# Polystyrene:
# A Pesky Pollution Problem
# with a Positive People Solution: Bill 127!

~Cheryl King, MSc.

SHARKASTICS™
TAKING A BITE OUT OF MARINE DEBRIS
WWW.SHARKASTICS.ORG


More
Turtles
Less
Nurdles!

# PLASTICS IN THE MARINE ENVIRONMENT:
## WHERE DO THEY COME FROM? WHERE DO THEY GO?

eunomia

**LAND BASED - INLAND** - 0.50 Mtpa

**LAND BASED - COASTAL**
9
Million tonnes per annum

**AT SEA**
1.75
**Mtpa**

**FISHING LITTER** - 1.15

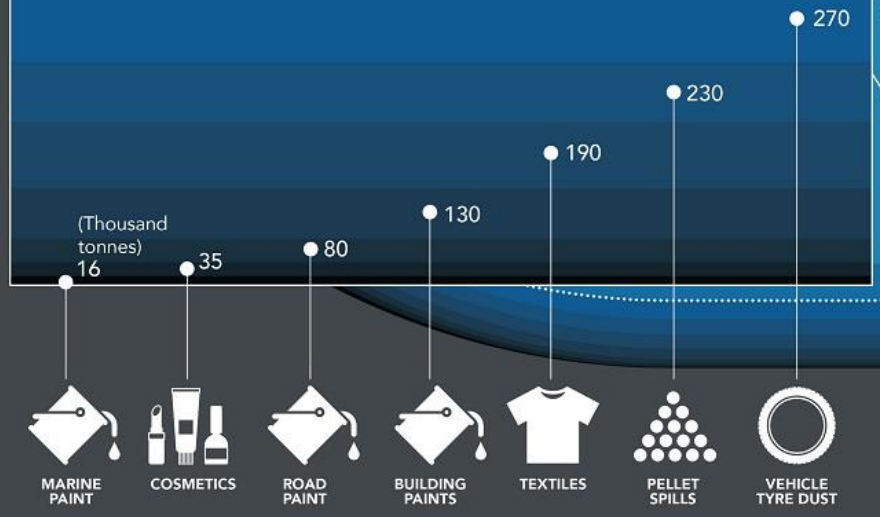
**SHIPPING LITTER** - 0.60

**TOTAL PLASTIC ENTERING THE MARINE ENVIRONMENT**
12.2
Million tonnes per annum

**BEACHES**
2,000kg/ km² (5% of total)

**OCEAN SURFACE**
18kg/ km²
(1% of total)*

**PRIMARY MICROPLASTIC** - 0.95 Million tonnes per annum



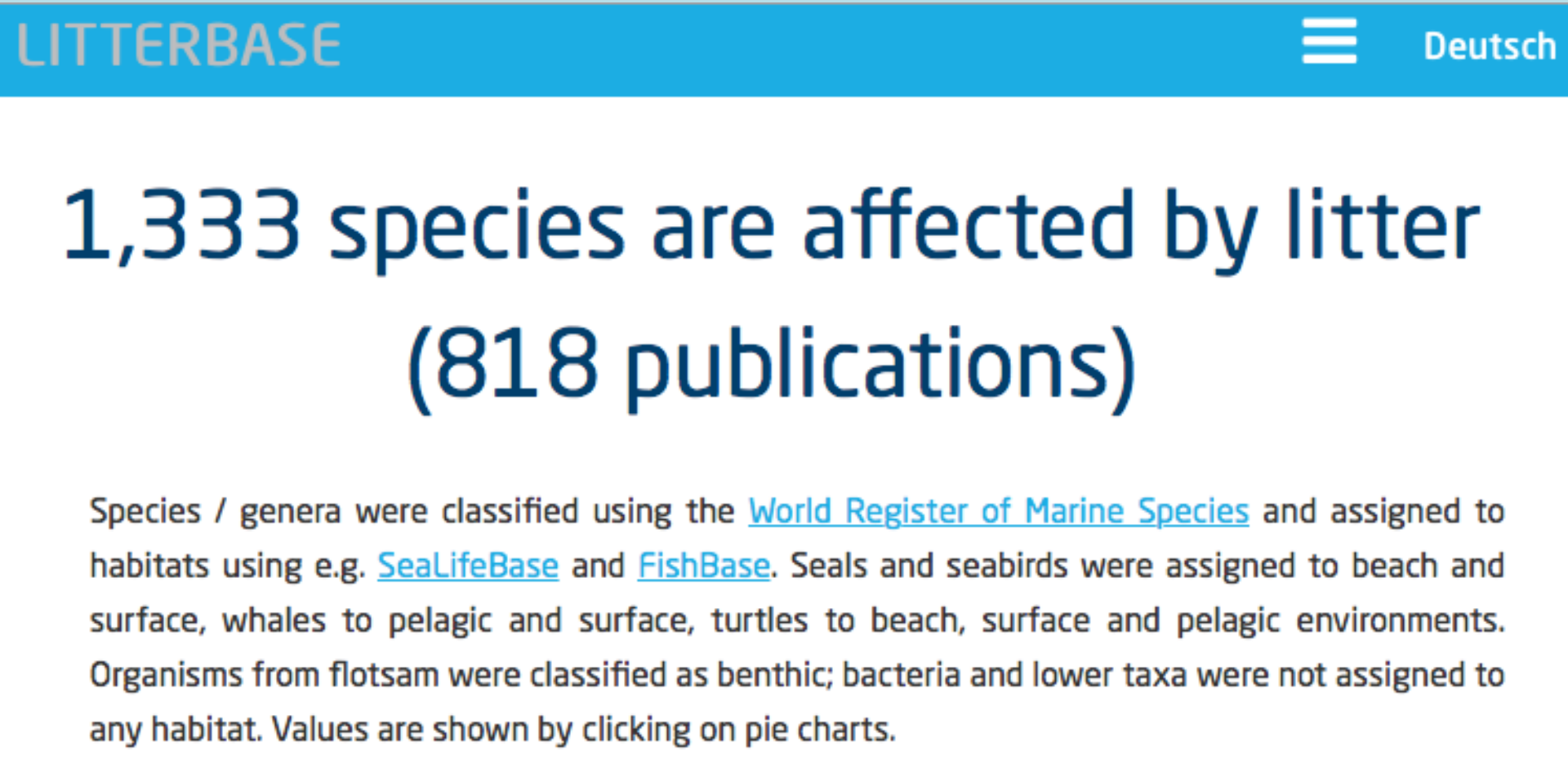

**SEA FLOOR**
70kg/ km² (94% of total)

*Peak concentration found in North Pacific gyre. Average concentration globally is <1kg per km²


Heineken


PLASTICS
IN THE
OCEAN
MICROPLASTICS
Microplastics are small plastics less than 5mm. They can come from large plastics breaking down, or can be produced as small plastics such as microbeads, which can be found in products such as toothpaste and face wash.
BOATS/NETS
Fishing gear can become marine debris when it is lost or abandoned.
INGESTION
Animals can easily mistake plastic debris for food.
ENTANGLEMENT
Marine life can get caught and killed in derelict fishing nets and other plastic debris.
RAIN & WINDS
Rain and wind can sweep debris into nearby waterbodies.
LITTERING
Intentional littering or improper disposal of trash can cause marine debris.
STREAMS & STORM DRAINS
Streams and storm drains can carry debris directly into the ocean or Great Lakes.
NOAA
https://marinedebris.noaa.gov/

# Marine Debris is a Global Issue



## References


Amorocho, D.F., Reina, R.D., 2007. Feeding ecology of the east Pacific green sea turtle *Chelonia mydas agassizii* at Gorgona National Park, Colombia. Endanger. Species Res. 3:43–51. http://dx.doi.org/10.3354/esr003043.

Ayres, M.A., Ayres-Jr, M., Ayres, D.L., Santos, A.A., 2007. BioEstat – Aplicações estatísticas nas áreas das ciências bio-médicas. Ong Mamirauá, Belém.

Balazs, G.H., 1985. Impact of ocean debris on marine turtles: entanglement and ingestion. Proceedings of the Workshop on the Fate and Impact of Marine Debris US National Oceanic and Atmospheric Administration (NOAA) Technical Memorandum 54. National Marine Fisheries Service, Honolulu, pp. 387–429.

Barnes, D.K.A., Galgani, F., Thompson, F.C., Barlaz, M., 2009. Accumulation and fragmentation of plastic debris in global environments. Philos. Trans. R. Soc. B 364:1985–1998. http://dx.doi.org/10.1098/rstb.2008.0205.

Baulch, S., Perry, C., 2014. Evaluating the impacts of marine debris on cetaceans. Mar. Pollut. Bull. 80:210–221. http://dx.doi.org/10.1016/j.marpolbul.2013.12.050.

Benedito, A.P.M., Awabdi, D.R., 2014. How marine debris ingestion differs among megafauna species in a tropical coastal area. Mar. Pollut. Bull. 88:86–90. http://dx.doi.org/10.1016/j.marpolbul.2014.09.020.

Bjorndal, K.A., 1979. Cellulose digestion and volatile fatty acid production in the green turtle, *Chelonia mydas*. Comp. Biochem. Physiol. A Physiol. 63:127–133. http://dx.doi.org/10.1016/0300-9629(79)90638-8.

Bjorndal, K.A., 1997. Foraging ecology and nutrition of sea turtles. In: Lutz, P.L. (Ed.), The Biology of Sea Turtles. CRC Press, Boca Raton, FL, pp. 199–231.

Bjorndal, K.A., Bolten, A.B., Lagueux, C.J., 1994. Ingestion of marine debris by juvenile sea turtles in coastal Florida habitats. Mar. Pollut. Bull. 28:154–158. http://dx.doi.org/10.1016/0025-326X(94)90391-3.

Bolten, A.B., 1999. Techniques for measuring sea turtles. In: Eckert, K.L., Bjorndal, K.A., Abreu-Grobois, F.A., Donnely, M. (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No Vol. 4, pp. 110–114.

Bugoni, L., Krause, L., Petry, M.V., 2001. Marine debris and human impacts on sea turtles in southern Brazil. Mar. Pollut. Bull. 41:1330–1334. http://dx.doi.org/10.1016/S0025-326X(01)00147-3.

Bugoni, L., Krause, L., Petry, M.V., 2003. Diet of sea turtles in southern Brazil. Chelonian Conserv. Biol. 4, 685–688.

Casale, P., Freggi, D., Paduano, D., Oliverio, M., 2016. Biases and best approaches for assessing debris ingestion in sea turtles, with a case study in the Mediterranean. Mar. Pollut. Bull. 110:238–249. http://dx.doi.org/10.1016/j.marpolbul.2016.06.057.

Ceppa, E.P., Fuh, K.C., Bulkley, G.B., 2003. Mesenteric hemodynamic response to circulatory shock. Curr. Opin. Crit. Care 9, 127–132.

Codina-García, M., Militão, T., Moreno, J., González-Solís, J., 2013. Plastic debris in Mediterranean seabirds. Mar. Pollut. Bull. 77:220–226. http://dx.doi.org/10.1016/j.marpolbul.2013.10.002.

Erlacher-Reid, A.C.D., Norton, T.M., Harms, C.A., Thompson, R., Reese, D.J., Walsh, M.T., Stamper, M.A., 2013. Intestinal and cloacal strictures in free- ranging and aquarium-maintained green sea turtles (*Chelonia mydas*). J. Zoo Wildl. Med. 44:408–429. http://dx.doi.org/10.1638/2012-0071R.1.

European Commission, 2013. Guidance on Monitoring of Marine Litter in European Seas. JRC Scientific and Policy Reports, Luxembourg (125 pp).

Faris, J., Hart, H., 1994. Sea of debris: a summary of the Third International Conference on Marine Debris. North Carolina Sea Grants College Program.

Fendall, L.S., Sewell, M.A., 2009. Contributing to marine pollution by washing your face. Microplastics in facial cleansers. Mar. Pollut. Bull. 58:1225–1228. http://dx.doi.org/10.1016/j.marpolbul.2009.04.025.

Ferreira, M.R.M.S., Garcia, M., Jupp, B.P., Al-Kilyumi, A., 2006. Diet of the green turtle (*Chelonia mydas*) at Ra's Al Hadd, Sultanate of Oman. Chelonian Conserv. Biol. 5:141–146. http://dx.doi.org/10.2744/1071-8443(2006)5[141:DOTGTC]2.0.CO;2.

Gall, S.C., Thompson, R.C., 2015. The impact of debris on marine life. Mar. Pollut. Bull. 92:170–179. http://dx.doi.org/10.1016/j.marpolbul.2014.12.041.

González-Carman, V., Botto, F., Gaitán, E., Albareda, D., Campagna, C., Mianzan, H., 2014a. A jellyfish diet for the herbivorous green turtle *Chelonia mydas* in the temperate SW Atlantic. Mar. Biol. 161:339–349. http://dx.doi.org/10.1007/s00227-013-2339-9.

González-Carman, V., Marcelo, A.E., Sara, M.M., Diego, A., Claudio, C., Hermes, M., 2014b. Young green turtles, *Chelonia mydas*, exposed to plastic in a frontal area of the SW Atlantic. Mar. Pollut. Bull. 78:56–75. http://dx.doi.org/10.1016/jmarpolbul.2013.11.012.

Goshe, L., Avens, L., Scharf, F.S., Southwood, A.L., 2010. Estimation of age at maturation and growth of Atlantic green turtles (*Chelonia mydas*) using skeletochronology. Mar. Biol. 157:1725–1740. http://dx.doi.org/10.1007/s00227-010-1446-0.

Gregory, M., 1996. Plastic 'scrubbers' in hand cleansers: a further (and minor) source for marine pollution identified. Mar. Pollut. Bull. 32:867–871. http://dx.doi.org/10.1016/S0025-326X(96)00047-1.

Guebert-Bartholo, F., Barletta, M., Costa, M.F., Monteiro-Filho, E.L.A., 2011. Using gut contents to assess foraging patterns of juvenile green turtles *Chelonia mydas* in the Paranaguá Estuary, Brazil. Endanger. Species Res. 13:131–143. http://dx.doi.org/10.3354/esr00320.

Hopewell, J., Dvorak, R., Kosior, E., 2009. Plastics recycling: challenges and opportunities. Philos. Trans. R. Soc. B 364:2115–2126. http://dx.doi.org/10.1098/rstb.2008.0311.

Ivar-do-Sul, J.A., Costa, M.F., 2007. Marine debris review for Latin America and the wider Caribbean region: from the 1970s until now, and where do we go from here? Mar. Pollut. Bull. 54:1087–1104. http://dx.doi.org/10.1016/j.marpolbul.2007.05.004.

Lemons, G., Lewison, R., Komoroske, L., Gaos, A., Lai, C.T., Dutton, P., Eguchi, T., Leroux, R., Seminoff, J.A., 2011. Trophic ecology of green sea turtle in a highly urbanized bay: insights from stable isotopes and mixing models. J. Exp. Mar. Biol. Ecol. 405:25–32. http://dx.doi.org/10.1016/j.jembe.2011.05.012.

Lusher, A.L., McHugh, M., Thompson, R.C., 2013. Occurrence of microplastics in the gastrointestinal tract of pelagic and demersal fish from the English Channel. Mar. Pollut. Bull. 67:94–99. http://dx.doi.org/10.1016/j.marpolbul.2012.11.028.

Magalhães, M.S., Freitas, M.L., Silva, N., Moura, C.E.B., 2010. Morfologia do tubo digestório da tartaruga verde (*Chelonia mydas*). Pesqui. Vet. Bras. 30:676–684. http://dx.doi.org/10.1590/S0100-736X2010000800012.

Magalhães, M.S., Santos, A.J.B., Silva, N.B., Moura, C.E.B., 2012. Anatomy of the digestive tube of sea turtles (Reptilia: Testudines). Zoologia 29:70–76. http://dx.doi.org/10.1590/S1984-46702012000100008.

Márquez, R., 1990. FAO species catalogue. Sea Turtles of the World, an Annotated and Illustrated Catalogue of Sea Turtles Known to Date. 11. FAO, Rome.

McCauley, S.J., Bjorndal, K., 1999. Conservation implications of dietary dilution from debris ingestion: sublethal effects in post-hatchling loggerhead sea turtles. Conserv. Biol. 13:925–929. http://dx.doi.org/10.1046/j.1523-1739.1999.98264.x.

Meylan, A.B., Meylan, P.A., 1999. Introduction to the evolution, life history, and biology of sea turtles. In: Eckert, K.L., Bjorndal, K.A., Abreu-Grobois, F.A., Donnelly, M. (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No Vol. 4, pp. 3–5.

Monteiro, D.S., Estima, S.C., Gandra, T.B., Silva, A.P., Bugoni, L., Swimmer, Y., Seminoff, J.A., Secchi, E.R., 2016. Long-term spatial and temporal patterns of sea turtle strandings in southern Brazil. Mar. Biol. 163:247. http://dx.doi.org/10.1007/s00227-016-3018-4.

Murray, F., Cowie, P.R., 2011. Plastic contamination in the decapod crustacean *Nephrops norvegicus* (Linnaeus, 1758). Mar. Pollut. Bull. 62:1207–1217. http://dx.doi.org/10.1016/j.marpolbul.2011.03.032.

Musick, J.A., Limpus, C.J., 1997. Habitat utilization and migration in juvenile sea turtles. In: Lutz, P.L., Musick, J.A. (Eds.), The Biology of Sea Turtles, Boca Raton, FL, pp. 137–164.

Nelms, S.E., Duncan, E.M., Broderick, A.C., Galloway, T.S., Godfrey, M.H., Hamann, M., Lindeque, P.K., Godley, B.J., 2016. Plastic and marine turtles: a review and call for research. ICES J. Mar. Sci. 73:165–181. http://dx.doi.org/10.1093/icesjms/fsv165.

Parks, D.A., Bulkley, G.B., Granger, D.N., 1983. Role of oxygen-derived free radicals in digestive tract diseases. Surgery 94, 415–422.

Plastics Europe, 2012. Plastics – The Facts 2012: An Analysis of European Plastics Production, Demand and Waste Data for 2011. Brussels, Belgium (36 pp).

Reisser, J., Proietti, M., Sazima, I., Kinas, P., Horta, P., Secchi, E., 2013. Feeding ecology of the green turtle (*Chelonia mydas*) at rocky reefs in western South Atlantic. Mar. Biol. 160:3169–3179. http://dx.doi.org/10.1007/s00227-013-2304-7.

Ryan, P.G., Moloney, C.L., 1993. Marine litter keeps increasing. Nature 361:23. http://dx.doi.org/10.1038/361023a0.

Santos, R.G., Andrades, R., Boldrini, M.A., Martins, A.S., 2015. Debris ingestion by juvenile marine turtles: an underestimated problem. Mar. Pollut. Bull. 93:37–43. http://dx.doi.org/10.1016/j.marpolbul.2015.02.022.

Schuyler, Q., Hardesty, B.D., Wilcox, C., Townsend, K., 2014a. Global analysis of anthropogenic debris ingestion by sea turtles. Conserv. Biol. 28:129–139. http://dx.doi.org/10.1111/cobi.12126.

Schuyler, Q., Wilcox, C., Townsend, K., Hardesty, B.D., Marshall, N.J., 2014b. Mistaken identity? Visual similarities of marine debris to natural prey items of sea turtles. BMC Ecol. 14:14. http://dx.doi.org/10.1186/1472-6785-14-14.

Shulman, A., Lutz, A., 1995. The effect of plastic ingestions on lipid metabolism in the green sea turtle (*Chelonia mydas*). NOAA technical memorandum no. 36, pp. 122–124.

Thompson, R.C., Moore, C.J., VomSaal, F.S., Swan, S.H., 2009. Plastics, the environment and human health: current consensus and future trends. Philos. Trans. R. Soc. B 364:2153–2166. http://dx.doi.org/10.1098/rstb.2009.0053.

Tourinho, P.S., Ivar-do-Sul, J.A., Fillmann, G., 2009. Is marine debris ingestion still a problem for the coastal marine biota of southern Brazil? Mar. Pollut. Bull. 60:396–401. http://dx.doi.org/10.1016/j.marpolbul.2009.10.013.

UNEP (United Nations Environment Programme), 2005. Marine Litter, an Analytical Overview. UNEP, Nairóbi (49 pp).

Vélez-Rubio, G.M., Estrades, A., Fallabrino, A., Tomás, J., 2013. Marine turtle threats in Uruguayan waters: insights from 12 years of stranding data. Mar. Biol. 160:2797–2811. http://dx.doi.org/10.1007/s00227-013-2272-y.

Walsh, M., 1999. Rehabilitation of sea turtles. In: Eckert, K.L., Bjorndal, K.A., Abreu-Grobois, F.A., Donnelly, M. (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No Vol. 4, pp. 202–207.

Wedemeyer-Strombel, K.R., George, S., James, H.B., Peterson, T.D., Wicksten, M.K., Plotkin, P.T., 2015. High frequency of occurrence of anthropogenic debris ingestion by sea turtles in the North Pacific Ocean. Mar. Biol. 162:2079–2091. http://dx.doi.org/10.1007/s00227-015-2738-1.

Work, T.M., 2000. Manual de necropsia de tortugas marinas para biólogos en refugios o areas remotas. National Wildlife Health Center, Hawaii Field Station (25 pp).

Wright, S.L., Rowe, D., Thompson, R.C., Galloway, T.S., 2013. Microplastic ingestion decreases energy reserves in marine worms. Curr. Biol. 23:1031–1033. http://dx.doi.org/10.1016/j.cub.2013.10.068.

Wyneken, J., 2001. The anatomy of sea turtles. NOAA Technical Memorandum NMFS-SEPSC-470, Miami (172 pp).

## Aquatic life affected by litter

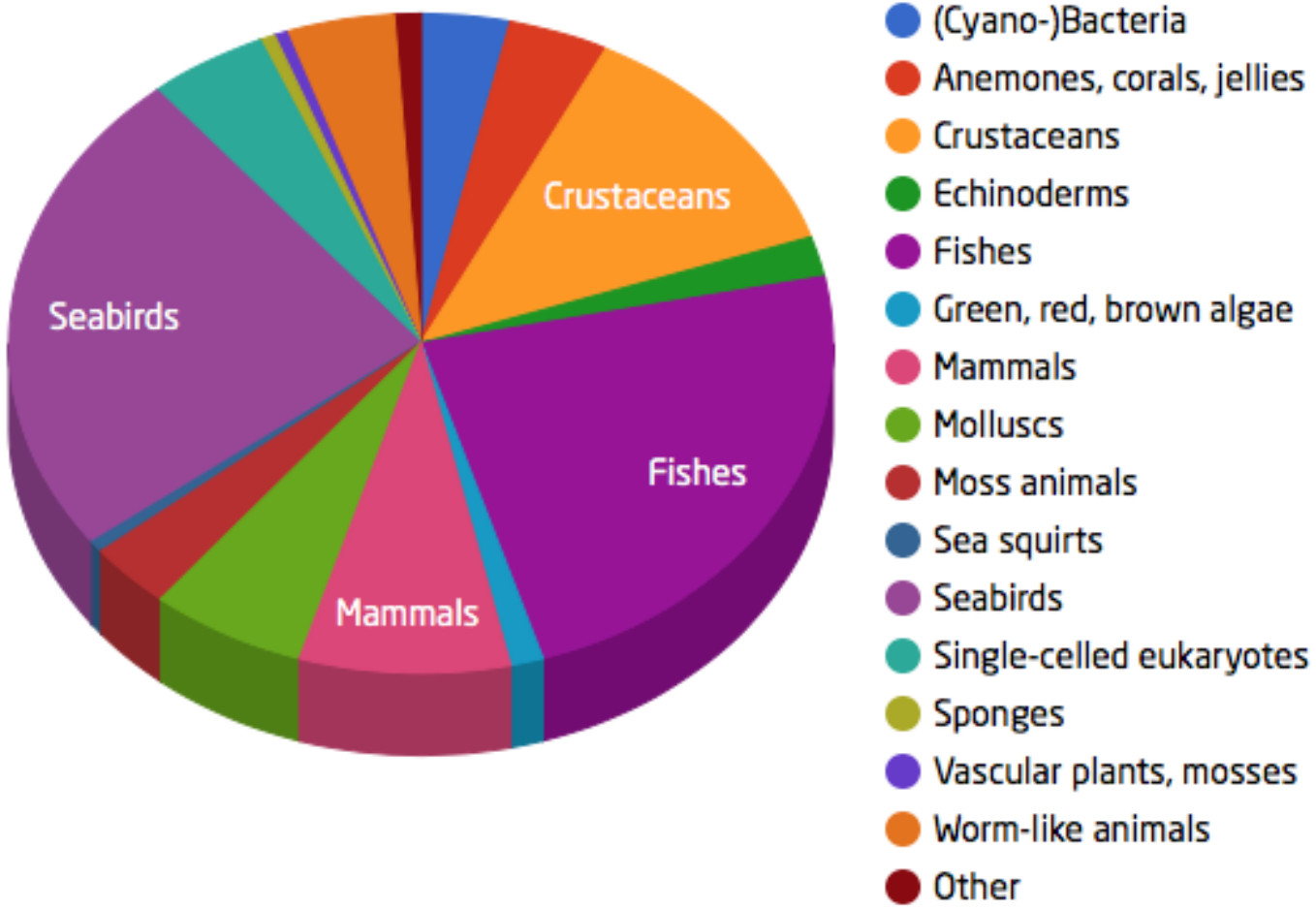
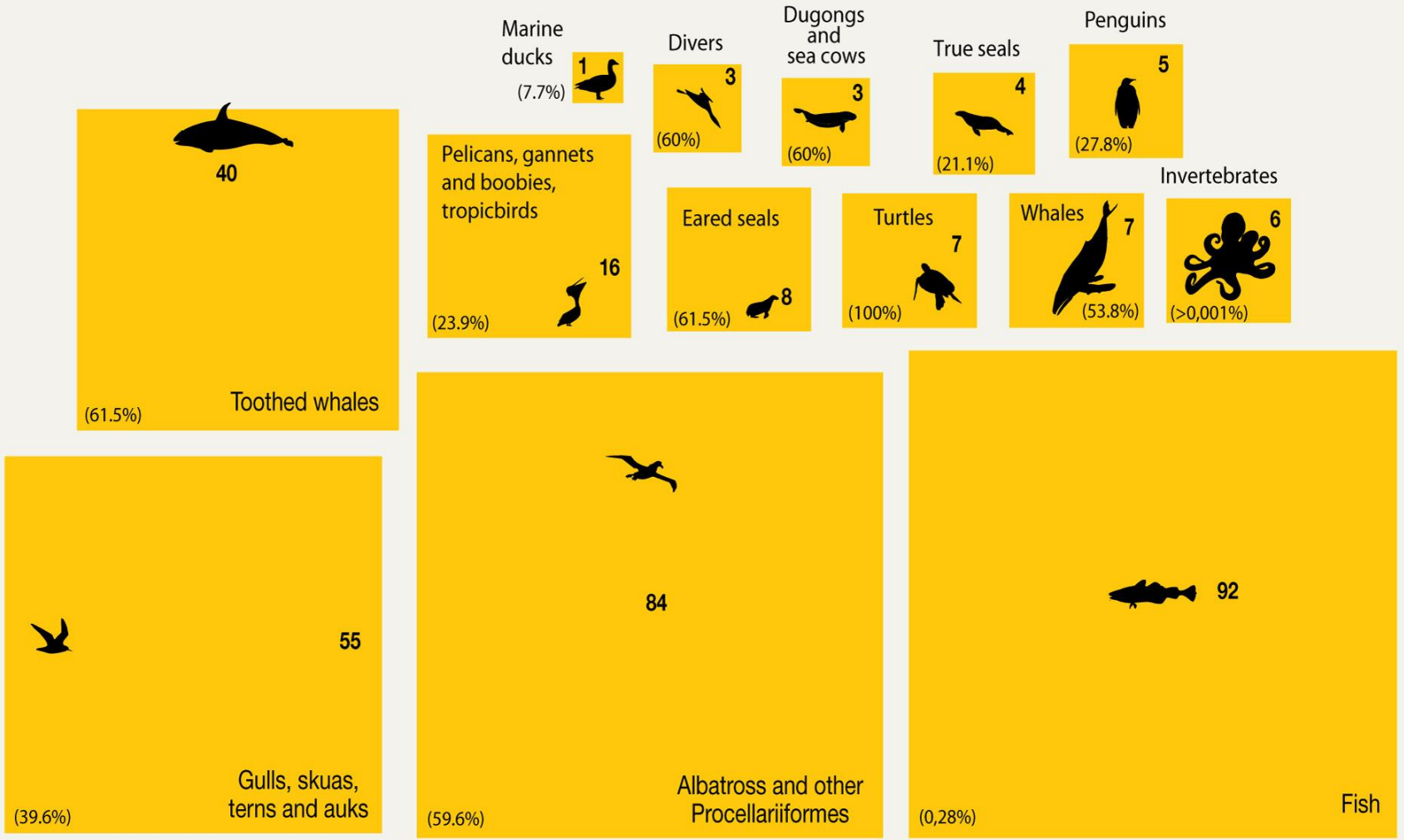


**Fig. 2.** Above are two examples of obstructions found in stomach of green sea turtles (*Chelonia mydas*) in southern Brazil, composed by compacted food material and anthropogenic solid debris. Obstructions could also be found in intestines. Faecalomas (below) are found in intestines only, also composed by food and plastics or other debris, but food is at a more advanced digestion stage and with a hardened consistency. Photos: CRAM archives.

# Plasticized animal species - Ingestion

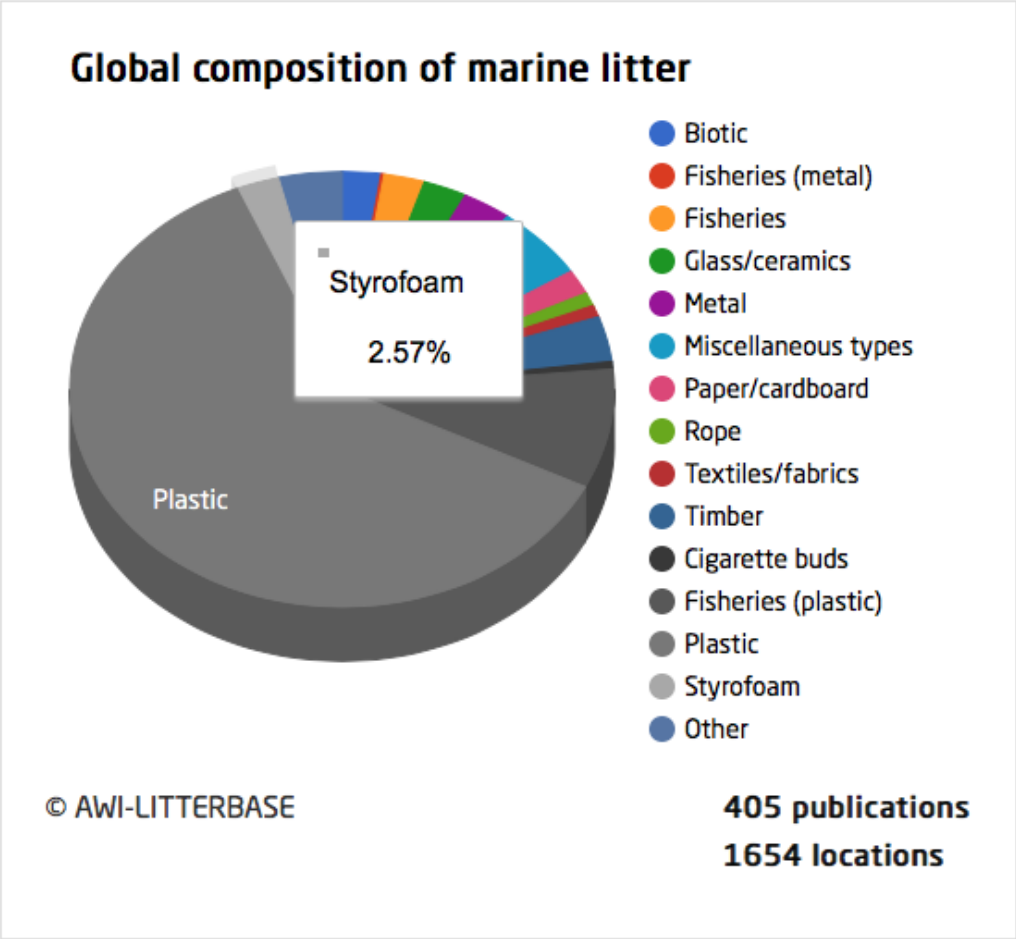
**Number of species with documented records of marine debris ingestion**

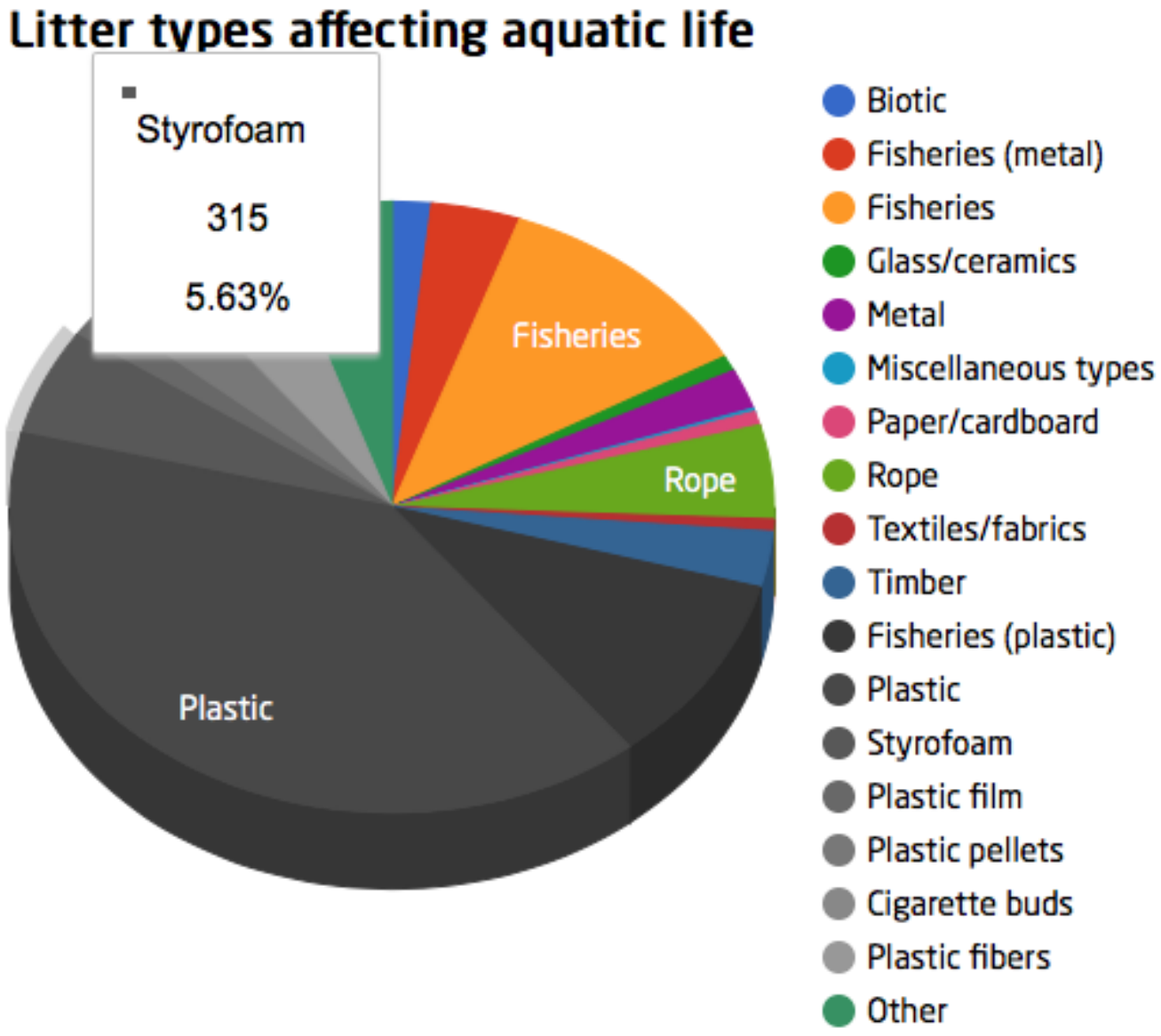



Source: Kühn, S., et al., Deleterious Effects of Litter on Marine Life, in Bergmann, M., et al., Marine Anthropogenic Litter, Springer, 2015

# Distribution of litter types in different realms (612 publications)

The proportion of different litter types contributing to the global composition was calculated as the weighted means from all considered studies, irrespective of units. Values are shown by clicking on pie charts.




Litter types affecting aquatic life
Styrofoam
315
5.63%
Fisheries
Rope
Plastic
Biotic
Fisheries (metal)
Fisheries
Glass/ceramics
Metal
Miscellaneous types
Paper/cardboard
Rope
Textiles/fabrics
Timber
Fisheries (plastic)
Plastic
Styrofoam
Plastic film
Plastic pellets
Cigarette buds
Plastic fibers
Other
© AWI-LITTERBASE

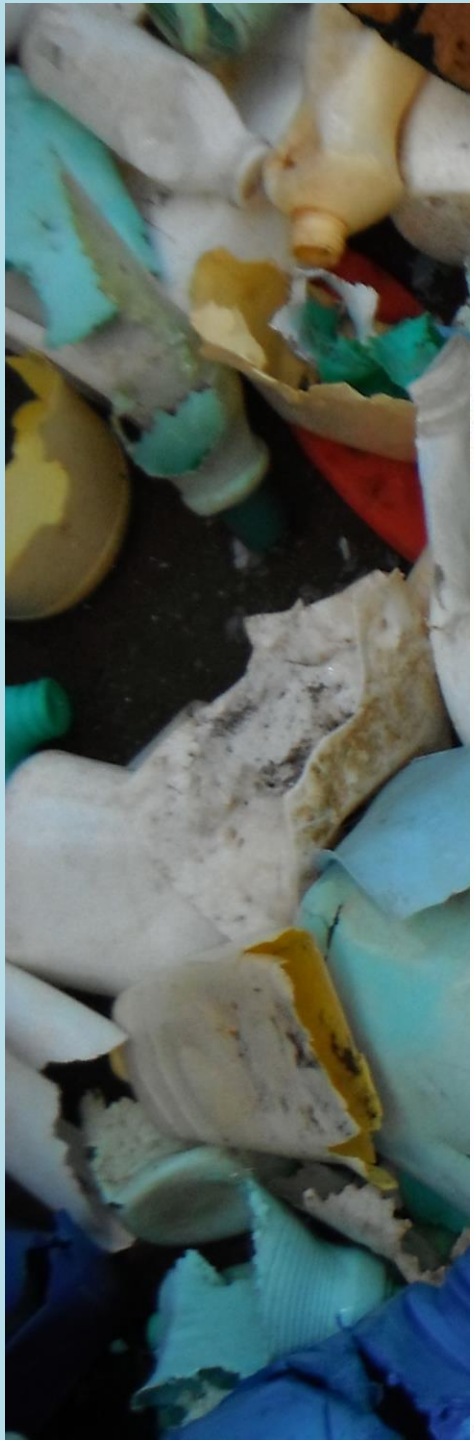


Photo credit:
Jorge Gamboa

# Global studies

## Alarming trends on plastic ingestion in loggerhead sea turtles, *Caretta caretta*, in the South West Indian Ocean

J. Dando*, C. Jean*, M. Barret* and S. Ciccione*

* Kelonia, The Observatory of marine turtles, 46 rue du General de Gaulle 97436 Saint-Leu, La Réunion, France. Email: joseph.dando@laposte.net Tel: (33) 652536370

### Context

Anthropogenic debris including plastic, discarded or lost in the marine environment, have become a critical issue in marine ecosystems worldwide, affecting a wide range of living organisms from zooplankton to megafauna, including sea turtles. The Marine Strategy Framework Directive (MSFD) identified *Caretta caretta* as an indicator to evaluate the good environmental status of European waters.

In the South-West Indian Ocean, Kelonia's care center has been surveying plastic ingestion in loggerheads sea turtles since 2007. Since 2015 the study has been adapted to the MSFD protocol to assess plastic debris ingestion in live and dead turtles.

### Methods

...ed from bycatch between 2007
...car and Reunion (Figure 1).
... ; mean weight : 44.9 kg ± 11 kg
...d from fecal excretions within
... care center, or during necropsy

...ured according to the MSFD
...ected, counted, categorized by
...weighed and measured (longest

...en compared to individual data
...r database: biometry, date and


Figure 1: Distribution of loggerhead bycatch between 2007 and 2016.

### Results

...(Min=18.5; Max=84)
...1 (Min=0.96; Max=74)
...ads had ingested marine debris

... debris consisted in plastic items.
...ngested debris available (N=108):
...astic debris: **48.8** ± 52.8 (Min=1;

...ic debris: **19.2 g** ± 18.7 (Min=0.14;

...ic debris: **28.5 mm** ± 40.7 (Min=5;

...acteristics
... around **1 or 2 cm** (Figure 2). Most
...ken by the turtle jaws or through
...tany hard plastic debris could be
...ed.

...Maximal debris length (mm)
...e plastics rejected by the turtles since 2007.

**No correlation between** turtle biometric characteristics **(ICC) and the weight of ingested plastic ($R^2$=0,00714)**. Predominance of **hard fragments** and **white plastics**: 90% and 43% of the total weight respectively (Figures 3 and 4).

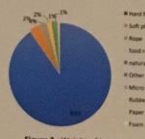



Figure 3 : Weight of ingested plastics by category.


Figure 4 : Weight of ingested plastics by color.

These results could be related to debris availability in the ocean (mostly white and hard) and also produced worldwide. Unless they reflects a selection according to these characteristics.

#### Evolution of plastic ingestion

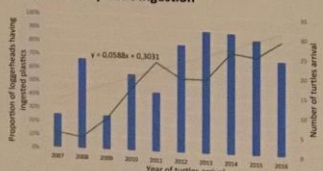



Figure 5: Occurrence frequency of plastic ingestion over time in loggerhead turtles rescued in Reunion.

Increasing plastic ingestion: approximately **1,6g/year**. Increasing occurrence frequency of plastic ingestion: **6%/year** (Figure 5) (= proportion of turtles having ingested plastic).

**Seasonal variations** were also observed:

➢ **Ingestion rate** of plastic debris

May and September show a greater proportion of turtles having ingested plastics (Figure 6). The variation in fishing activities location does not explain these variations.

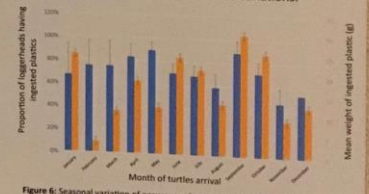



Figure 6: Seasonal variation of occurrence frequency and mean weight of plastic ingestion by loggerhead turtles rescued in Reunion between 2007 and 2016.

➢ **Mean weight** of ingested debris

The high ingestion rate in September showed an important quantity of plastic debris ingested (Figure 6). However, this is not the case in May. We cannot conclude that May and September are months during which the availability of plastic in oceanic currents is more important. It is likely that these variations are due to turtle nutritional needs variation along the year.

February revealed particularly low weights of plastic ingested.

### Conclusion

...rescued at Kelonia's care center ingested significantly more plastic debris each year, which is consistent with the increasing trend of global plastic production and ...ssing this issue requires a systemic approach of the plastic pollution problem, and not only the « turtle » point of view. However, these results, even if their ...n hypothesis stage, can bring real improvements in loggerhead ecology:
... their nutritional needs should be further studied;
...al impact of plastic debris could lead to a better knowledge of loggerheads health.



## MARINE DEBRIS INGESTION BY GREEN TURTLES (*Chelonia mydas*) IN NORTHERN PERU

Astrid Jiménez Heredia[1], Sergio Pingo Paiva[1], Joanna Alfaro-Shigueto[1,2,3], Jeffrey C. Mangel[1,2]

1. ProDelphinus, 2. University of Exeter, 3. Universidad Cientifica del Sur, Lima - Peru

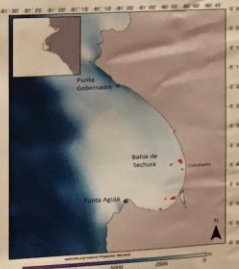
krolina.20@hotmail.com, astrid@prodelphinus.org

### 1. INTRODUCTION

- Plastics are a major contaminant of the marine environment, representing a serious threat to ocean wildlife and their ingestion has been widely reported over the last decades.
- Debris ingestion can have lethal outcomes either through the impaction or perforation of the alimentary system, but it can also have sublethal impacts.
- Sea turtles, like many other marine taxa, are increasingly prone to marine debris ingestion (e.g. plastic bags, packing, fishing gear) and associated problems, possible mistaken for prey items.

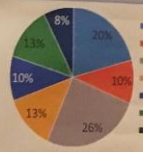
### 2. MATERIALS AND METHODS

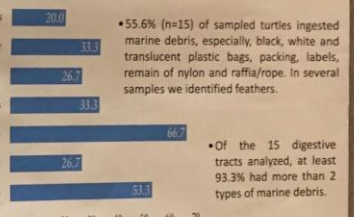
- We collected stomach contents from dead green turtles (*Chelonia mydas*), caught incidentally in the artisanal net fishery operating in Sechura Bay.
- Data were collected from July 2013 to June 2014.
- For all types of marine debris consumed, we estimated the Frequency of Occurrence (%FO).




### 3. RESULTS

- 27 digestive tracts of *C. mydas* were examined.
- Turtles sampled included 86.7% juveniles and 13.3% subadults (LCC: 52.7 ± 1.8 cm; range: 40.5 to 66.5 cm).




- 55.6% (n=15) of sampled turtles ingested marine debris, especially, black, white and translucent plastic bags, packing, labels, remain of nylon and raffia/rope. In several samples we identified feathers.
- Of the 15 digestive tracts analyzed, at least 93.3% had more than 2 types of marine debris.
- Transparent bags had the highest frequency of occurrence (n = 10, FO = 66.7%), while additional items had the lowest FO value (n = 3, FO = 20%).

### 4. CONCLUSIONS AND RECOMMENDATIONS

- This study highlights the high frequency of plastic items as part of the diet of green turtles in Sechura Bay.
- We recommend that future work in Sechura include recommendations for better management of waste from anthropogenic activities (e.g. local commerce, fisheries), and include green turtles as a sentinel species for monitoring marine pollution in the bay.

### ACKNOWLEDGEMENTS

This work was supported by NOAA-Pacific Islands Regional Office, NOAA-Pacific Islands Fisheries Science Center, Darwin Initiative, National Fish and Wildlife Foundation, University of Exeter and ProDelphinus.

Attendance to the Symposium was possible through the support of the Shared Earth Foundation, Disney's Animals, Science and Environment, International Seafood Sustainability Foundation, Sirtrack & Lotek, George Balazs, Frank Paladino, CLS America, International Sea Turtle Society and ProDelphinus.

# Where does our debris come from?

## Our friendly neighbor islands!

# “Slipper Island”, O‘ahu

Photo credit: Matt Bickel

# “Slipper Island”, O‘ahu

**Photo credit: Matt Bickel**


North
Pacific
Subtropical
Gyre
PACIFIC
OCEAN
Aleutian Islands
Midway
(U.S.)
Hawaiian Islands
Honolulu
HAWAII
(U.S.)
Anchorage
Whitehorse
Juneau
Seattle
Portland
San Francisco
Los Angeles
San Diego
Tijuana
Las Vegas
Salt Lake

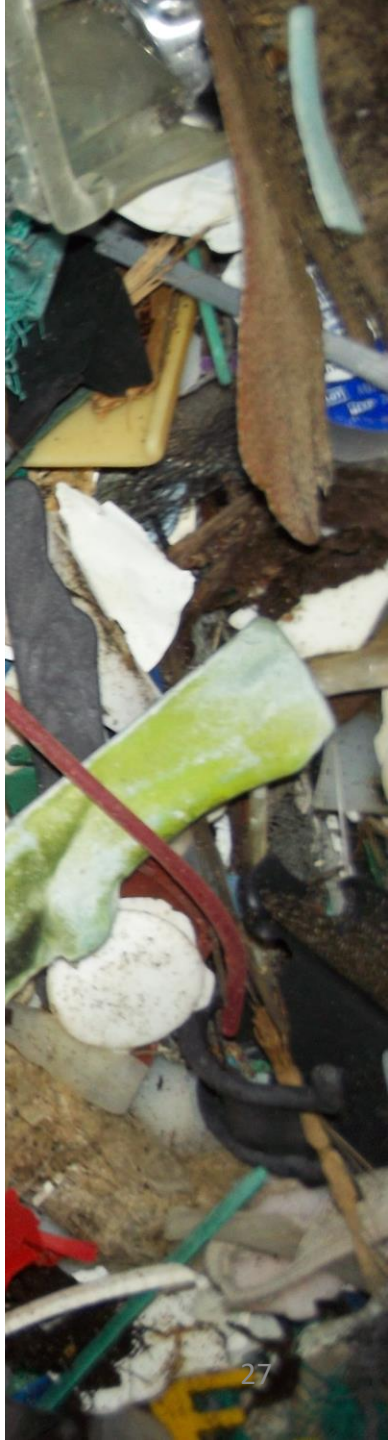
# Data Summary from Ka'ehu Cleanups


Turtles don't want to nest amongst trash...
Please help us clean Ka'ehu, Waiehu!
4th Sunday of every month (9am-noon)
SHARKASTICS
TAKING A BITE OUT OF MARINE DEBRIS
WWW.SHARKASTICS.ORG


"Hey, please pick up your rubbish- this stuff is dangerous to us!"
~C~King

# Mahalo to all who've helped!

| SHARKastics Marine Debris | Weather: | | | # of Bags: | |
|---|---|---|---|---|---|
| Location: Ka'ehu | Vols: | Date: | | Pounds: | |
| **PLASTICS** | **# of pieces** | **TOTAL** | | **# of pieces** | **TOTAL** |
| FOAM fragments: | foam food-related: | | insulation/packaging: | buoys: | |
| Plastic fragments (hard) | | | | | |
| Plastic fragments (film) | | | | | |
| Food wrappers: | | | Food packaging: | | |
| Beverage bottles | | | **GLASS** | **# of pieces** | **TOTAL** |
| Cleaning bottles: | oil bottles: | | Beer or other bottles: | wine bottles: | |
| Fishing containers/packaging: | | | Jars | | |
| Bottle or container caps/lids | | | Glass fragments | | |
| Cigarettes/filters/cigars: | cigar tips: | | *Fiberglass pieces* | | |
| Cigarette lighters | | | *Other- lightbulb* | | |
| 6 pack rings | | | *Other- ceramics* | | |
| Bags | | | ***TOTAL All Glass*** | | |
| Plastic rope/small net pieces | | | **Rubber** | **# of pieces** | **TOTAL** |
| Buoys and floats | | | Flip-flops/slippers | | |
| Fishing lures: | line: | | Gloves | | |
| Cups: | plates: | | Tires | | |
| Plastic utensils | | | Rubber fragments | | |
| Straws | | | *Auto parts* | | |
| Balloons: | ribbons: | | *Rubber toys (tennis balls)* | | |
| Sanitary: Diapers: | 1st Aid: Pers.Care: | | ***TOTAL All Rubber*** | | |
| *Toothbrushes* | | | **Processed Lumber** | **# of pieces** | **TOTAL** |
| *Combs/brushes* | | | Cardboard cartons | | |
| ***:^^SHARKASTICS^^:*** | | | Paper and cardboard | | |
| *Oyster spacer Small* | | | Paper bags | | |
| *Oyster spacer Large* | | | Lumber/building material | | |
| *Hagfish traps* | | | ***TOTAL All Lumber*** | | |
| *Strapping bands* | | | **Cloth/Fabric** | **# of pieces** | **TOTAL** |
| *Weed whacker pieces* | | | Clothing (including hats) | | |
| *Zipties* | | | Shoes (non rubber) | | |
| *Irrigation tubing/parts (pvc too)* | | | Gloves (non-rubber) | | |
| *Toys (plastic only)* | | | Towels/rags | | |
| *Firecracker remnants* | | | Rope/net (non-nylon) | | |
| *Duct tape pieces* | | | Fabric pieces | | |
| *Golf balls* | | | *Carpet pieces:* | *padding:* | |
| *Christmas tree parts/ornaments* | | | *Linoleum* | | |
| *Pens/markers/pencils* | | | *Vinyl pieces* | | |
| *Melted plastic* | | | ***TOTAL All Cloth/Fabric*** | | |
| *Snorkel/dive/surf/kayak/camping gear* | | | **Metal** | **# of pieces** | **TOTAL** |
| *DVD/cd/cassette/records* | | | Aluminum cans: | food tins: | |
| *Spools* | | | Aerosol cans: | roofing: | |
| *Popsicle sticks* | | | Metal fragments | | |
| *Shotgun shells* | | | *Auto parts* | | |
| *Lightsticks* | | | *Bottle caps* | | |
| *Gardening pots/trays* | | | *Batteries* | | |
| *Crates/trays:* | *large drums/jugs:* | | *Fishing pole/gear* | | |
| *Auto parts* | | | *Wire, stakes & pipes* | | |
| *Shipping Tags* | | | *Foil* | | |
| *Drug:* | *personal stuff:* *pet stuff:* | | ***TOTAL All Metals*** | | |
| *Misc. household items* | | | **GRAND TOTAL ITEMS** | | |
| ***TOTAL All Plastics*** | | | | | |
| **Large debris or labeled items** | **Description** | **Width(m)** | **Length (meters)** | **Status** | **Pix** |
| | | | | | |

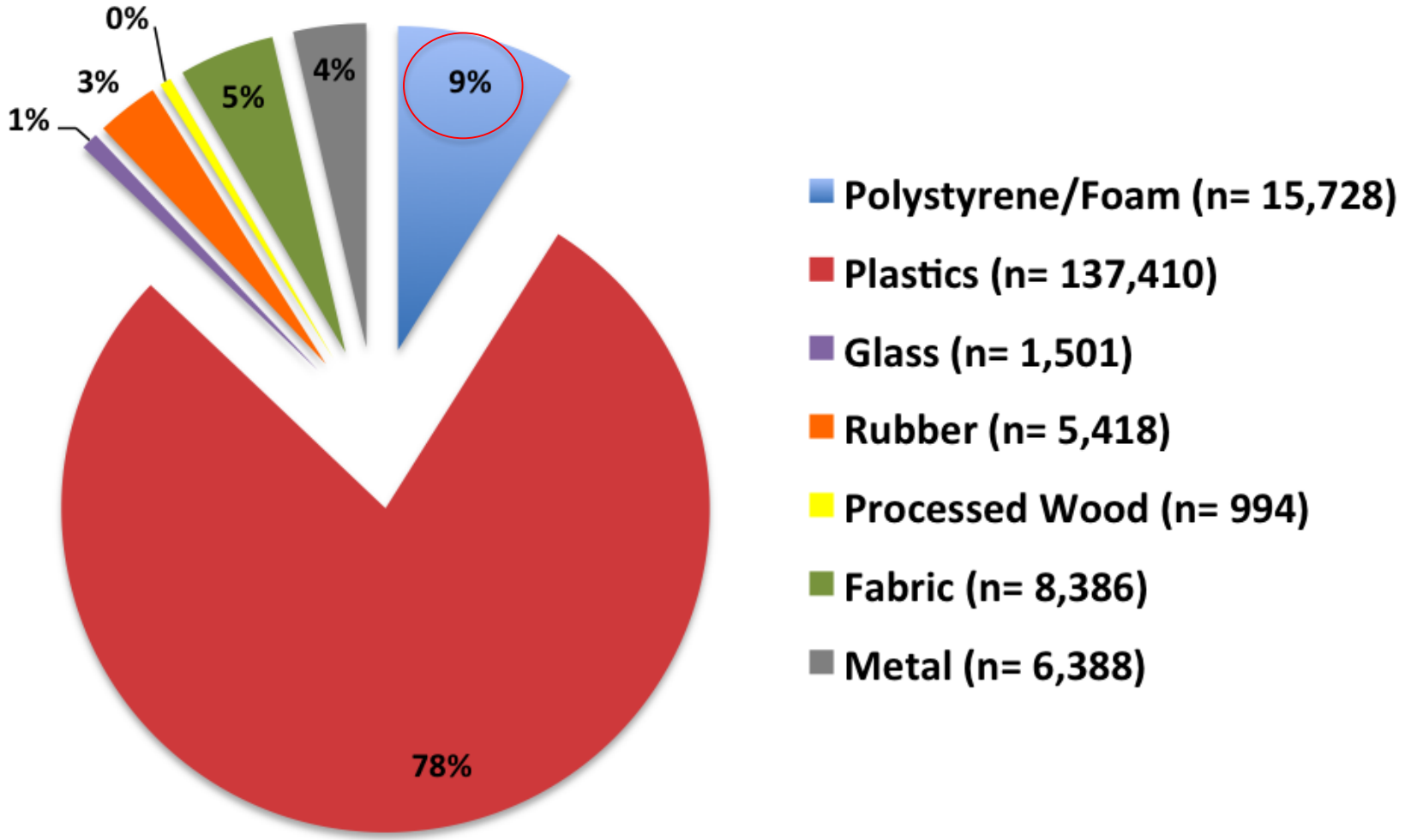



**Polystyrene Data Summary from Ka'ehu Cleanups**
May 2, 2017

We spearhead community-based marine debris cleanups on the 4th Sunday of every month at Ka'ehu, in Waiehu, to help restore this important habitat for the marine and terrestrial resources that utilize this special place. Marine debris is removed from a ~100 to 200 yard stretch of this rocky/sandy coast. The effort varies depending on the participants, not due to the shortage of marine debris- it's always washing ashore! It comes from all over the Pacific Ocean and from Hawai'i-based sources. To bring this global issue into context with this Maui County polystyrene reduction bill, here are some numbers to quantify this pollution problem we're dealing with:

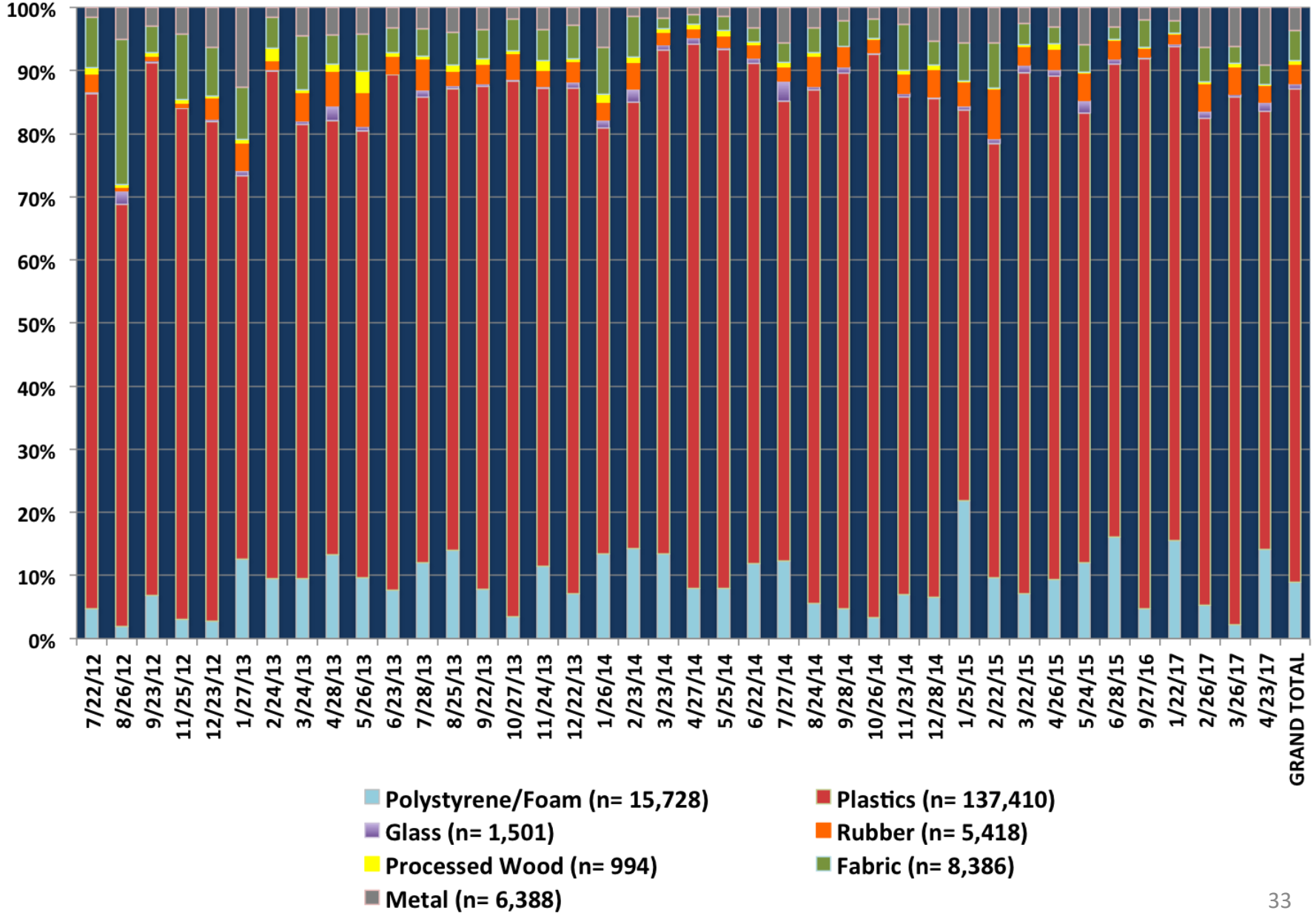
In addition to simply removing the debris from this coast every month, we also sorted and counted each piece of marine debris at our monthly cleanups from July 22, 2012 through June 28, 2015, on September 27, 2016 ("Get the Drift and Bag It" campaign), and 4 months in 2017 so far: January through April. This process is very time consuming with all of our specific categories we're analyzing, but collecting data during 40 out of the 56 monthly cleanups yielded:

# Marine Debris Items Collected from 40 Ka'ehu Cleanups (2012-2017)




Total # of pieces of marine debris collected/analyzed (in 40 out of the 54 cleanups): **175,825**!

# Daily Percentages of Marine Debris Items Removed from Ka'ehu (2012-2017 Cleanups)



Marine Pollution Bulletin 105 (2016) 292–298

Contents lists available at ScienceDirect

Marine Pollution Bulletin

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

# Trends and drivers of debris accumulation on Maui shorelines: Implications for local mitigation strategies

Lauren C. Blickley *, Jens J. Currie, Gregory D. Kaufman

**Monthly and daily accumulation surveys at three sites using NOAA marine debris shoreline survey methodologies…**

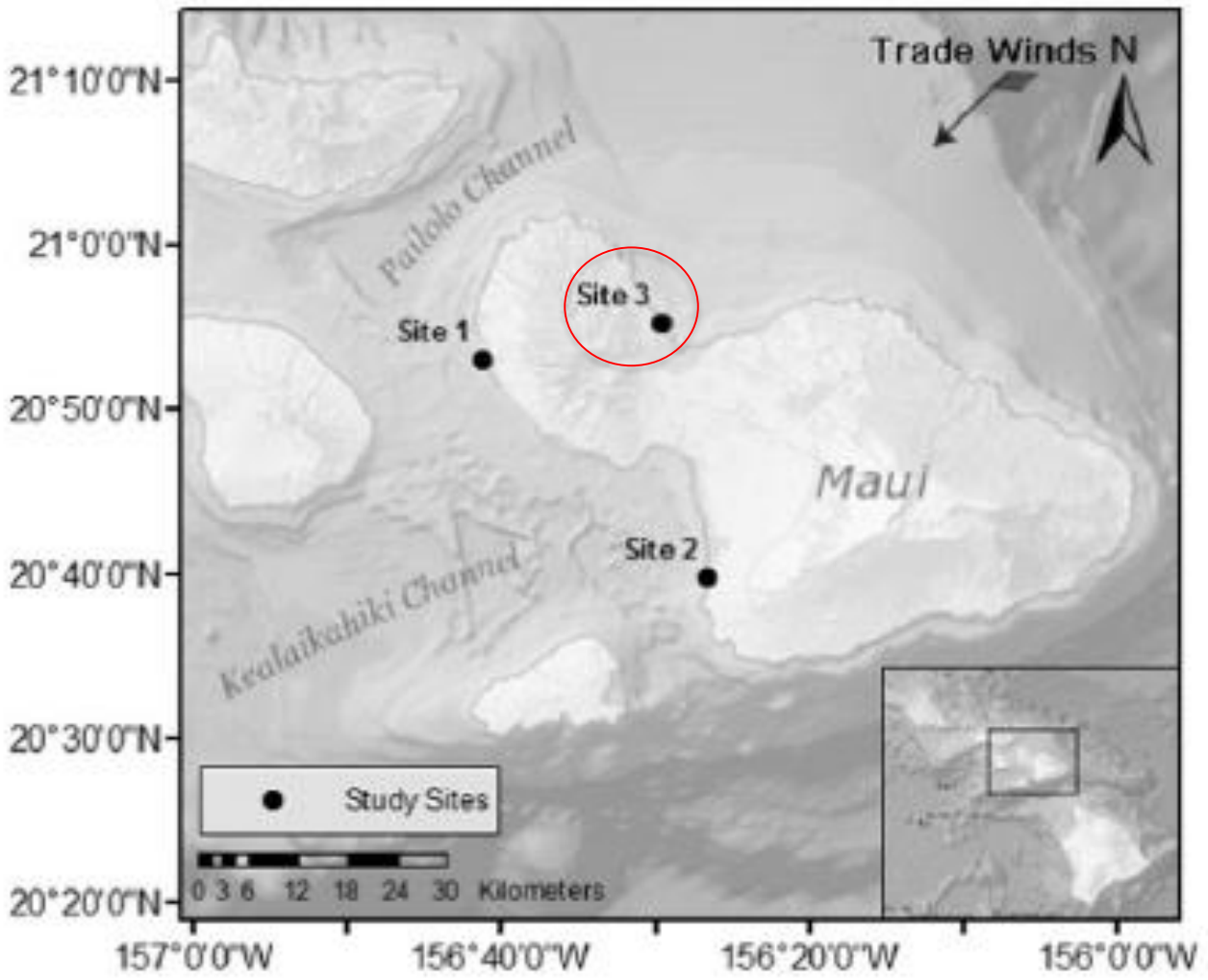



**Fig. 1.** Map showing the direction of prevailing trade winds and location of the three study sites on Maui. Site 1 = Pu'unoa Beach; Site 2 = Po'olenalena Beach; Site 3 = Lower Waiehu Beach.

**Percentages of the total debris items collected that were foam:**

**Site 1= 3.45%**

**Site 2= 7.42%**

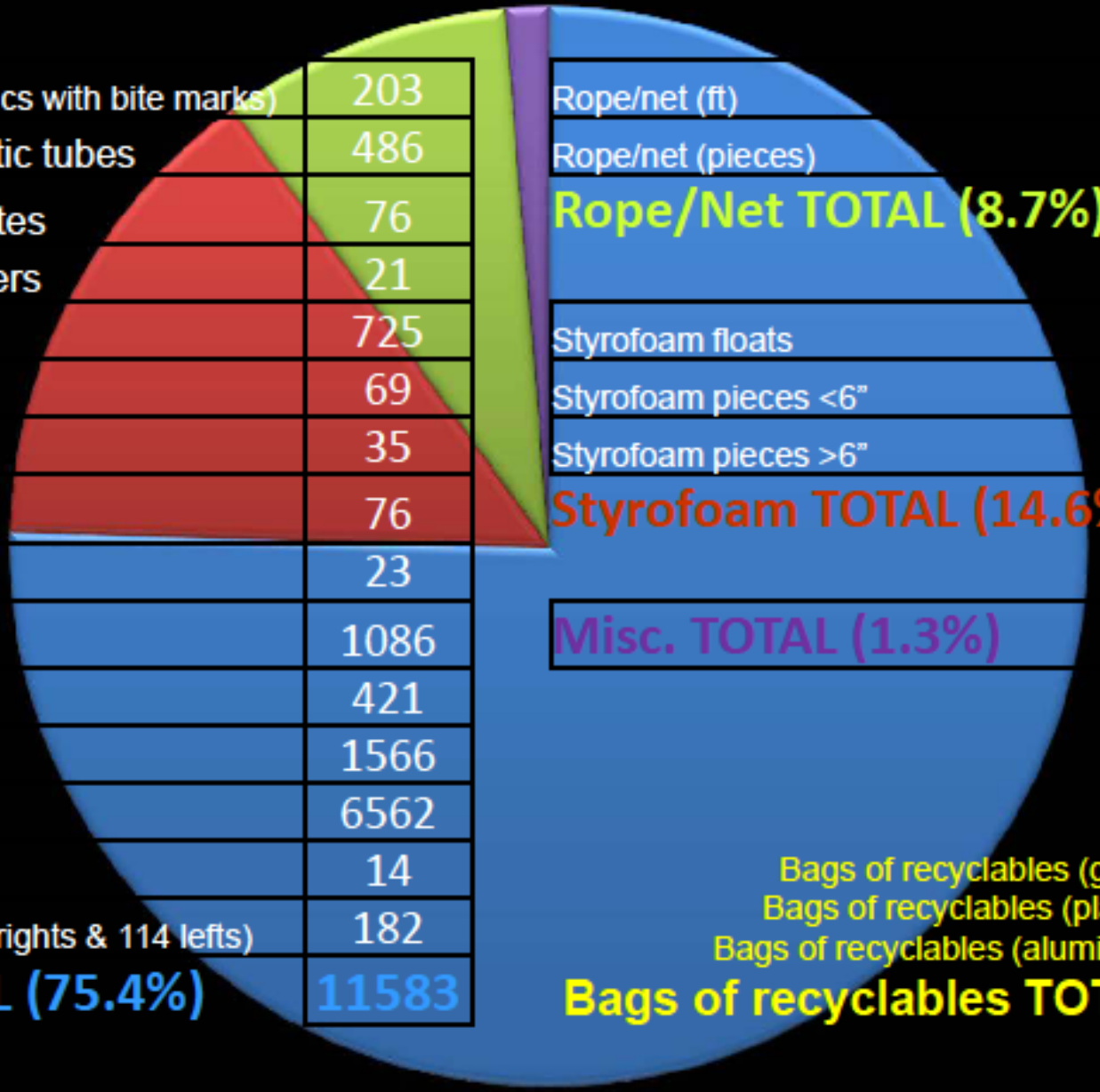
**Site 3= 7.82%**

# Kanapou Bay, Kaho‘olawe



Kanapou Debris Re-accumulation


# Marine Debris Data from Sept 25th, 2010 Kanapou Cleanup (~1/2 acre)

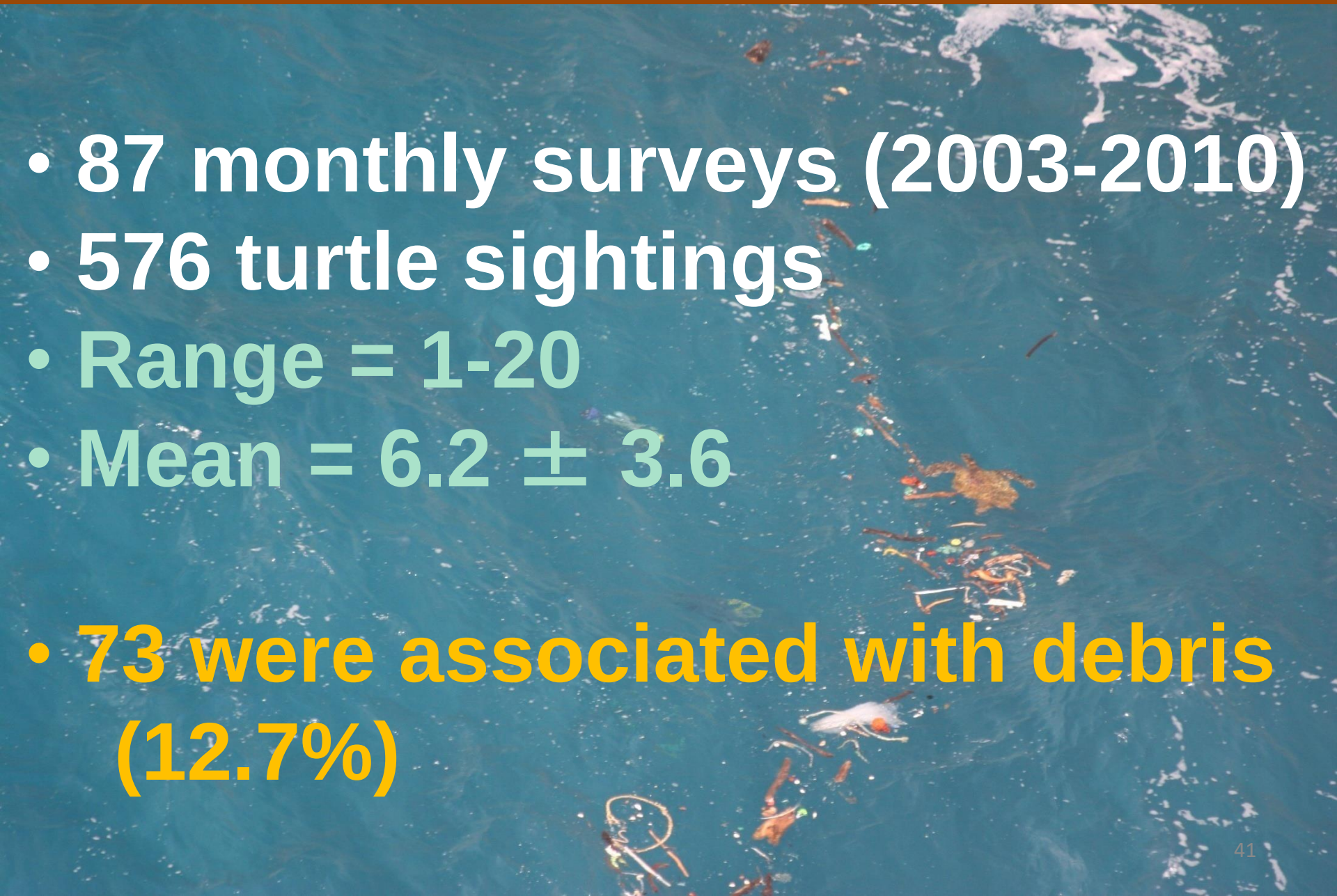


| | |
|---|---|
| "Sharkastics" (plastics with bite marks) | 203 |
| Oyster fishery plastic tubes | 486 |
| Plastic baskets/crates | 76 |
| Fishing lures/bobbers | 21 |
| Hagfish traps | 725 |
| Plastic buoys | 69 |
| Lighters | 35 |
| Toys | 76 |
| Toothbrushes | 23 |
| Plastic bottles | 1086 |
| Plastic caps/lids | 421 |
| Plastic pieces <6" | 1566 |
| Plastic pieces >6" | 6562 |
| Snorkel/dive fins | 14 |
| Shoes/slippers (68 rights & 114 lefts) | 182 |
| **Plastics TOTAL (75.4%)** | **11583** |

| | |
|---|---|
| Rope/net (ft) | 804 |
| Rope/net (pieces) | 529 |
| **Rope/Net TOTAL (8.7%)** | **1333** |
| Styrofoam floats | 323 |
| Styrofoam pieces <6" | 826 |
| Styrofoam pieces >6" | 1090 |
| **Styrofoam TOTAL (14.6%)** | **2239** |
| **Misc. TOTAL (1.3%)** | **~200** |

| | |
|---|---|
| Bags of recyclables (glass) | 2 |
| Bags of recyclables (plastic) | 13 |
| Bags of recyclables (aluminum) | 2 |
| **Bags of recyclables TOTAL** | **17** |

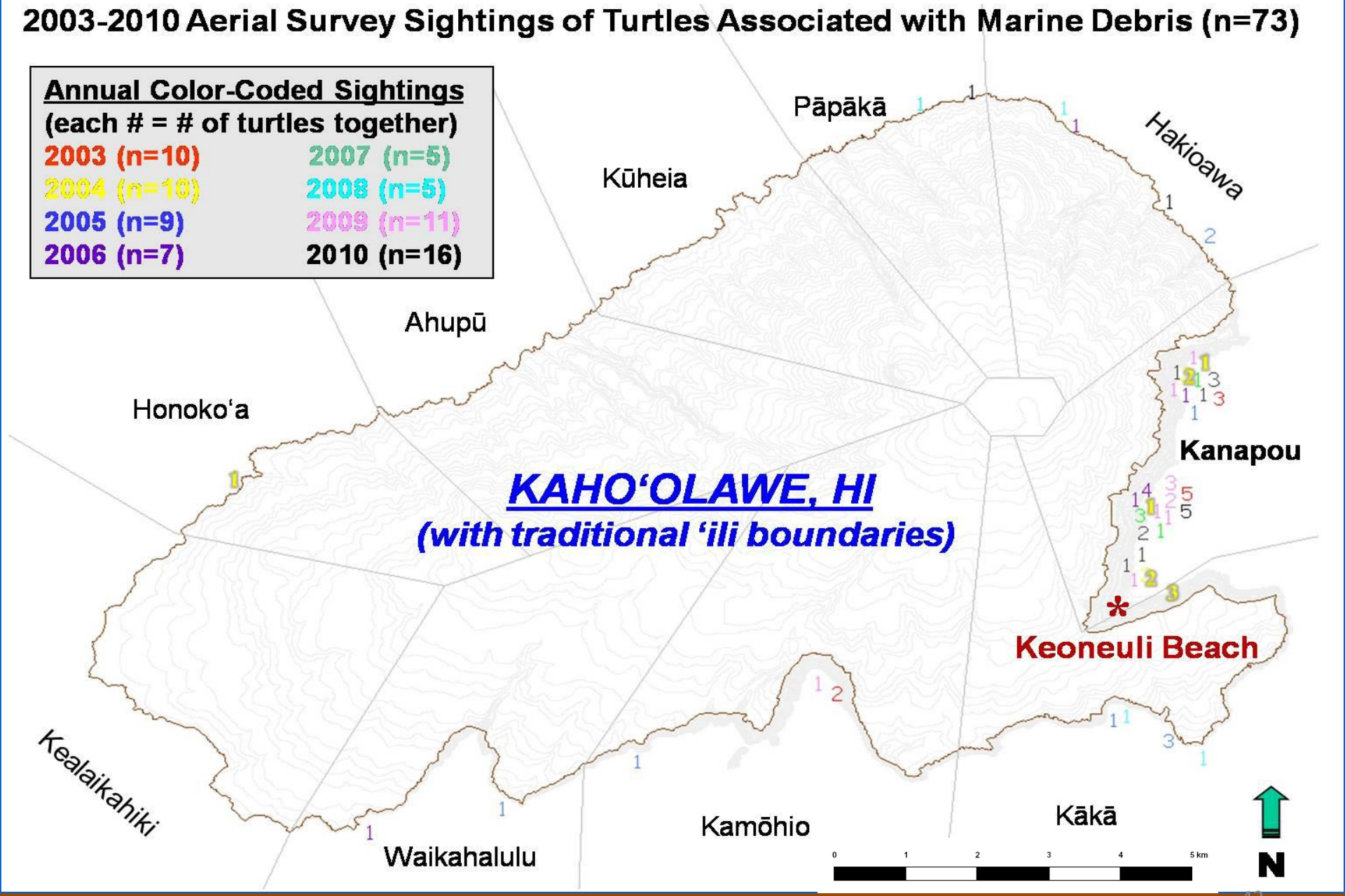
# Aerial Circumnavigation Surveys



- 87 monthly surveys (2003-2010)
- 576 turtle sightings
- Range = 1-20
- Mean = 6.2 ± 3.6

- 73 were associated with debris (12.7%)

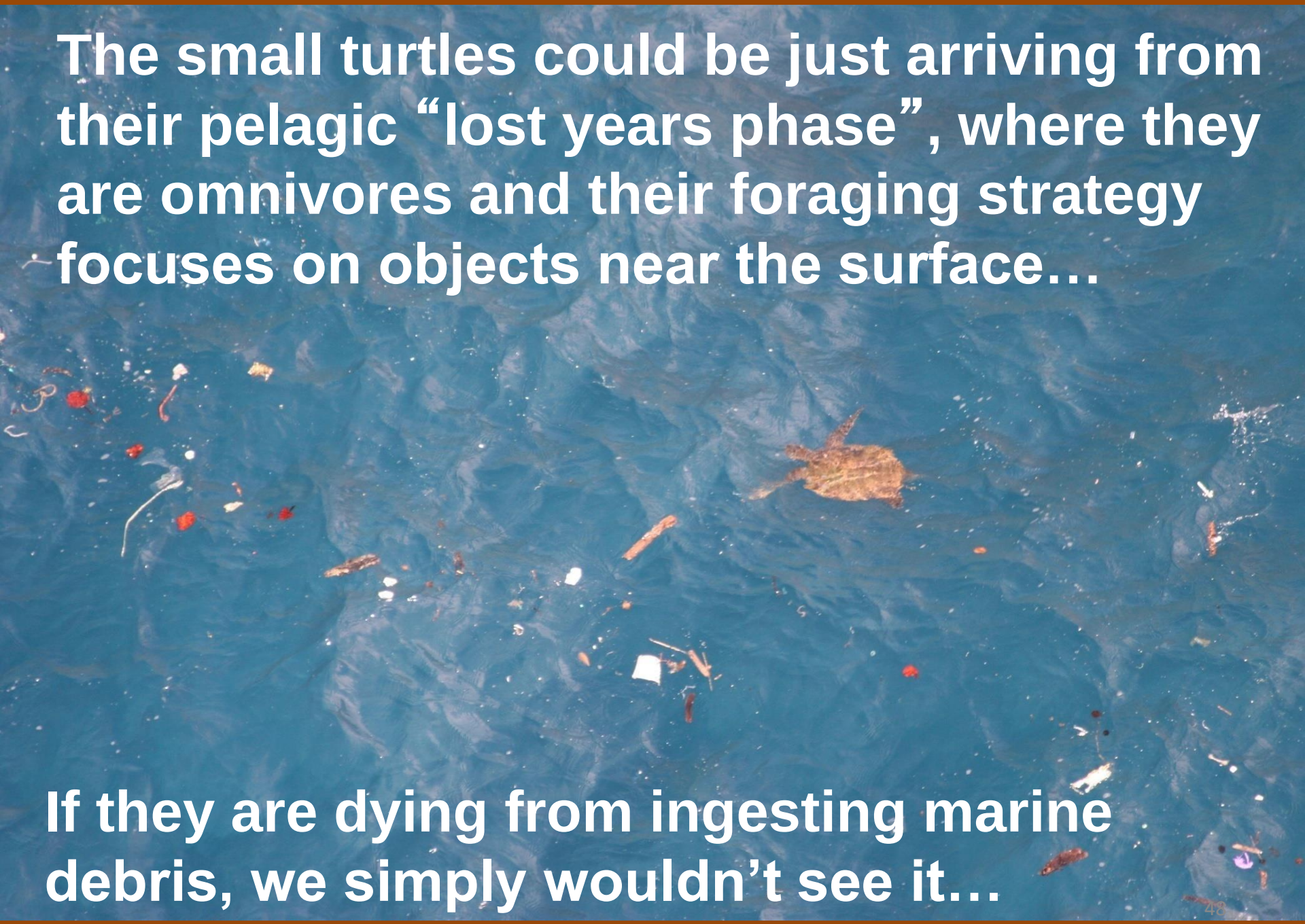
# 2003-2010 Aerial Survey Sightings of Turtles Associated with Marine Debris (n=73)

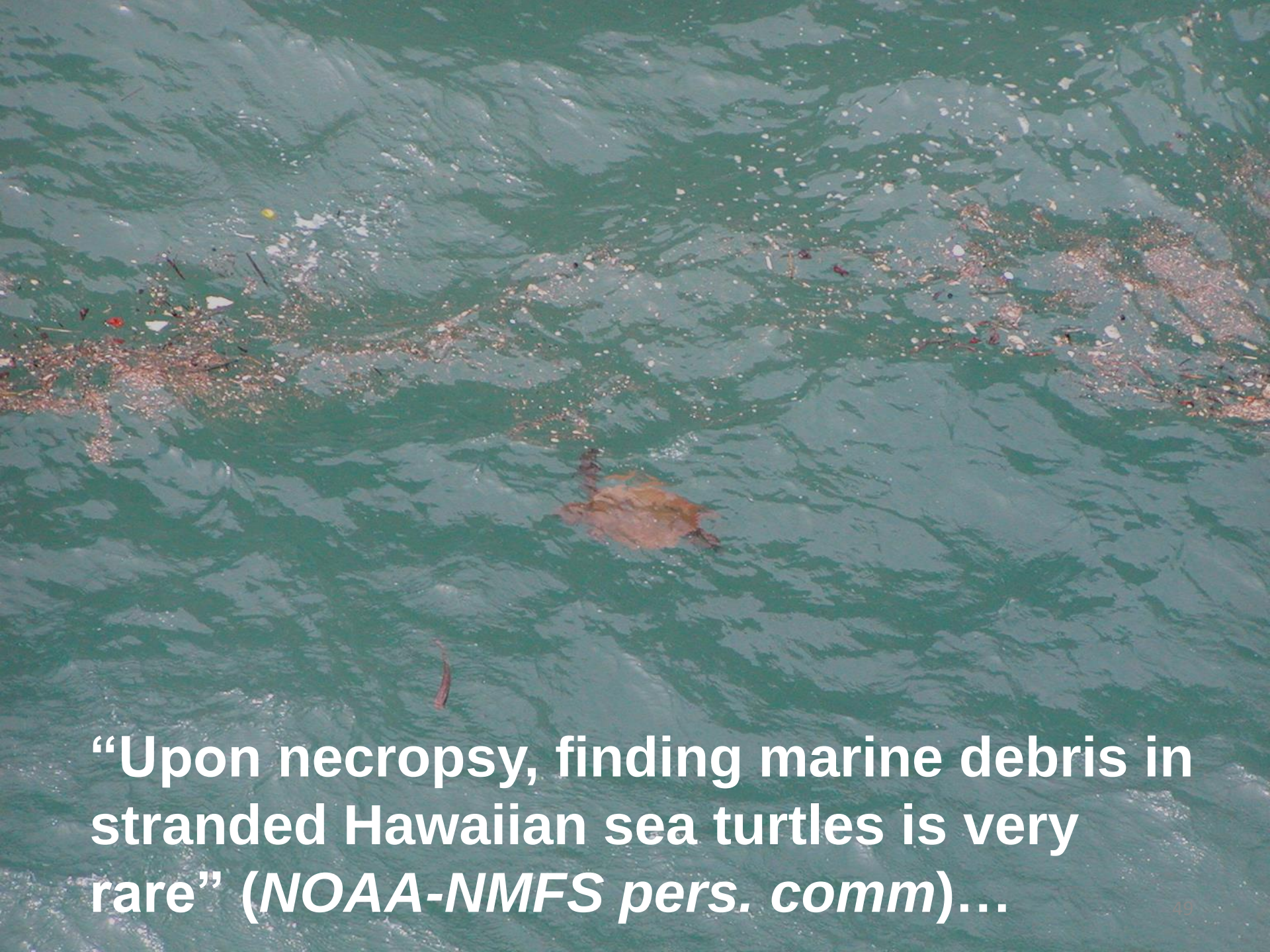


# Are they actually eating the marine debris?

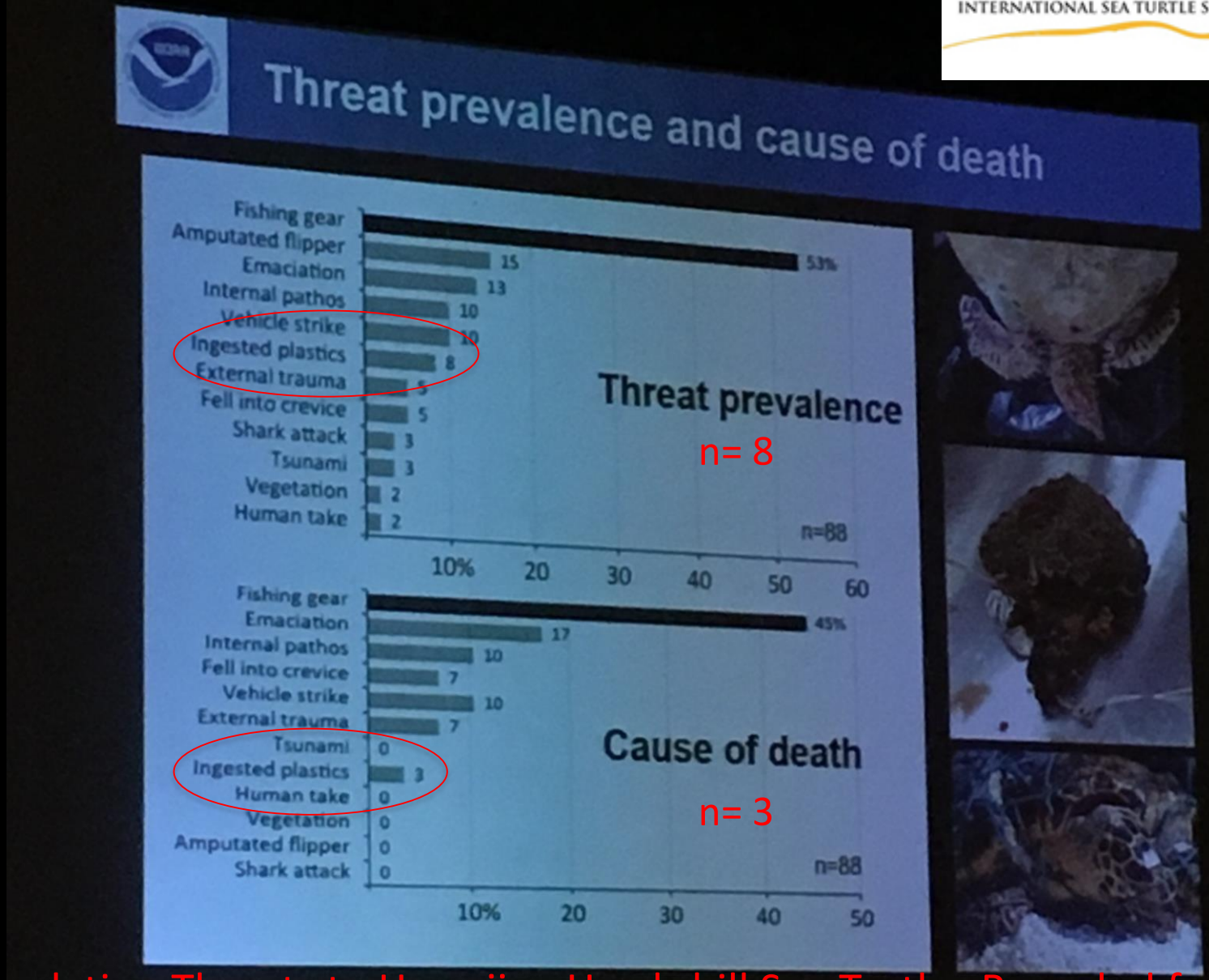
They’re “attracted to it” for some reason(s)…

**Photo credit:**
**Megan Lamson, DAR**


The small turtles could be just arriving from their pelagic “lost years phase”, where they are omnivores and their foraging strategy focuses on objects near the surface…
If they are dying from ingesting marine debris, we simply wouldn’t see it…



**“Upon necropsy, finding marine debris in stranded Hawaiian sea turtles is very rare” (*NOAA-NMFS pers. comm*)…**




"Population Threats to Hawaiian Hawksbill Sea Turtles Revealed from Three Decades of Strandings"- Shandell Brunson

Ecology and Evolution 2016; 6(8): 2378-2389

Open Access

# The developmental biogeography of hawksbill sea turtles in the North Pacific

Kyle S. Van Houtan[1,2]*, Devon L. Francke[3], Sarah Alessi[3], T. Todd Jones[1], Summer L. Martin[4], Lauren Kurpita[5,6], Cheryl S. King[7] & Robin W. Baird[8]

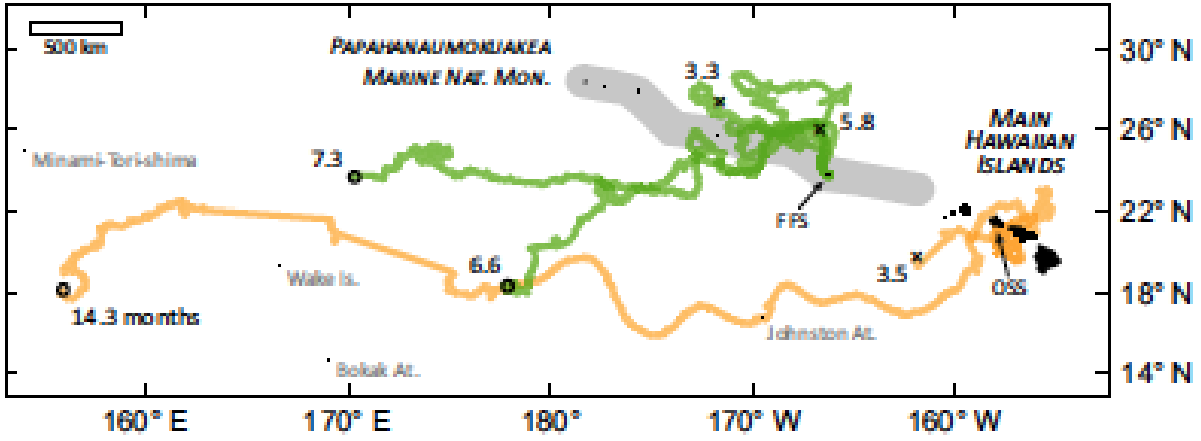
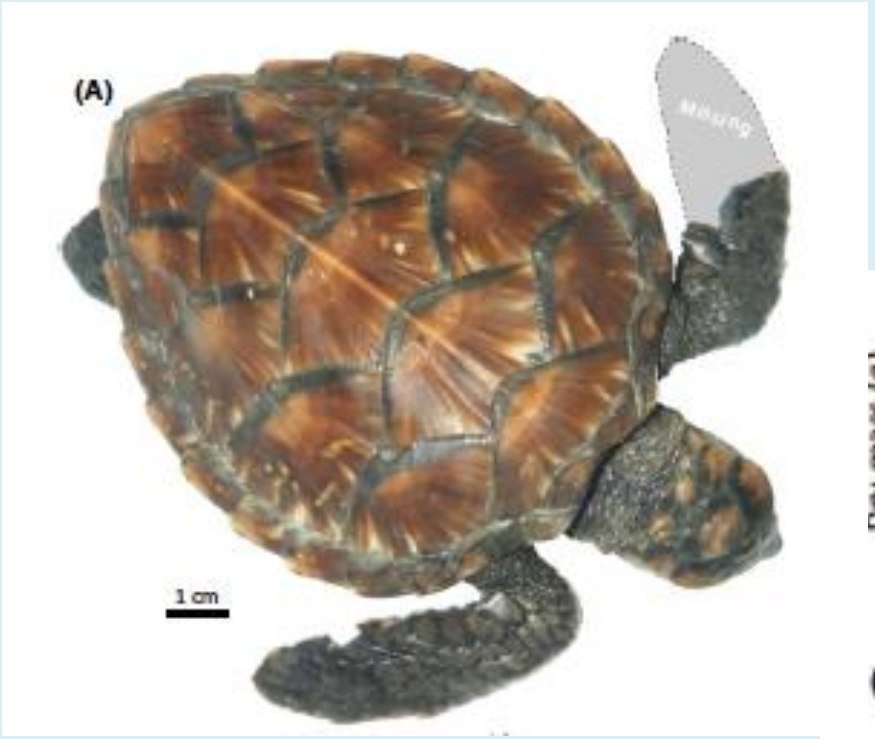
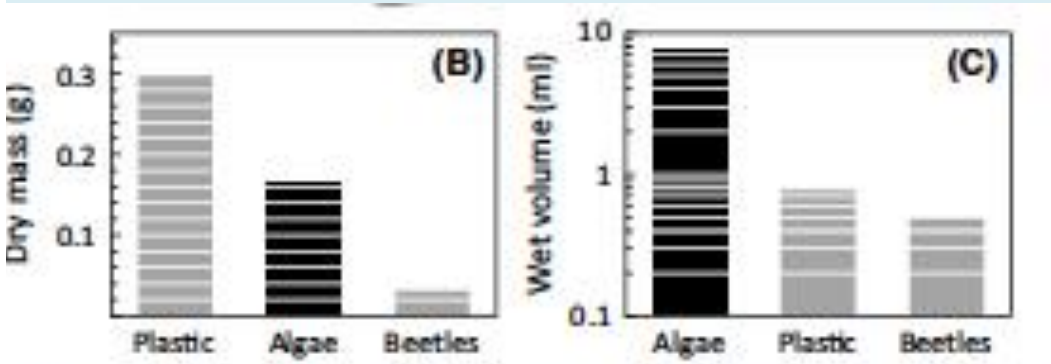
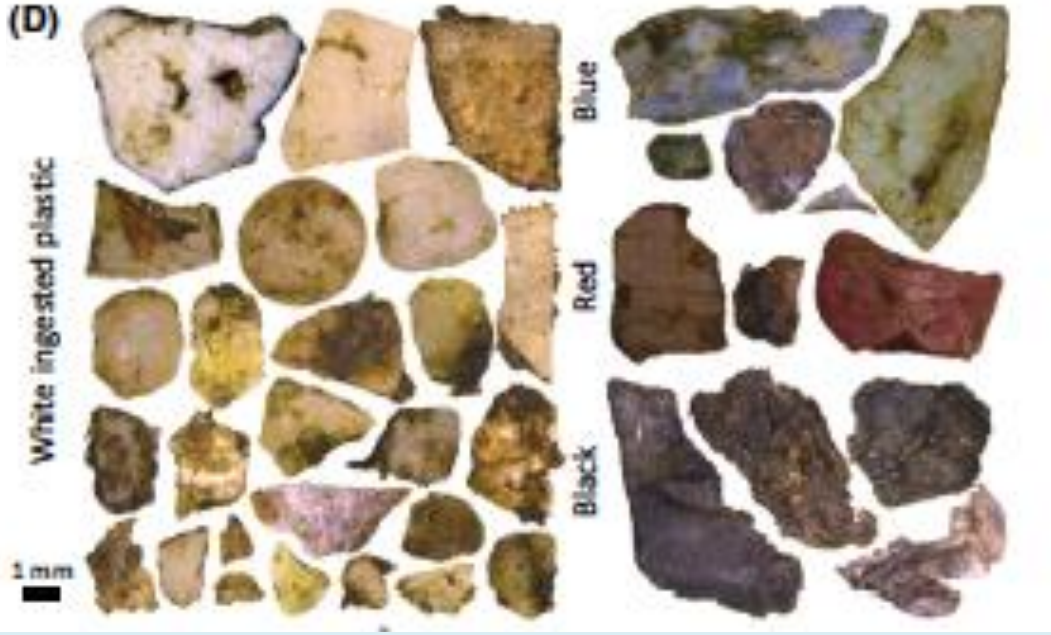



**Figure 2.** Surface drifter trajectories from hawksbill and green turtle nesting areas in the Hawaiian Archipelago indicate young juveniles may reside near the archipelago for several months or more. Green lines are 4 PSAT drifters released from French Frigate Shoals (FFS) in July–August 2014, simulating green turtle posthatchling trajectories from their primary nesting beach in the northwestern Hawaiian Islands. Orange lines are 2 PSAT surface drifters released near Oahu's south shore (OSS) in December 2013, simulating hawksbill posthatchling trajectories from the Main Hawaiian Islands. The timing and location of release parallel predominant conditions for both populations. Paths are Argos location codes 3-B, "x" at path endpoint indicates transmission ends, "o" indicates drifter still active, and number is trajectory age in months. Gray region is the extent of the Papahanaumokuakea Marine National Monument.


(A)
Missing
1 cm


(B)
Dry mass (g)
0.3
0.2
0.1
Plastic
Algae
Beetles
(C)
Wet volume (ml)
10
1
0.1
Algae
Plastic
Beetles


(D)
White ingested plastic
Blue
Red
Black
1 mm

Marine Pollution Bulletin xxx (2017) xxx-xxx

Contents lists available at ScienceDirect

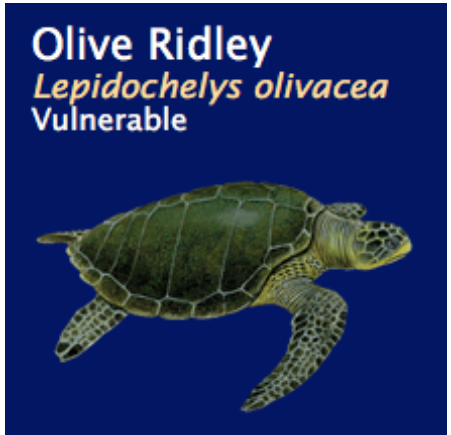
Marine Pollution Bulletin

journal homepage: www.elsevier.com

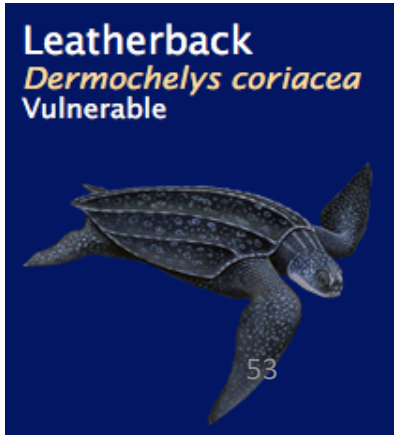
# Investigation of plastic debris ingestion by four species of sea turtles collected as bycatch in pelagic Pacific longline fisheries

Katharine E. Clukey[a], Christopher A. Lepczyk[a, d], George H. Balazs[b], Thierry M. Work[c], Jennifer M. Lynch[e, *]

[a] Department of Natural Resources and Environmental Management, University of Hawai'i at Mānoa, Honolulu, HI, United States
[b] Pacific Islands Fisheries Science Center, National Marine Fisheries Service, Honolulu, HI, United States
[c] National Wildlife Health Center, Honolulu Field Station, U.S. Geological Survey, Honolulu, HI, United States
[d] Auburn University, School of Forestry and Wildlife Science, Auburn, AL, United States
[e] Chemical Sciences Division, National Institute of Standards and Technology, Kaneohe, HI, United States





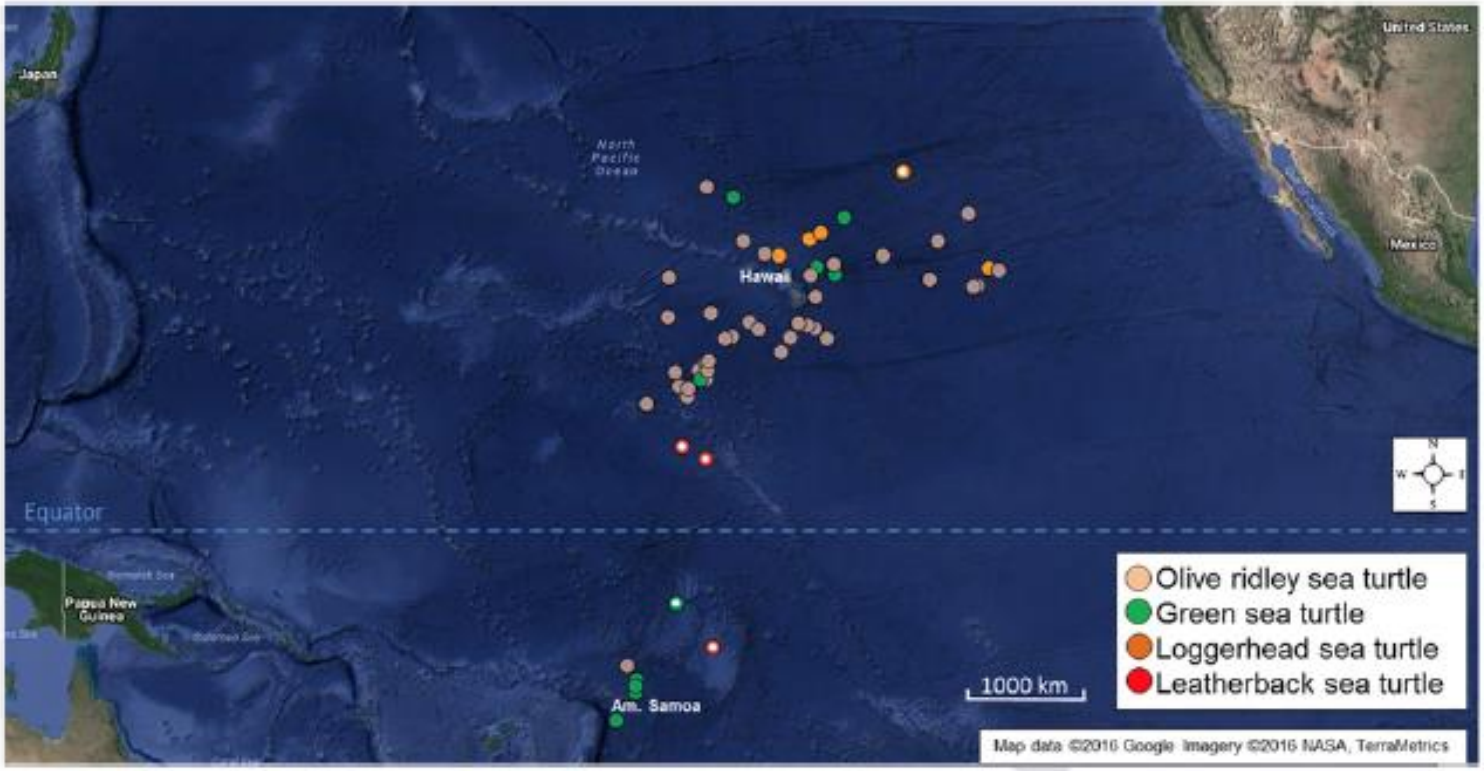
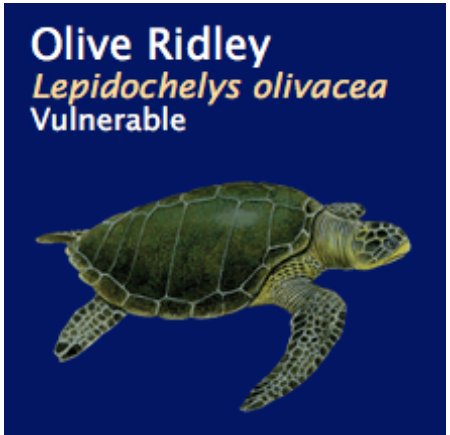



**Fig. 1.** Pacific pelagic longline capture locations of sea turtles sampled in this study. Olive ridley turtles (brown, n = 37), green turtles (green, n = 10), loggerhead turtles (orange, n = 5) and leatherback turtles (red, n = 3). Capture locations of turtles that had no ingested plastic are indicated with inner white circles. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)



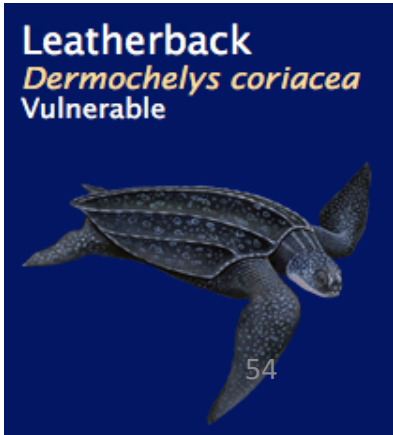




**Figure S3.** Anthropogenic debris ingested by a pelagic Pacific loggerhead sea turtle (*Caretta caretta*), turtle ID LL554807.



**Figure S2.** Anthropogenic debris ingested by a pelagic Pacific green sea turtle (*Chelonia mydas*), turtle ID LL513310.

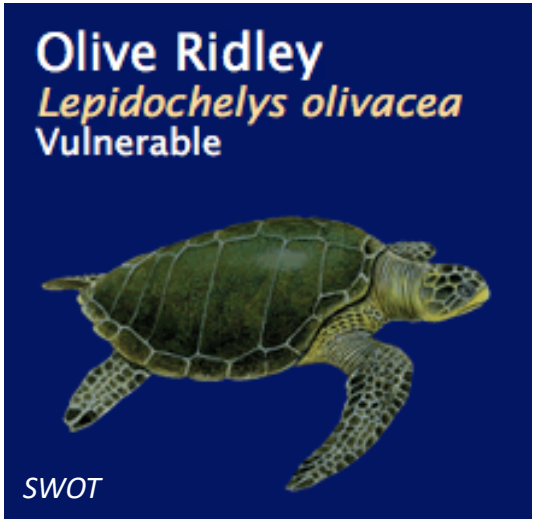




**Figure S1.** Anthropogenic debris ingested by a pelagic Pacific olive ridley sea turtle (*Lepidochelys olivacea*), turtle ID LL450502.

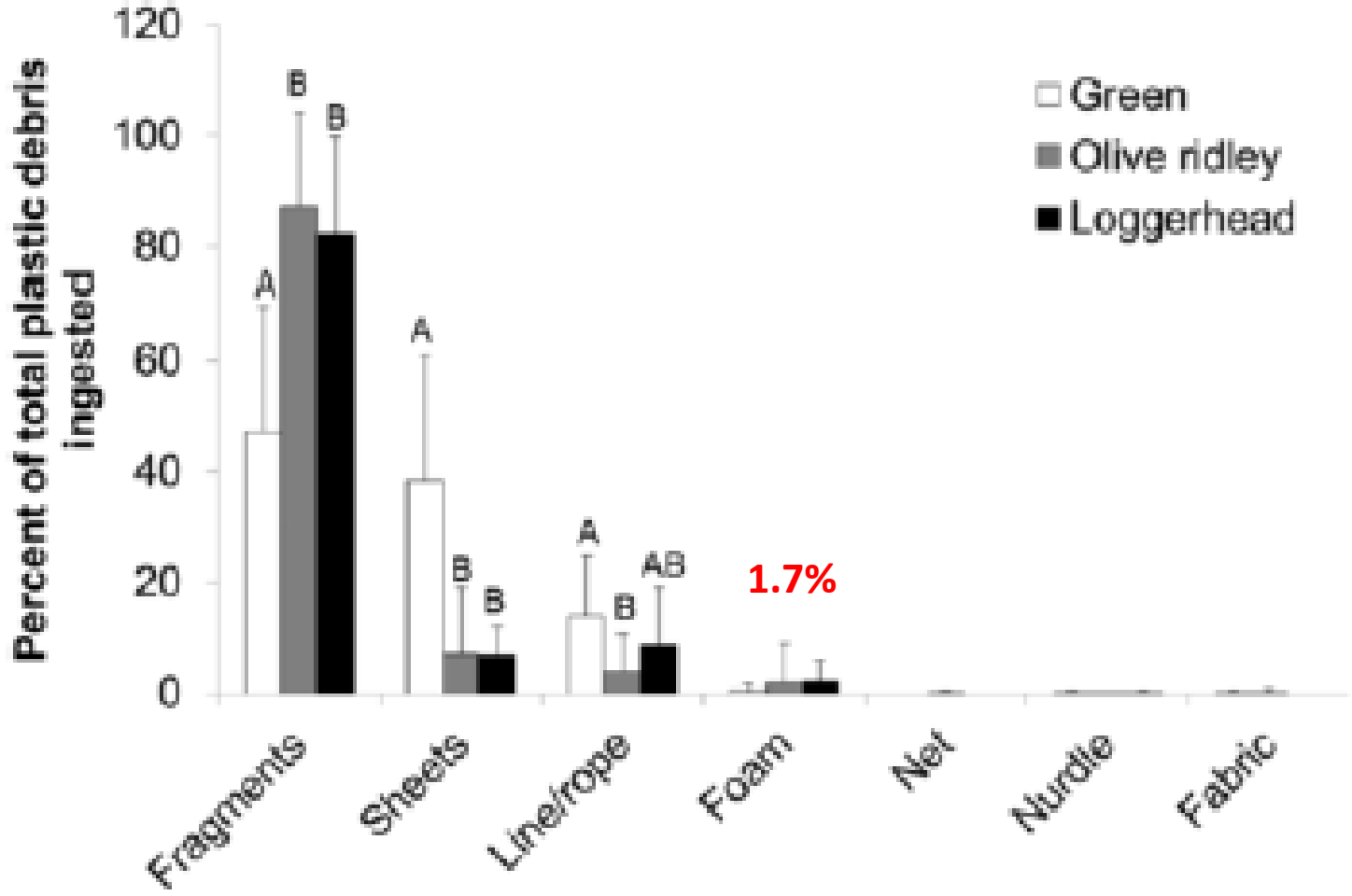



Fig. 5. Debris types ingested by three species of pelagic Pacific sea turtles. Data are the percentage of total plastic pieces consisting of each particular type ingested by each turtle, and shown as mean and standard deviation across turtles of each species. Turtles that did not consume plastic were excluded from this analysis. Different letters above bars indicate significant differences between species for that debris type (Wilcoxon each pair tests, $p < 0.05$).

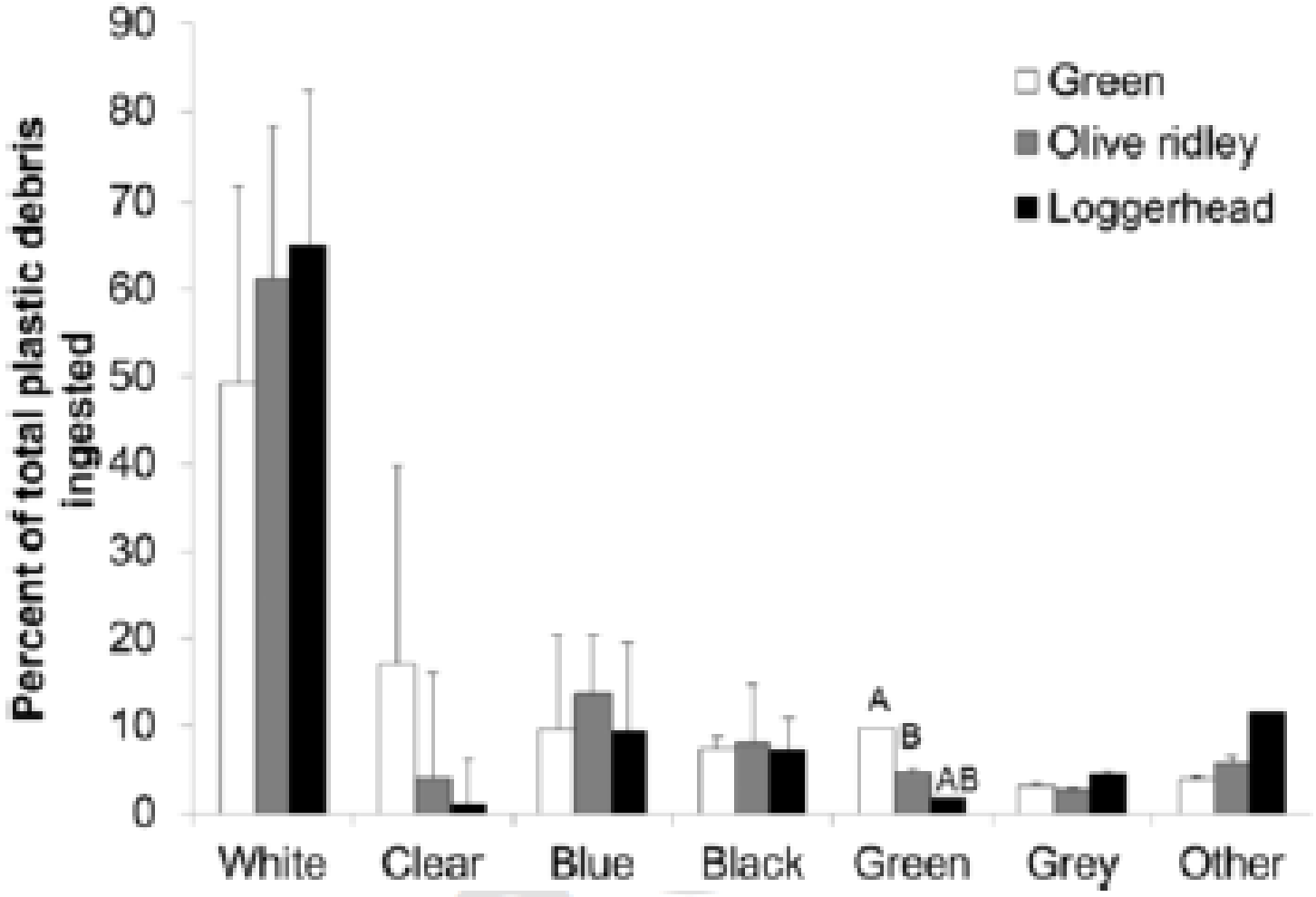



Fig. 6. Debris colors ingested by three species of pelagic Pacific sea turtles. Data are the percentage of total plastic pieces consisting of each particular color ingested by each turtle, and shown as mean and standard deviation across turtles of each species. "Other" colors include pink, orange, red and silver. Turtles that did not consume plastic were excluded from this analysis. Different letters above bars indicate significant differences between species for that debris color (Wilcoxon each pair tests, $p < 0.05$).

# SHARKASTICS

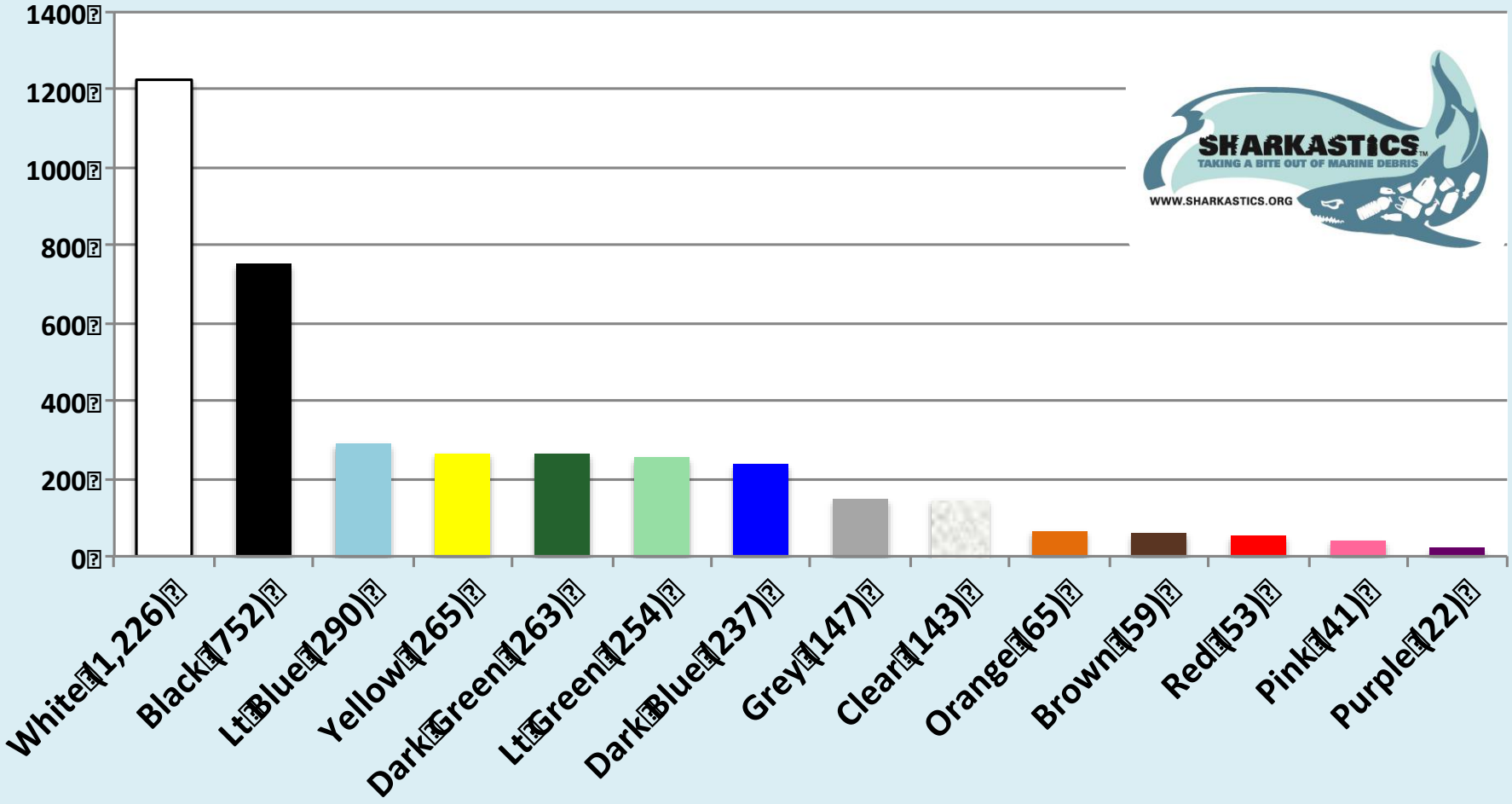

"SHARKASTICS" are what we've termed pieces of plastic marine debris with obvious bite marks (jagged serrations &/or punctures)...


Bites from sharks,
sea birds, turtles,
monk seals, & fish


SPICY PENNE
PASTA
VEGETARIAN
2017.02.26


201302.24

# Color-sorted SHARKastics (n=3,817) from 42 Ka`ehu Cleanups (2012-2017)




**Maybe these animals are just “test biting” the plastics… but if they’re actually ingesting these materials, it can’t be good for them…**


CM155
Cc


The fate of our ocean is in your hands!


PLEASE SUPPORT Bill 127!
“Keep the sea foam-free for you & me!”
SHARKASTICS™
TAKING A BITE OUT OF MARINE DEBRIS
WWW.SHARKASTICS.ORG