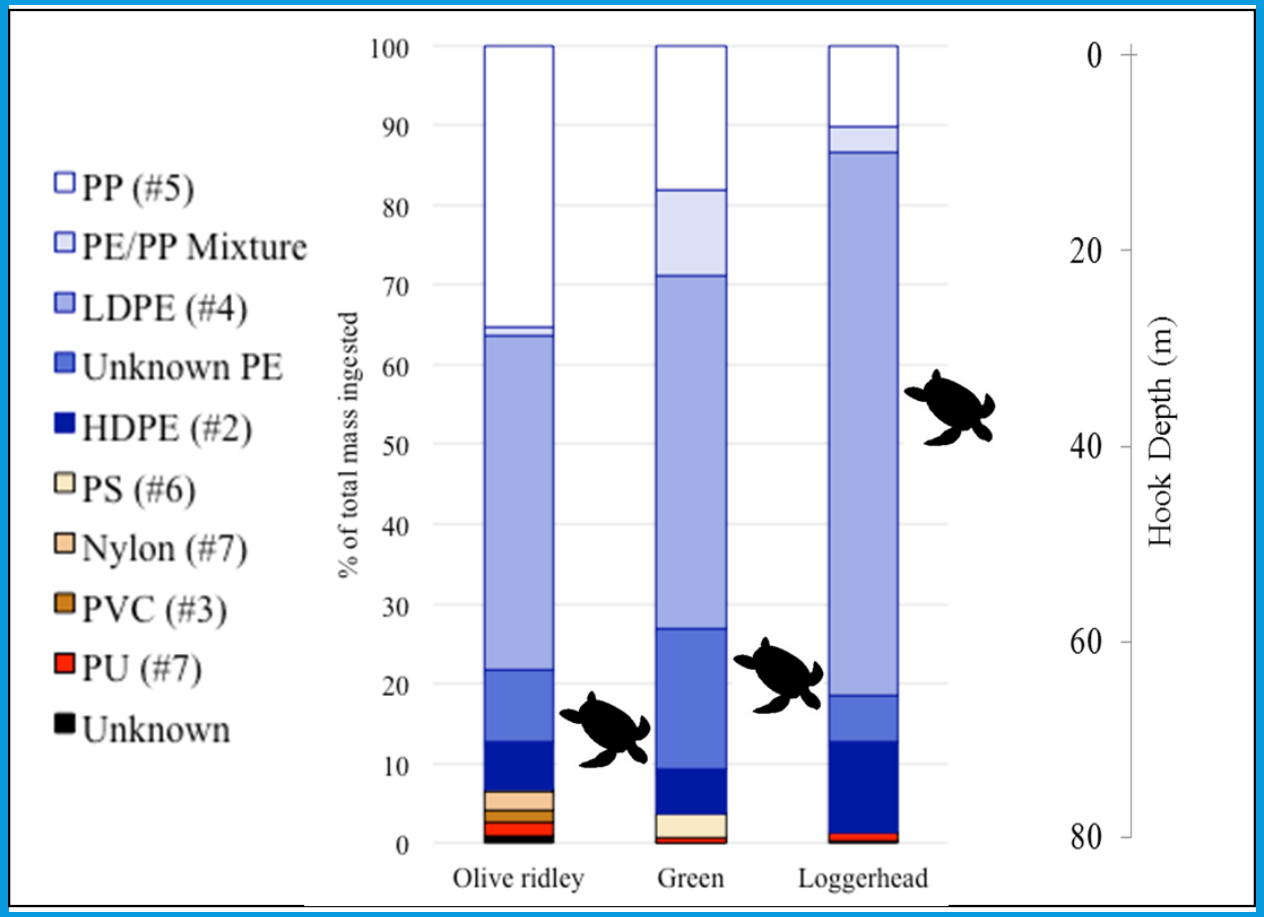
WHAT POLYMER TYPES DO TURTLES INGEST?



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