Recent advances in macroplastic risk assessments

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Background

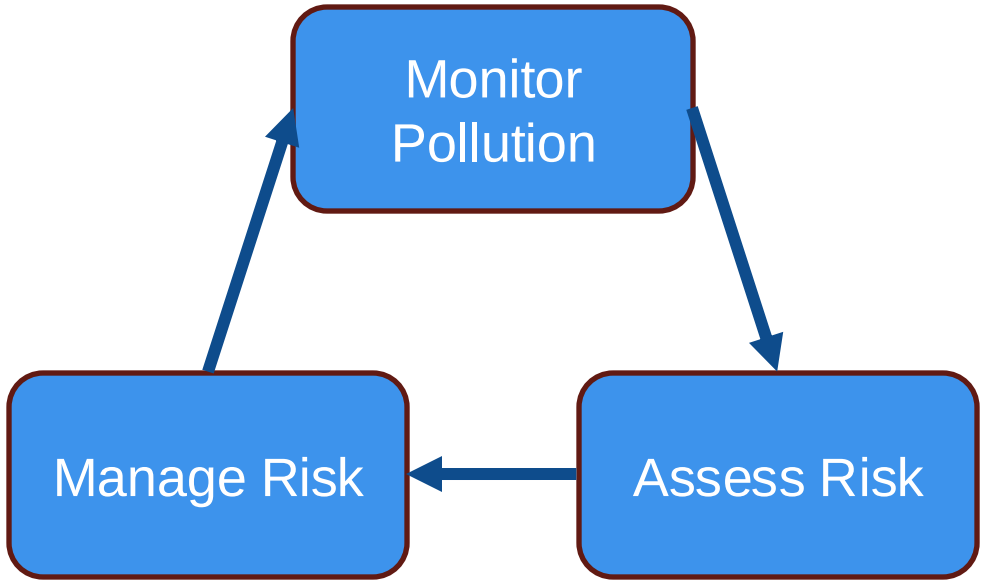
- Plastic interactions in 1300 marine species
- Linked to lethal and sublethal effects
- Unknown risk to animal and population health

All photos: NOAA

Motivation

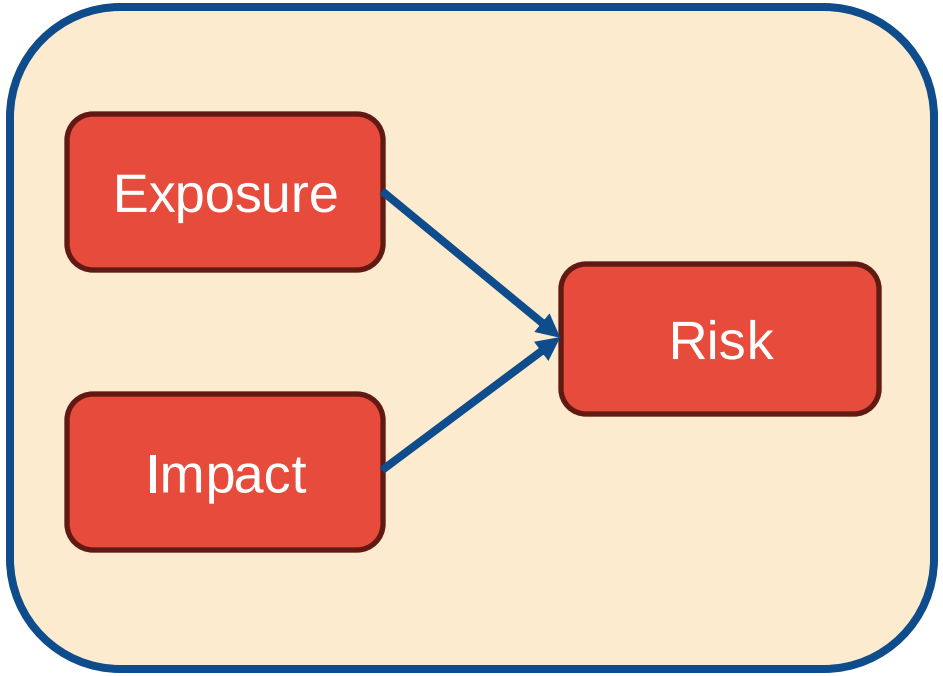
Motivation: Develop a suite of monitoring and management tools for macroplastic to track the problem, identify risk thresholds, and inform guidelines, goals, and regulations.

Outputs:
- Monitoring protocol
- Risk assessment methodology
- Risk management framework



Risk assessments

- Process to identify potential hazards
- Applications:
  - Human health, animal health, ecosystem health
- Types:
  - Quantitative, qualitative, semi-quantitative, scenario-based



Previous Research

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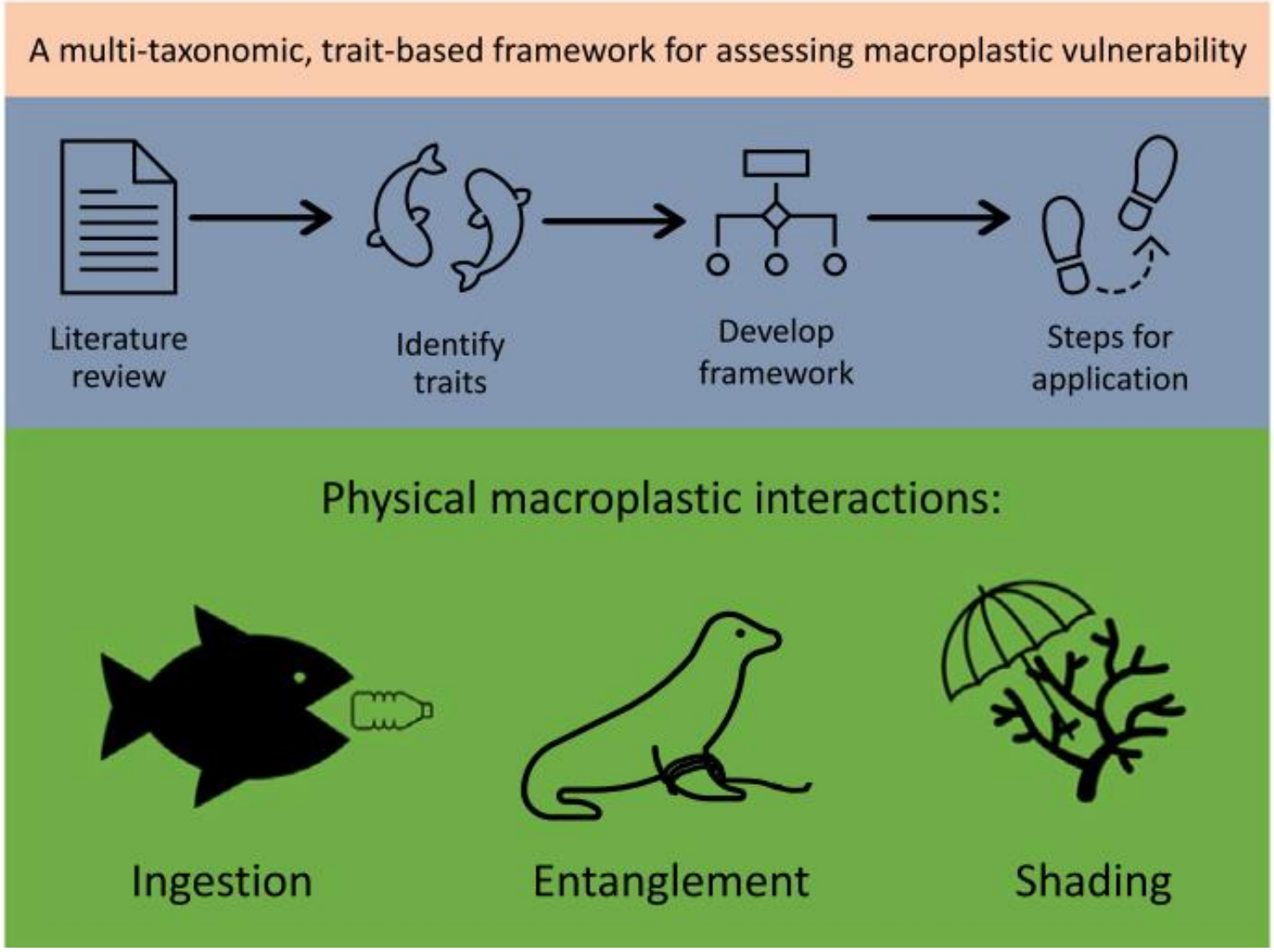
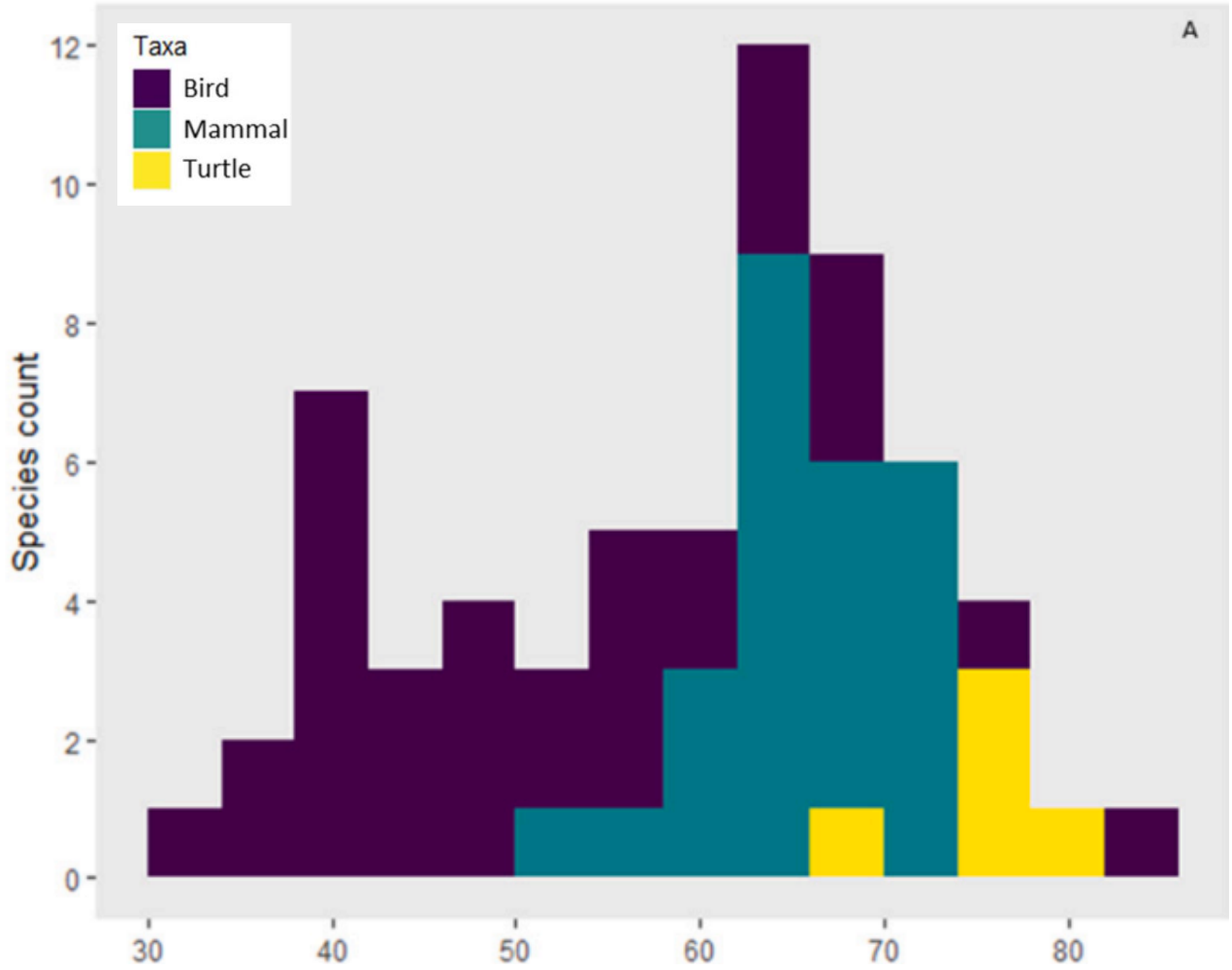
Relative vulnerability indices





Bryde's Whale (*B. edeni*)	High	70.4
North Pacific Right Whale (E. *japonica)*		70.7
Sei Whale (*B. borealis*)		71.7
Fin Whale (*B. physalus*)		72.3
Hawaiian Monk Seal (*N. Schauinslandi*)		72.6
Blue Whale (*B. musculus*)		73
Green Turtle (*C. mydas*)		74.7
Hawaiian Petrel (P. *sandwichensis*)		75
Loggerhead (C. *caretta*)		76.1
Hawksbill (*E. imbricata*)		77.4
Leatherback (*D. coriacea*)		81.4
Short-tailed Albatross (*P. albatrus*)		82.9

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A macroplastic vulnerability index for marine mammals, seabirds, and sea turtles in Hawai'i

Erin L. Murphy [a,b,c,*], Leah R. Gerber [a,b], Chelsea M. Rochman [c], Beth Polidoro [a,b,d]

Ongoing Research

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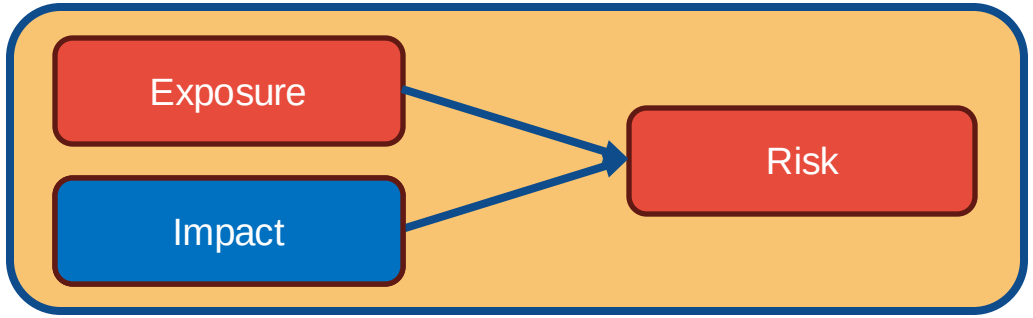
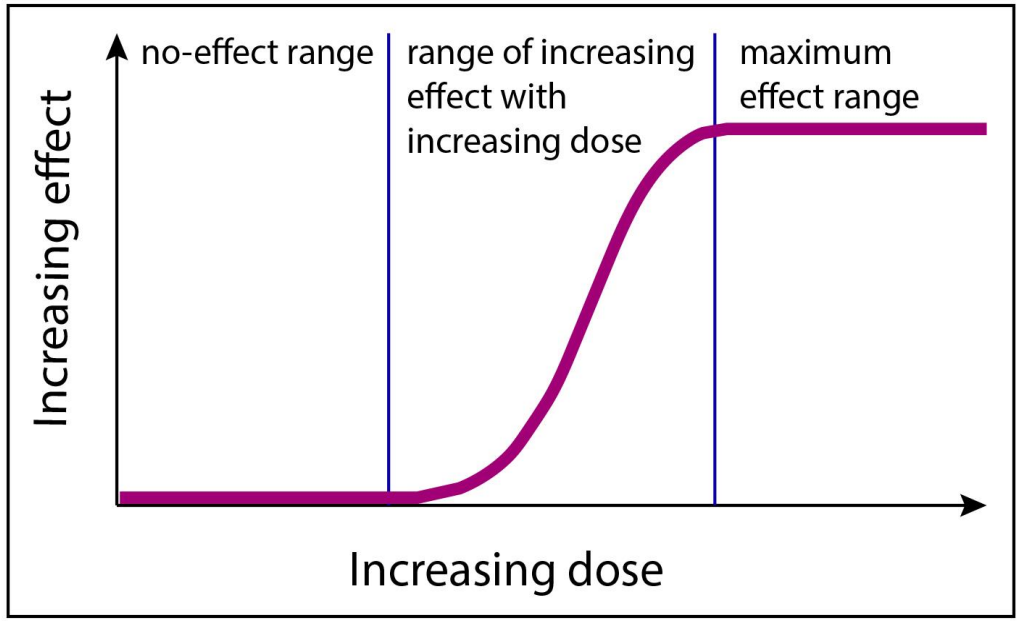
Our objective: impact modeling

- Quantify likelihood of mortality based on gastrointestinal load





Our Approach

Global database

- Review literature on macroplastic interactions
- Extract necropsy data

Risk assessment tool

- Develop model
- Pilot model for 3 taxa

Outputs

- Global thresholds for 3 taxa
- Risk assessment tool
- Reporting methods

Literature Review

Approach

- Literature review (1900 to 2023)
  - Search terms: plastic debris, marine debris, macroplastic, mesoplastic, OR fisheries debris AND ingestion
- Check against other reviews
  - GLOVE database & Zhu et al. *in prep*

Inclusion Criteria

- Sea turtles, marine mammals, seabirds
- Macroplastics (>5 mm)
- Cause of mortality reported
- Individual data on ingestion

Data Collection (Reporting Methods)

Organismal Data

- Family
- Species
- Age
- Sex
- Location
- Cause of death

Plastic Data

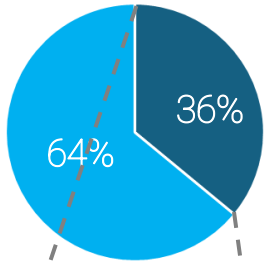
- Type: Hard, soft, rubber, fishing debris, cloth, foam, other
- Pieces by type (all >5mm)
- Volume by type
  - Estimate volume
- Plastic causing death

Necropsy data

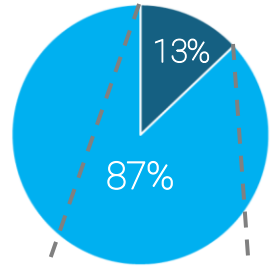
- Ingested plastic
- Ingested no plastic

- Died of plastic ingestion
- Died of other cause

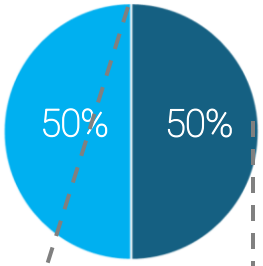
N=1,430



N=6,725

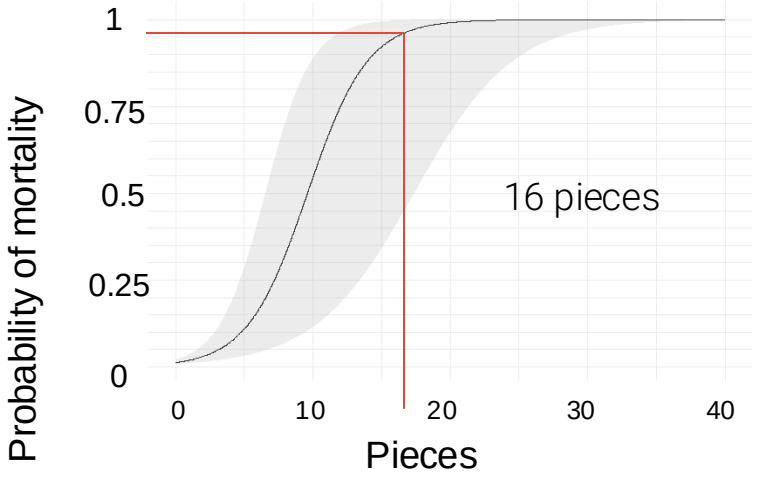


N=1,314

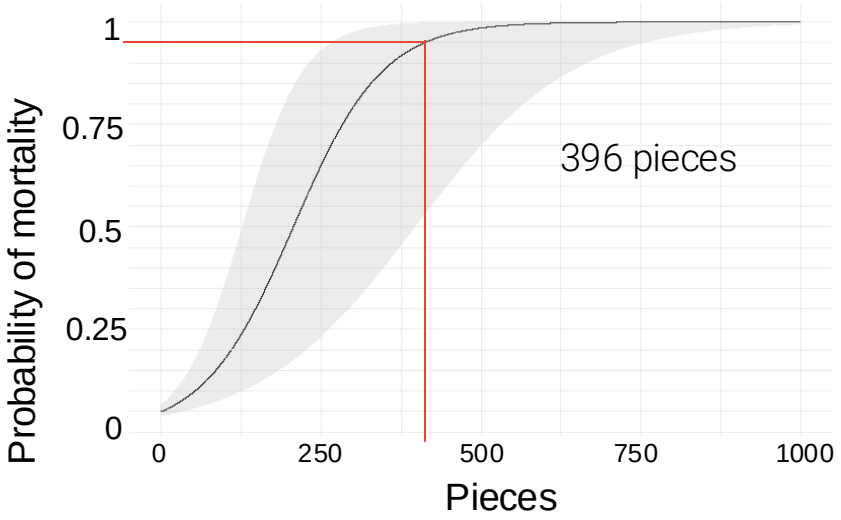


95% Probability of death: # plastic consumed

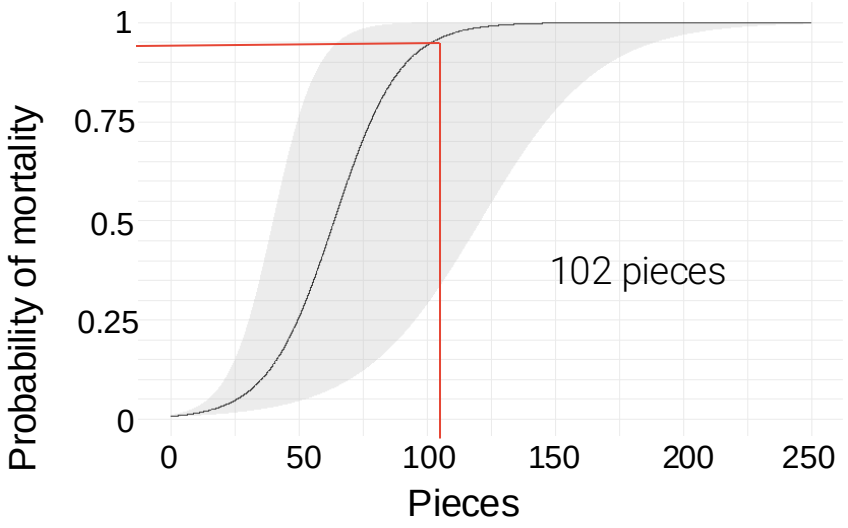
Seabirds



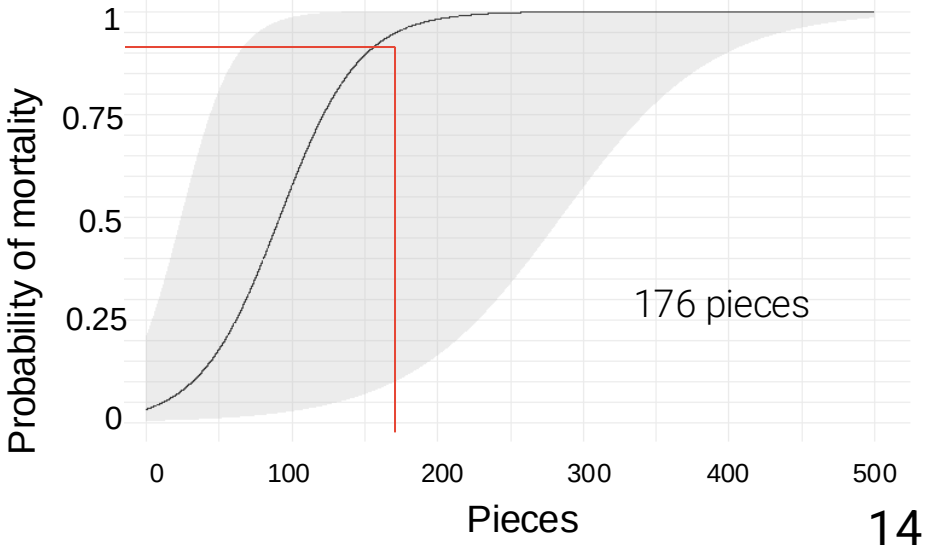
Sea Turtles



Marine mammals

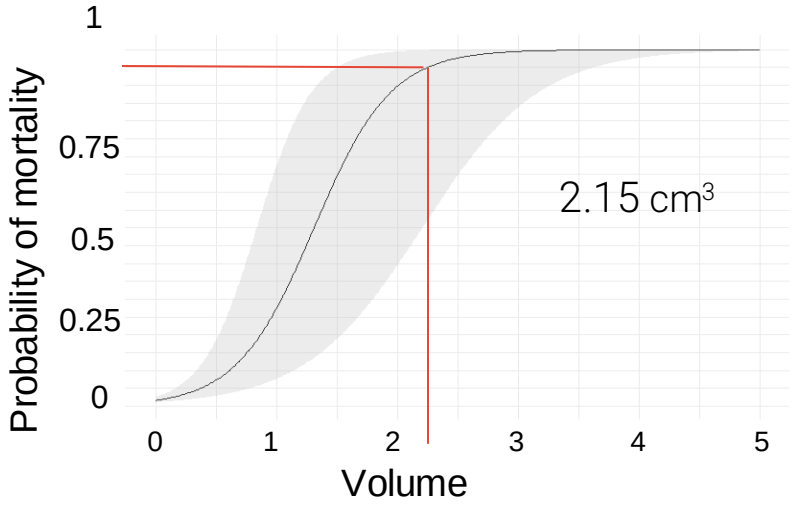


Young Sea Turtles

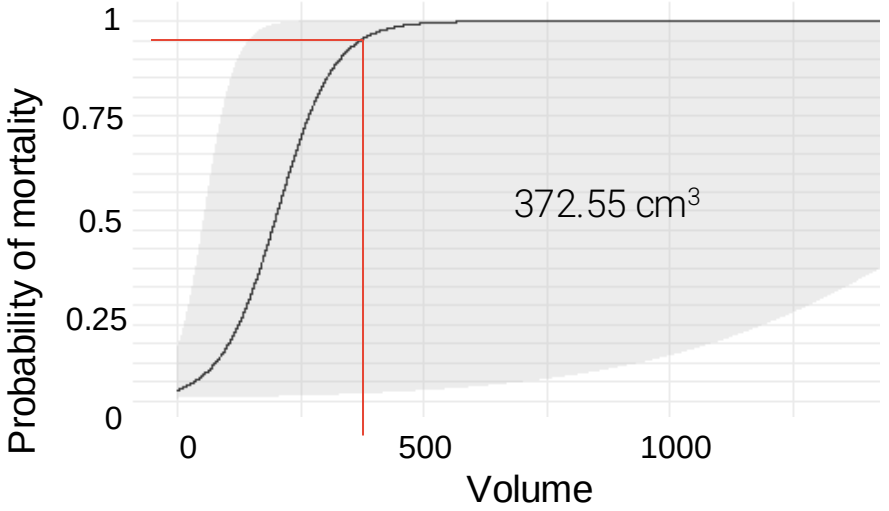


95% Probability of death: Volume consumed

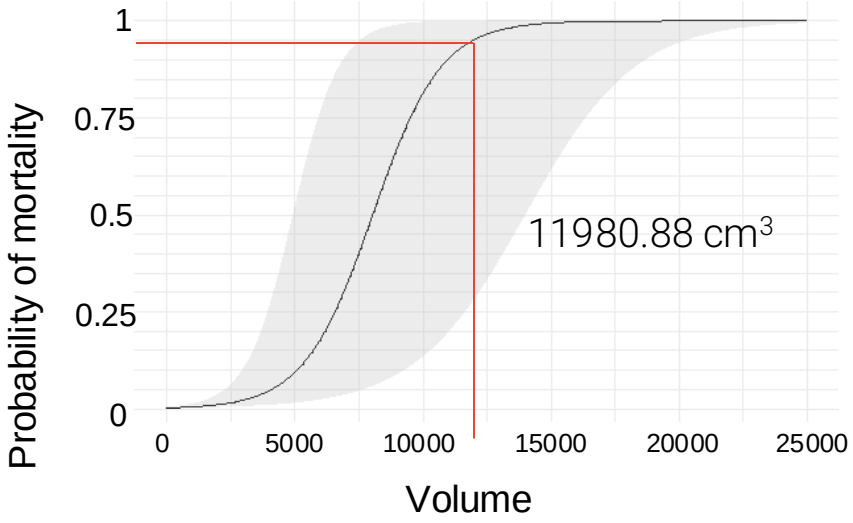
Seabirds



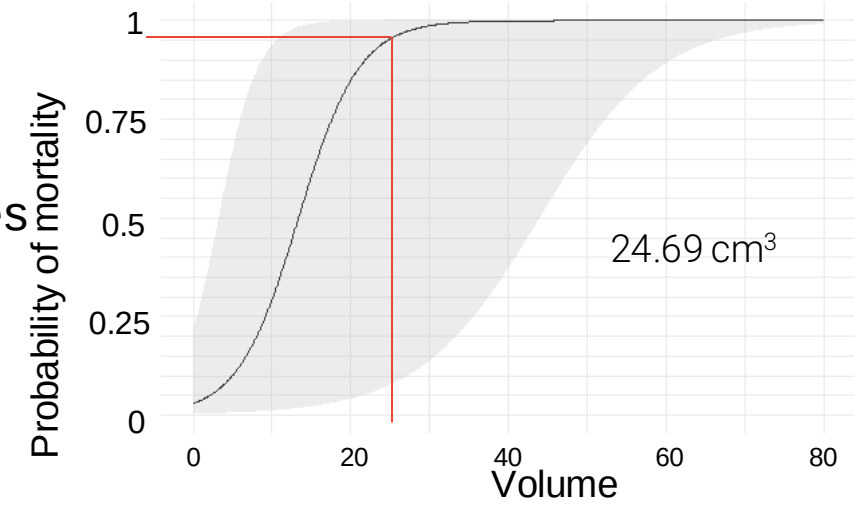
Sea Turtles



Marine mammals



Young Sea Turtles



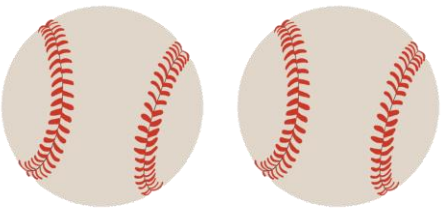
Mortality thresholds by plastic type & taxa

Mortality model	95% threshold (#)	95% threshold (size)
Birds		
Total plastic	16 pieces	2 cm^3
Hard plastic	23 pieces	1 cm^3
Rubber	7 pieces	2 cm^3
Mammals		
Total plastic	102 pieces	11,981 cm^3
Soft plastic	9 pieces	730 cm^3
Fishing Debris	202 pieces	652 cm^3
Adult turtles		
Total plastic	396 pieces	373 cm^3
Hard plastic	305 pieces	71 cm^3
Soft plastic	472 pieces	266 cm^3
Fishing debris	401 pieces	1181 cm^3
Young Turtles (<35cm)		
Total plastic	176 pieces	25 cm^3

2 sugar cubes

2.5 soccer balls

2 baseballs



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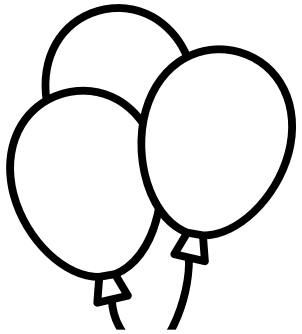
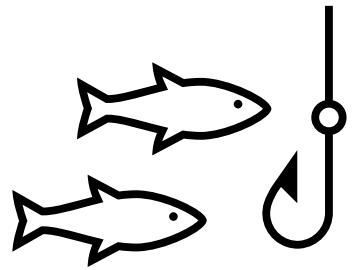
Macroplastics pose mortality risk to marine wildlife. Risk varies by plastic type and taxon.

Policy Implications

- Monitoring: Identify baseline and track management progress
- Risk assessment: Inform science-based targets
- Management: Prioritize policy and management approaches





Next Steps

- Short term:
  - Publish risk assessment and framework
  - Publish biota monitoring methods
- Long term:
  - International science working group
    - Integrate exposure into risk assessment tool
    - Develop monitoring protocol for the environment and biota
    - Create risk management framework

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