Towards Ecosystem Metrics of Plastic Ingestion by Hawaiian Seabirds

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RACE FOR WATER ODYSSEY

Speaking on Behalf of a Big Flock

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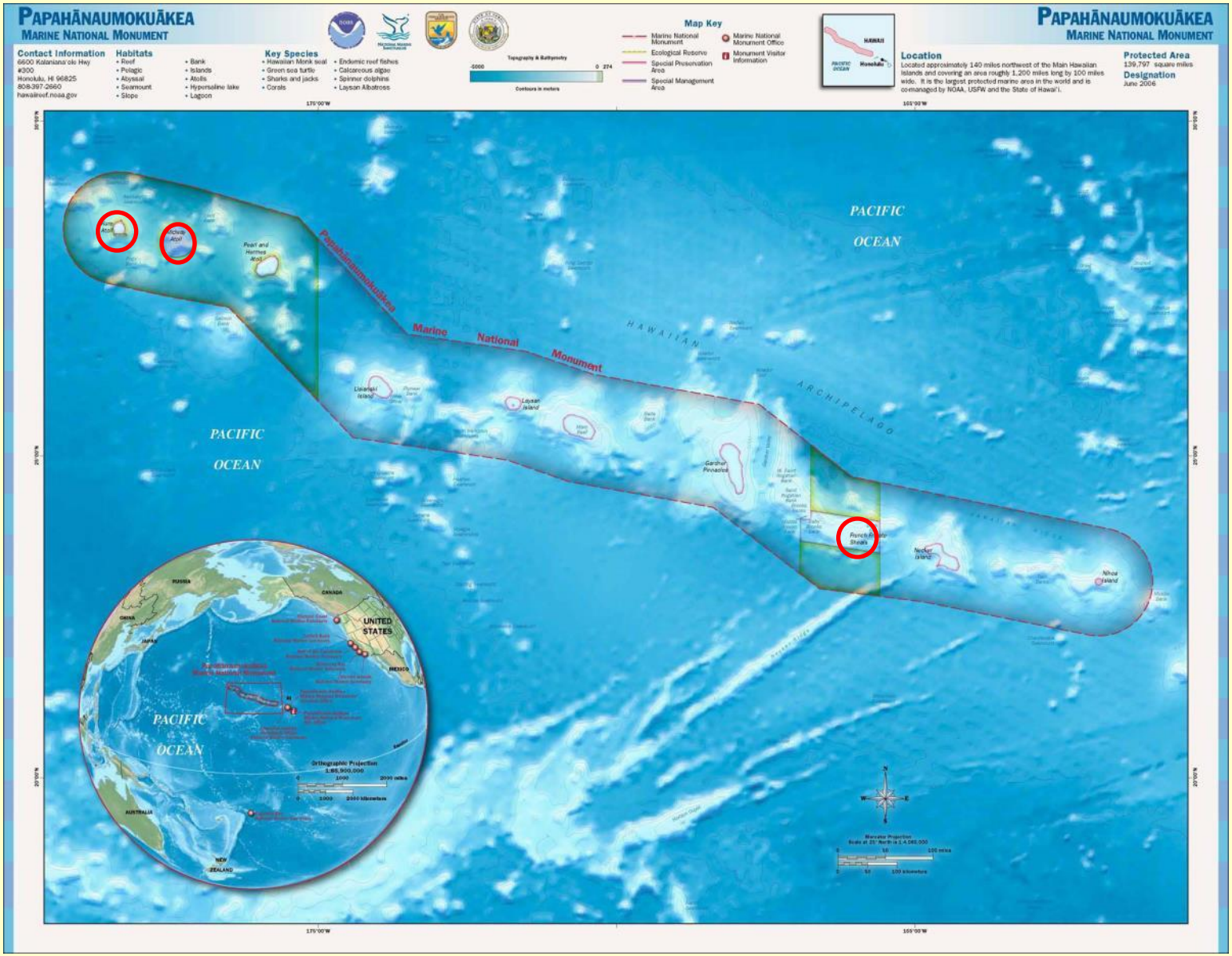
Motivation: Monitoring Trends

Biological Indicators of Ocean Plastic Pollution

Use seabirds as biological indicators of plastic pollution in the marine environment

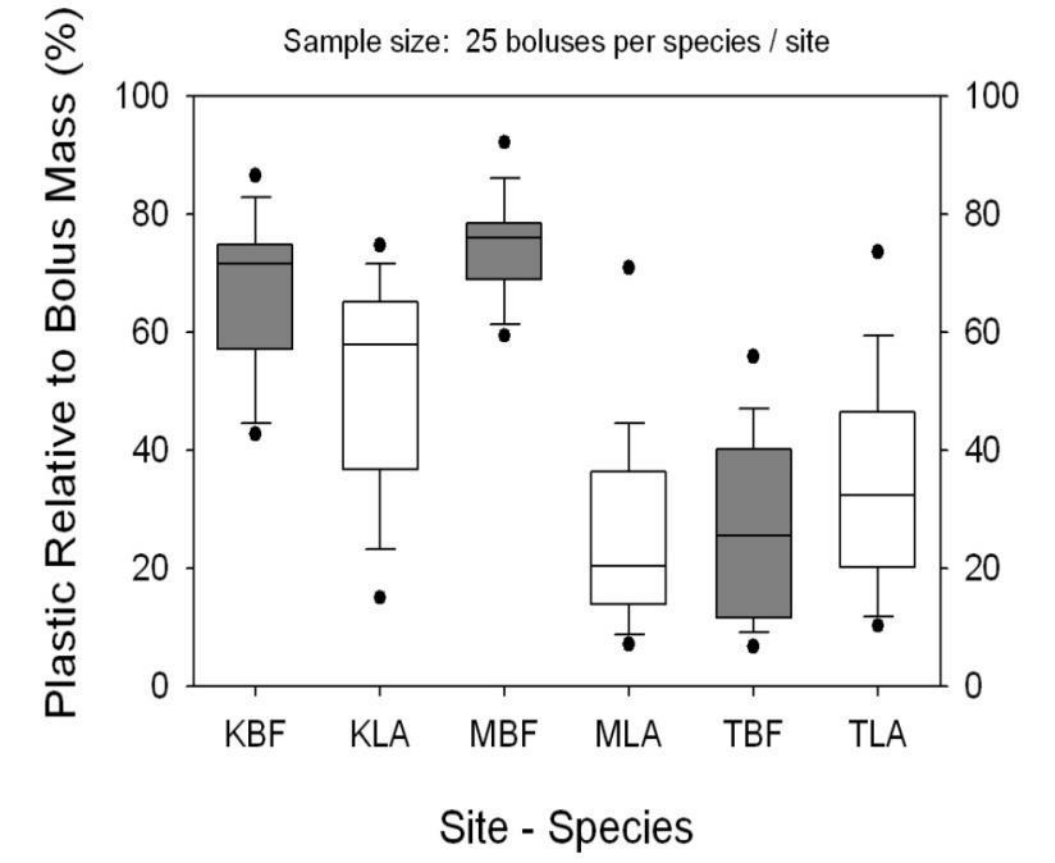
Quantify exposure and impacts from this ingestion

Case Study I : Regional Metrics



Results: Plastic Mass

Black-footed (BF) & Laysan (LA) Albatross plastic mass at 3 sites: Kure (K), Midway (M), Tern (T).



(R-squared = 0.779)

Plastic in every bolus (100%incidence, n = 150)

Plastic mass differed by species ($p < 0.001$) (BFAL > LAAL)

Plastic mass differed by site ($p < 0.001$) (Kure > Midway > Tern)

Significant ($p < 0.001$) species*colony

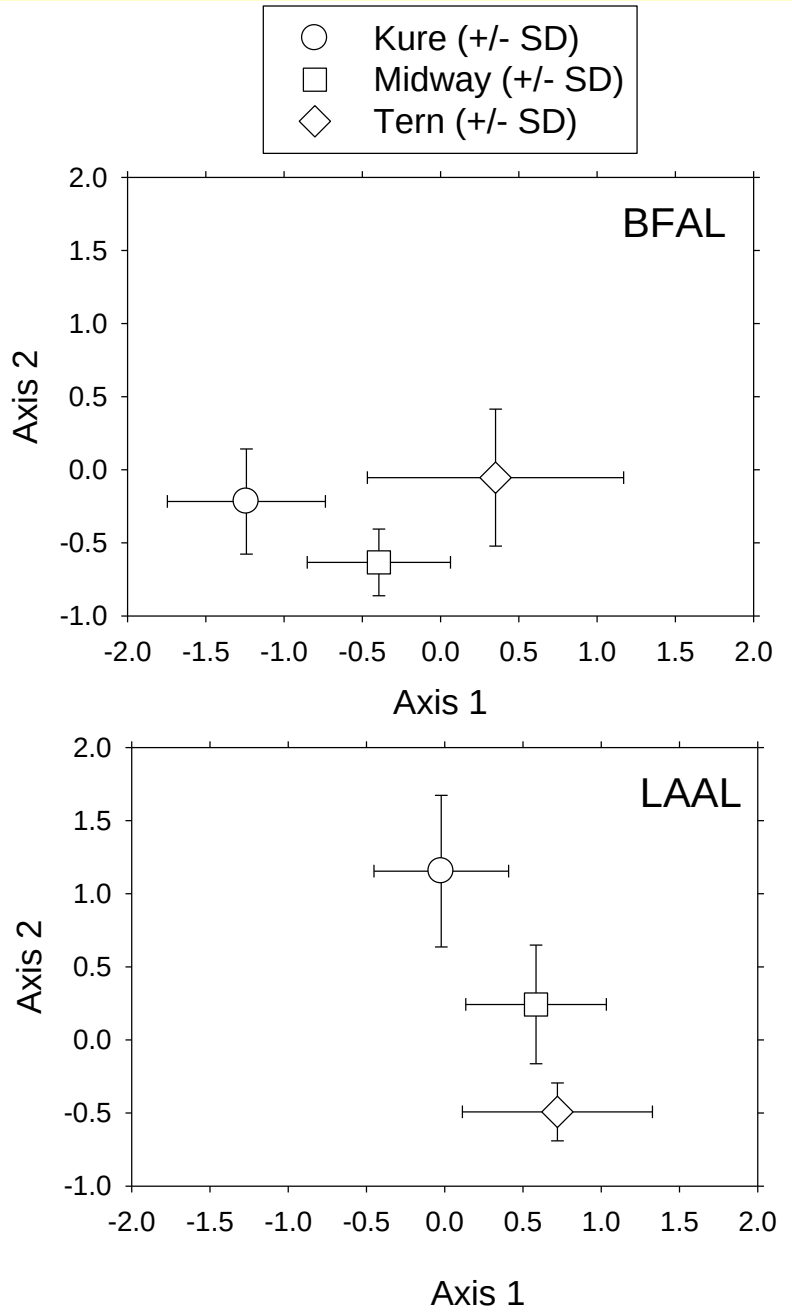
Results: Plastic Types

Ordination of mass and volume of 4 plastic types) yielded 2 significant axes ($p = 0.001$)

PermANOVA test revealed 3 significant patterns ($p < 0.001$)

Explained 58.88% of variance:

- species (18.88%)
- colony (15.29%)
- their interaction (14.71%)



Case Study 2: Local Metrics

Oceanic Institute
Sea Life Park
Hawai'i Pacific University

SEABIRD NECROPSY PROGRAM
O'AHU, HAWAII

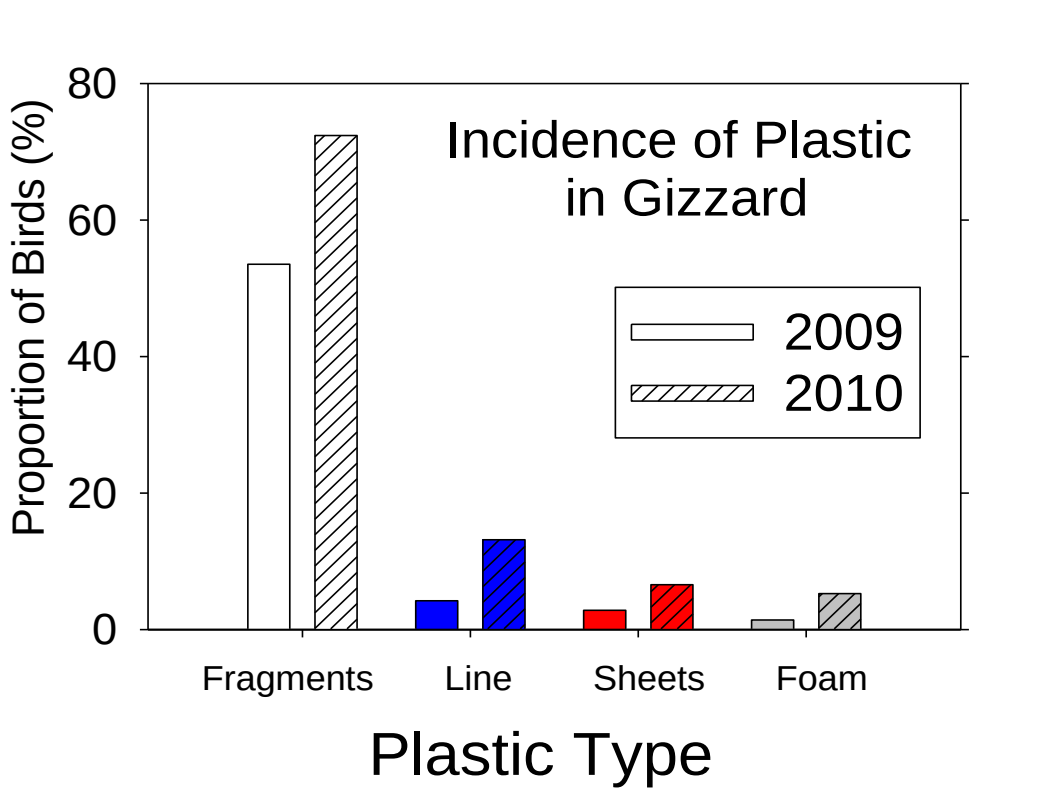
- 142 chicks necropsied (2009 and 2010)
- Morphometric measurements
- Assessment of individual condition and health
- Tissues sampled for isotopic diet and pollutants

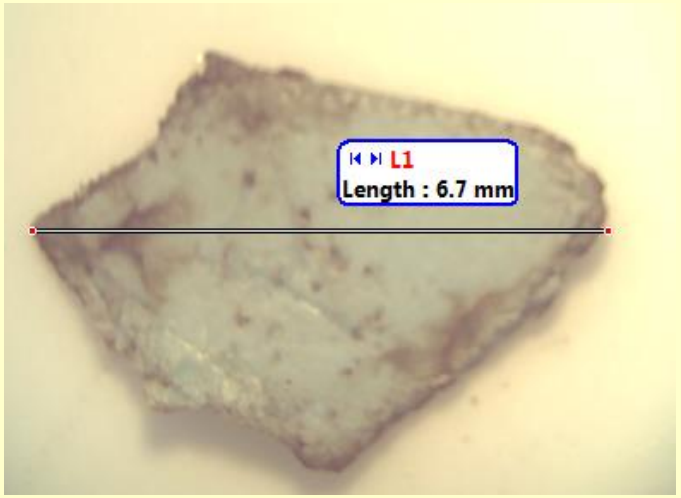
Manana Island

'U au' Kani

Results: Plastic Types

- 72.5% of O'ahu WTSH chicks contain plastic
- Fragments dominant; line, sheets, foam present
- Year-to-year differences in incidence / mass





Fragment Size
Range: 0.3 – 7.7 mm

Case Study 3: Community-Wide Assessment

Tern Island: 16 breeding seabird species

Emerging Pathways of Food Web Transfer

Masked Booby (50%)

Brown Booby (33%)

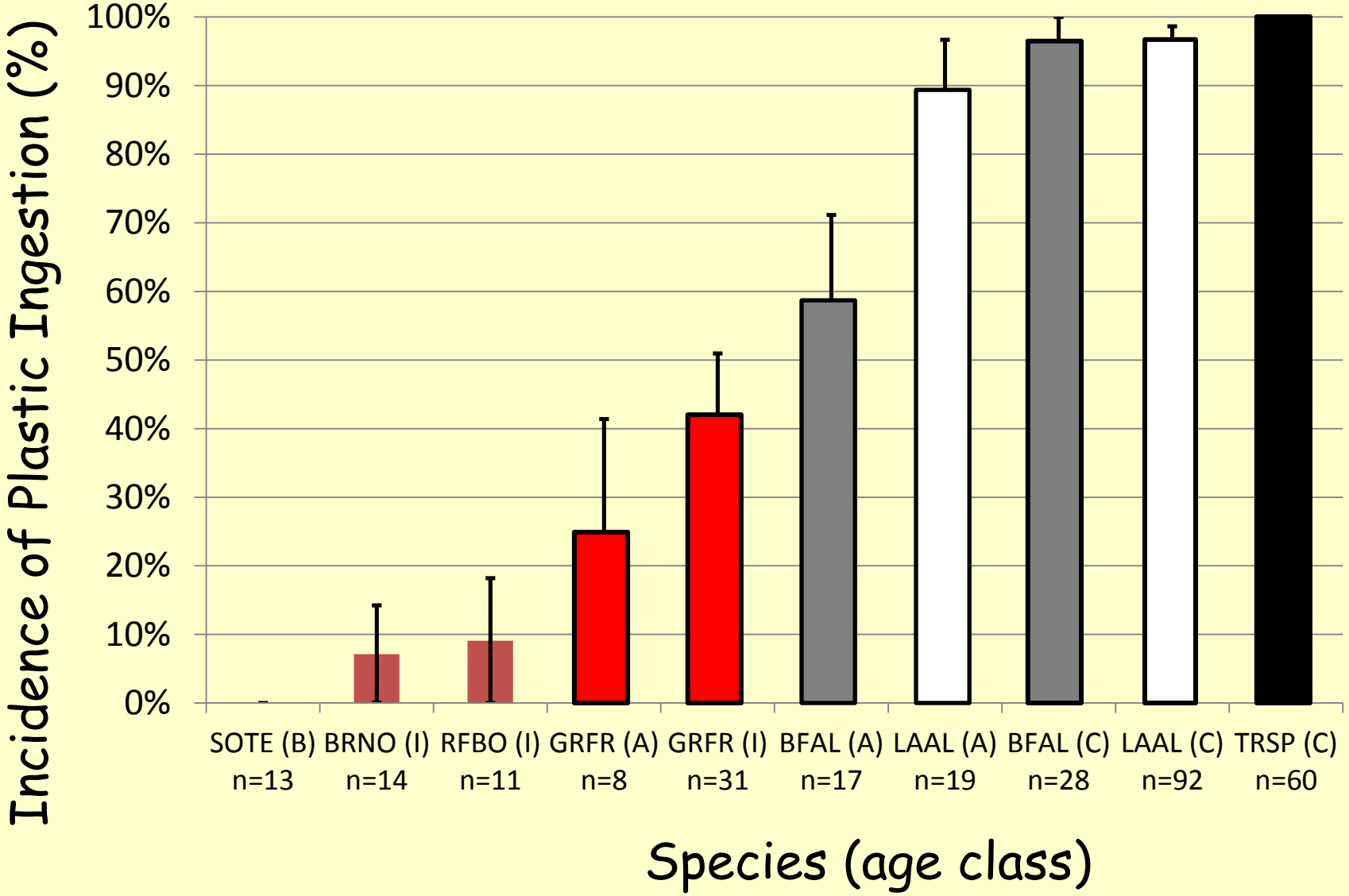
White-tailed Tropicbird (33%)

Secondary Ingestion

GRACIAS

Community-Wide Plastic Ingestion

French Frigate Shoals Species (n ≥ 8 Birds)



Scope of Plastic Ingestion – Hawai'i

100% Hawaiian (Black-Footed, Laysan) albatross boluses have plastic (since 2008)

On average 70% of Black-footed albatross bolus volume (65% bolus weight) is plastic

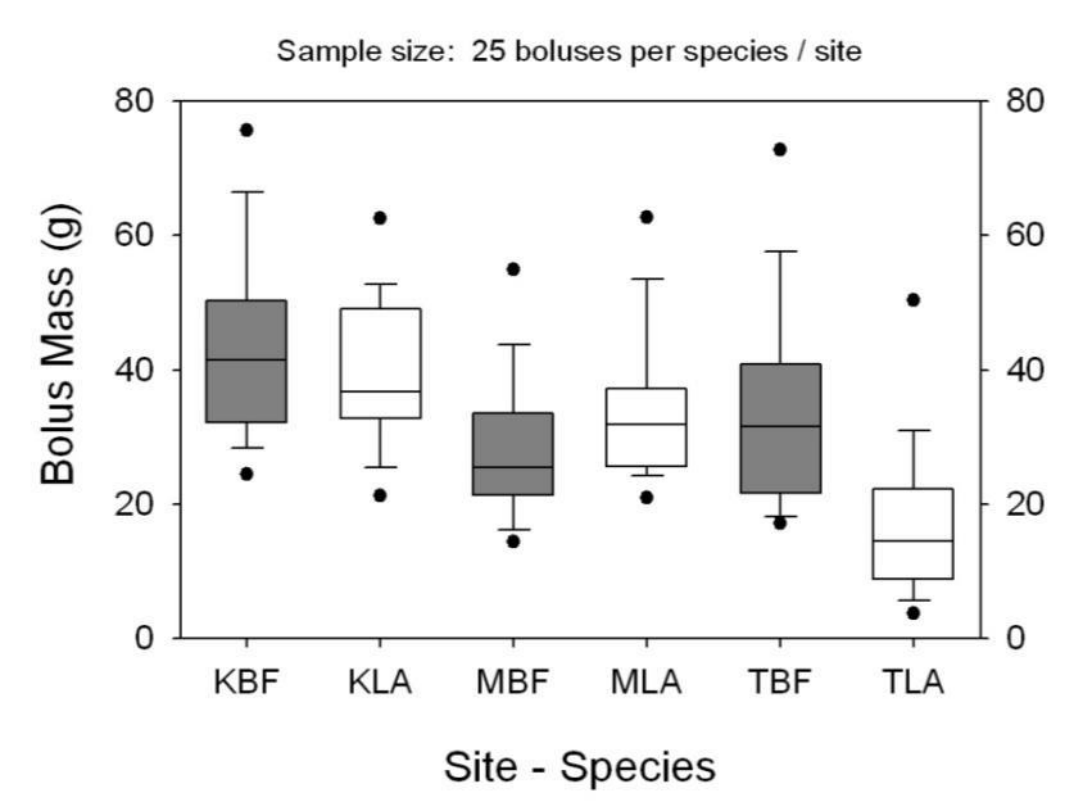
72.5% of O'ahu Wedge-tailed Shearwater chicks contain plastic (2009 – 2010)

100% of Tern Island's Tristram's Storm-petrels contain plastic (2007 - 2012)

New species: frigates, boobies, tropicbirds

Results: Bolus Mass

Black-footed (BF) & Laysan (LA) Albatross bolus mass at 3 sites: Kure (K), Midway (M), Tern (T).



(R-squared = 0.443)

Bolus mass differed by species ($p = 0.002$) (BFAL > LAAL)

Bolus mass differed by site ($p < 0.001$) (Kure > Midway >Tern)

Significant ($p < 0.001$) species*colony

Results: Plastic Categories

Differences in bolus composition of BFAL / LAAL (by mass)

(n = 150 boluses)

Category	BF mean (± SD)	LA mean (± SD)	*p*
Proportion Plastic	**65.6 (± 12.9)**	51.7 (± 18.6)	**< 0.001**
Proportion sheet	**2.2 (± 0.9)**	0.3 (± 0.9)	**< 0.001**
Proportion line	**28.3 (± 12.9)**	2.2 (± 4.3)	**< 0.001**
Proportion foam	**22.9 (± 12.6)**	3.7 (± 4.0)	**< 0.001**
Proportion fragment	12.1 (± 9.4)	**45.3 (± 20.5)**	**< 0.001**

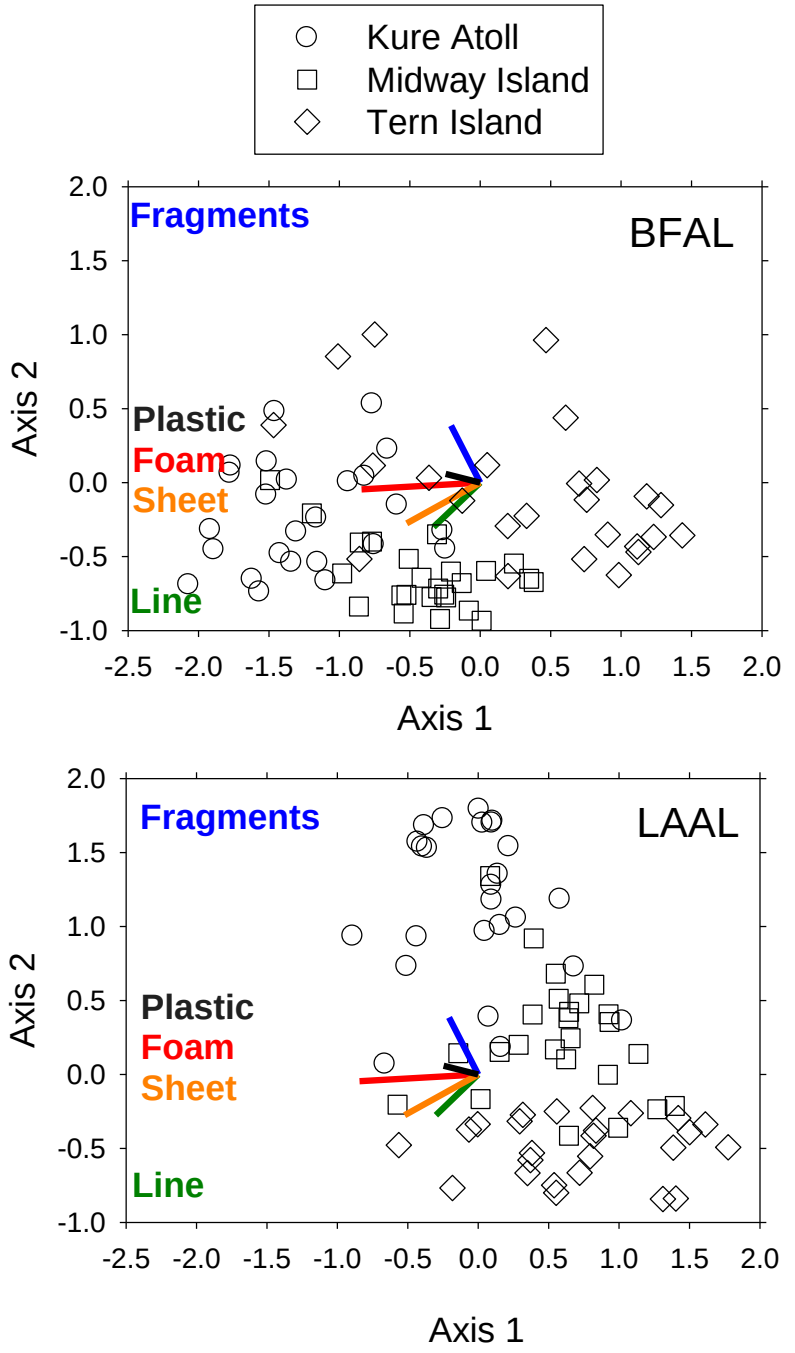
Results - PCA

Ordination of 12 variables (mass and volume of bolus, all plastic, 4 plastic types) yielded two significant axes (p = 0.001)

Explained 84.62% of variability

PC1 indicative of changing bolus size, overall plastic load and abundance of foam / sheet

PC2 indicative of changing abundance of line / fragments



Fine-Scale Tracking: 2012 & 2013

USGS
science for a changing world

National Fish and Wildlife Foundation

Forestry and Wildlife Hawaii

oikonos

GPS tags (10 & 10 BFALs)
Feb-April 2012 & 2013

PAPAHĀNAUMOKUĀKEA
Marine National Monument

Goal: Develop Multiple Bio-Indicators

- Three-tier approach:
  - *Legacy species*: Allow comparisons with "precious" samples collected in the past

    comparable methods, sporadic (periodic) sampling
  - *Sampler species*: Facilitate marine debris monitoring within specific spatial domain

    standardized methods, annual (periodic) sampling
  - *Community sentinels*: Opportunistic broad-scale sampling of multiple guilds

    standardized methods, occasional (event) sampling