The necessity of power analysis to effectively monitor microplastics contamination in fish

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Acknowledgments

Ekaluktutiak Hunters and Trappers Organization

Environment and Climate Change Canada

Environnement et Changement climatique Canada

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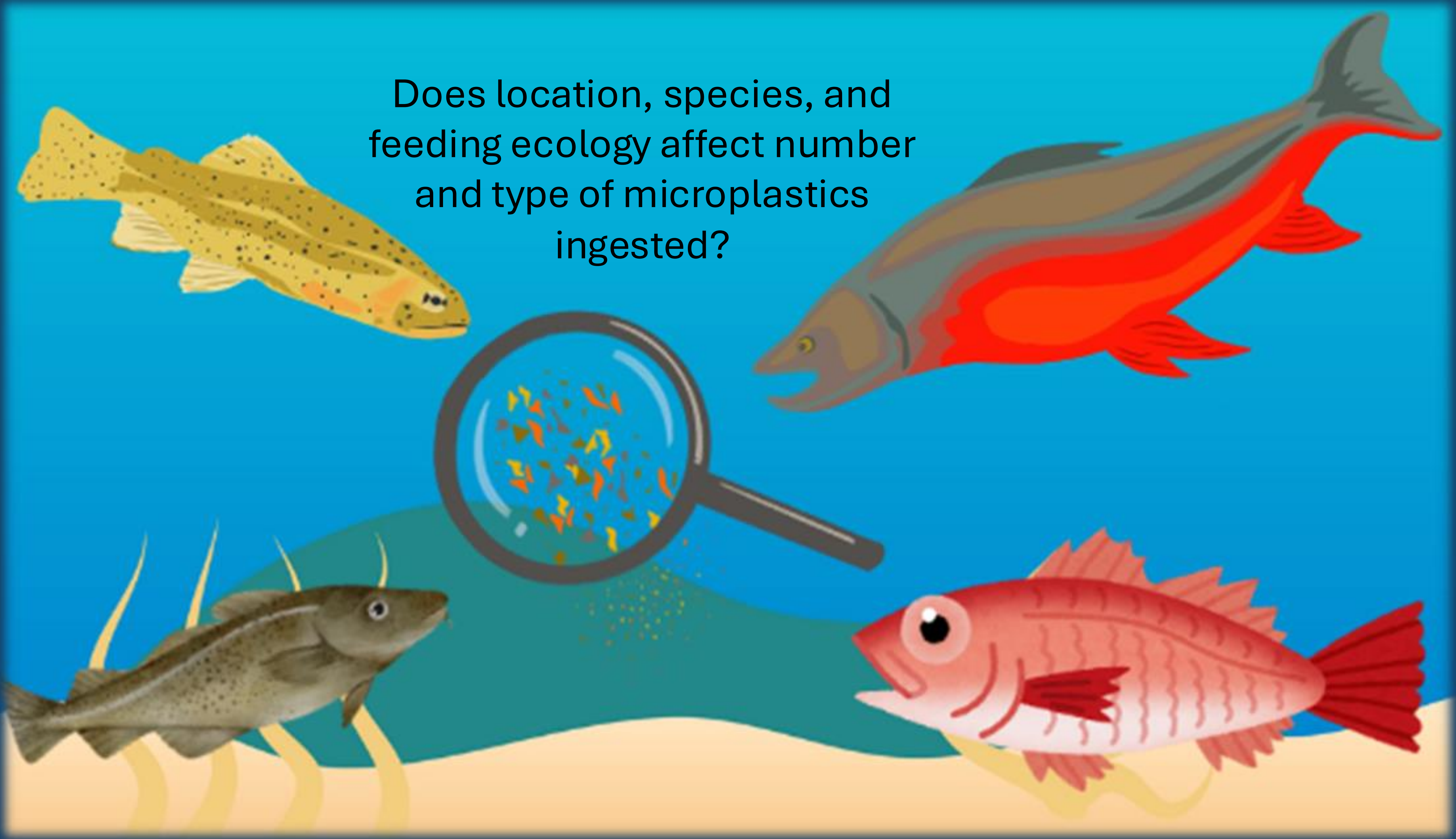
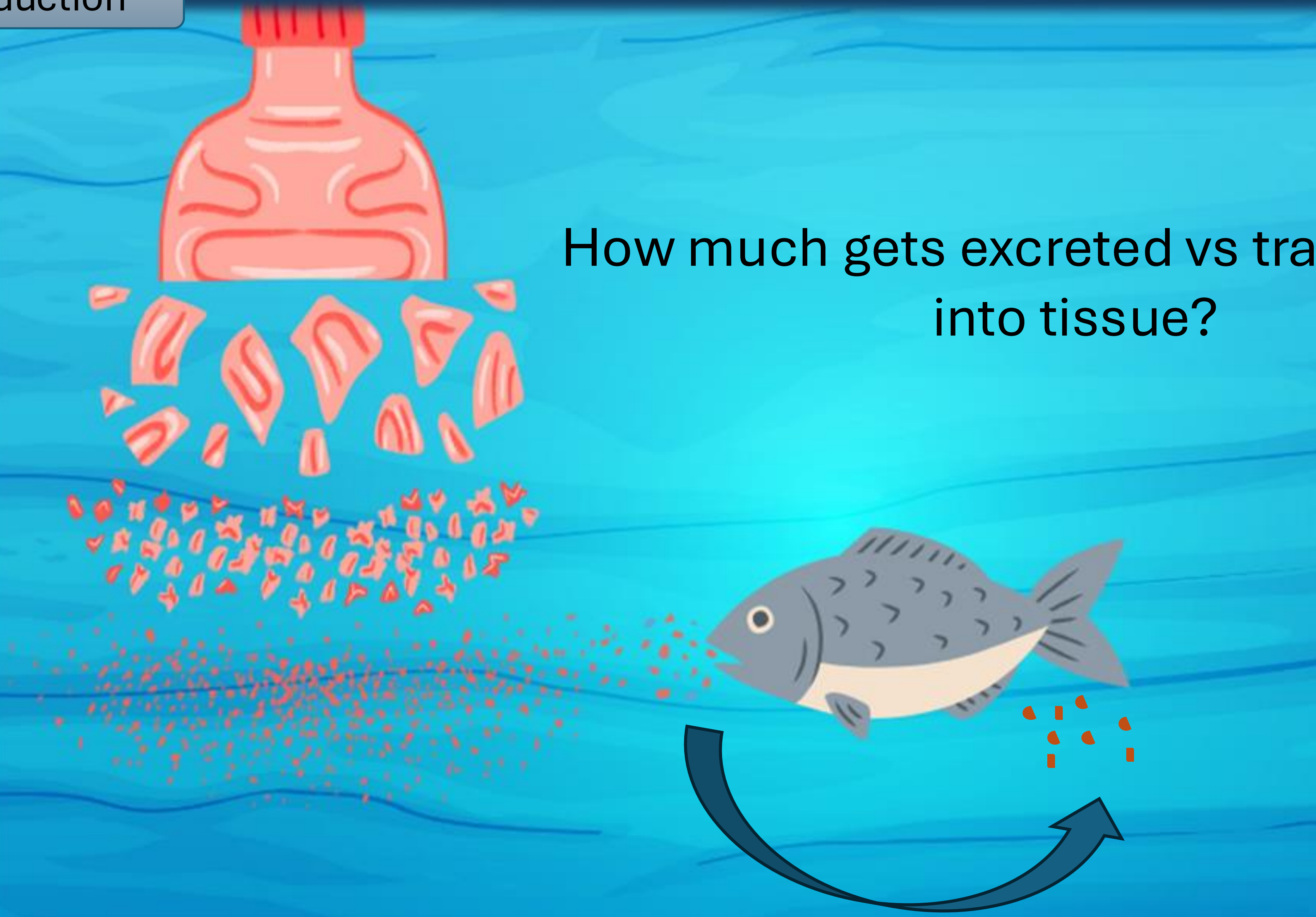
Introduction

Why are we here?


Does location, species, and
feeding ecology affect number
and type of microplastics
ingested?

How much gets excreted vs translocated into tissue?



What are our monitoring standards?

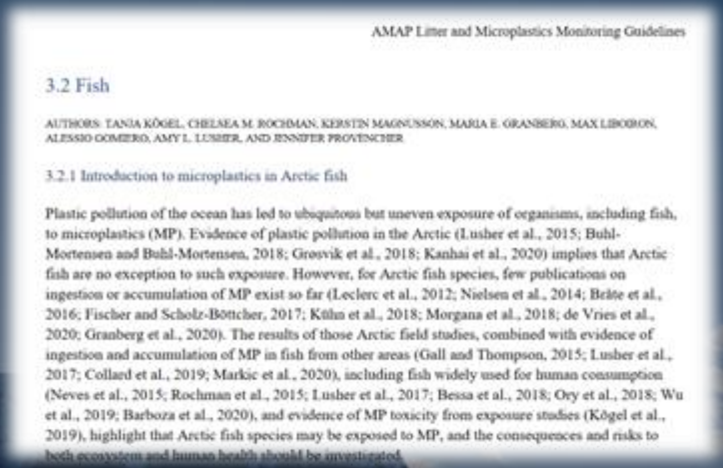
When do we have enough fish?

Does one sample size fit all (monitoring efforts)?

Power Analysis

Methods

Methods



AMAP Litter and Microplastics Monitoring Guidelines

3.2 Fish

AUTHORS: TANJA KÖGEL, CHELSEA M. ROCHMAN, KERSTIN MAGNUSSON, MARIA E. GRANBERG, MAX LIBOIRON, ALESSIO GOMIERO, AMY L. LUSHER, AND JENNIFER PROVENCHER

3.2.1 Introduction to microplastics in Arctic fish

Plastic pollution of the ocean has led to ubiquitous but uneven exposure of organisms, including fish, to microplastics (MP). Evidence of plastic pollution in the Arctic (Lusher et al., 2015; Buhl-Mortensen and Buhl-Mortensen, 2018; Grøsvik et al., 2018; Kanhai et al., 2020) implies that Arctic fish are no exception to such exposure. However, for Arctic fish species, few publications on ingestion or accumulation of MP exist so far (Leclerc et al., 2012; Nielsen et al., 2014; Bråte et al., 2016; Fischer and Scholz-Böttcher, 2017; Kühn et al., 2018; Morgana et al., 2018; de Vries et al., 2020; Granberg et al., 2020). The results of those Arctic field studies, combined with evidence of ingestion and accumulation of MP in fish from other areas (Gall and Thompson, 2015; Lusher et al., 2017; Collard et al., 2019; Markic et al., 2020), including fish widely used for human consumption (Neves et al., 2015; Rochman et al., 2015; Lusher et al., 2017; Bessa et al., 2018; Ory et al., 2018; Wu et al., 2019; Barboza et al., 2020), and evidence of MP toxicity from exposure studies (Kögel et al., 2019), highlight that Arctic fish species may be exposed to MP, and the consequences and risks to both ecosystem and human health should be investigated.

95% Confidence

80% Power

AMAP

10% difference in microplastic ingestion per monitoring period

Photos from AMAP

Methods

Criteria for selected studies:

Detection limit = < 500 μm, but > 10 μm

Strict quality assurance/control protocols

Representative of Arctic, Pacific, Atlantic, and Great Lakes

Methods


The Arctic:
Hamilton et al., 2024
The Atlantic:
Brawn et al., 2023
The Pacific:
Rochman et al., 2015
The Great Lakes:
Milne et al., 2024; Munno et al., 2022

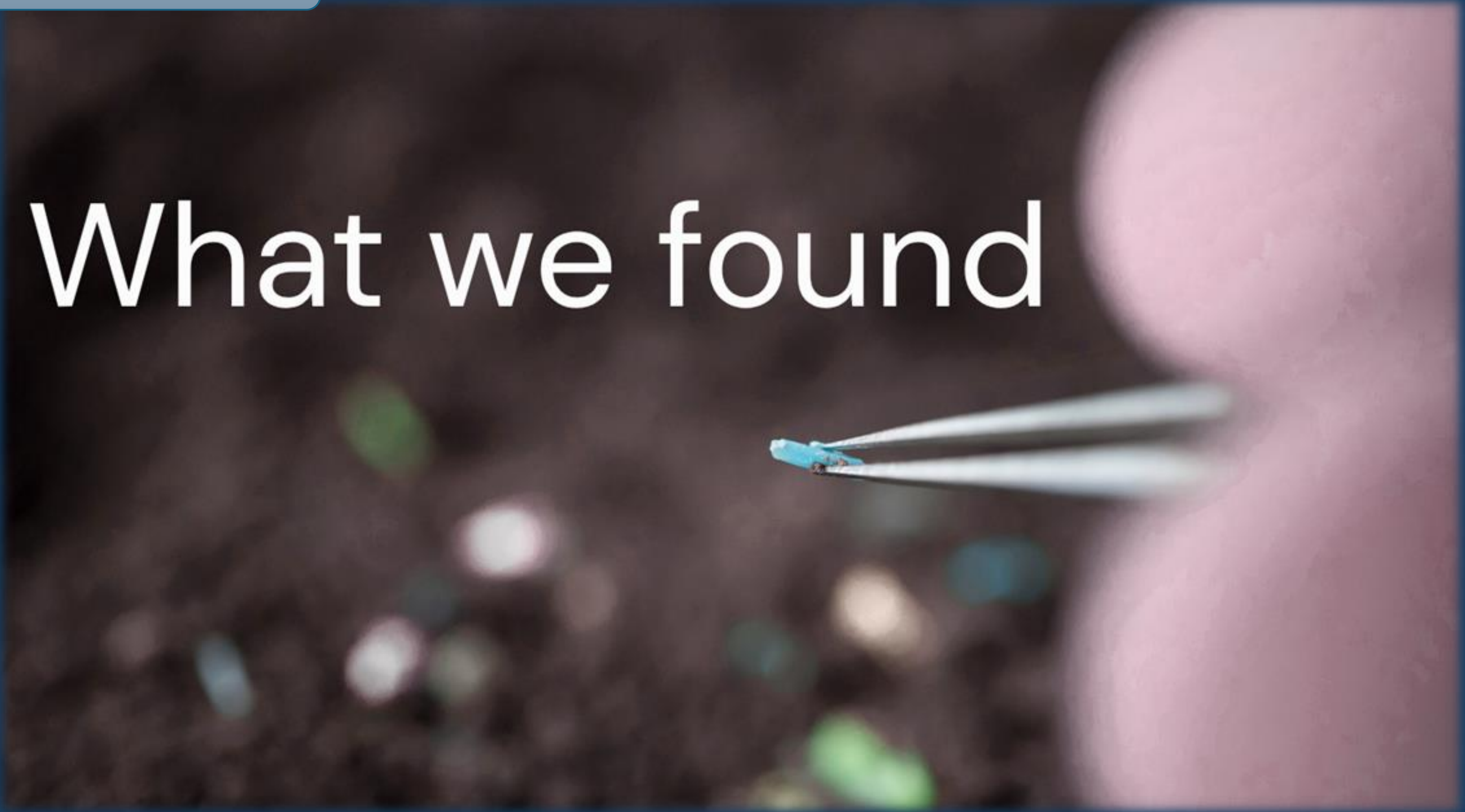
The Formula

Franeker and Meijboom, 2002

$$n = 2 \times \left\{ \frac{[z_{\alpha/2} - z_{\pi}] \times \frac{CV}{100} \times \mu_I}{\mu_I - 100} \right\}^2$$

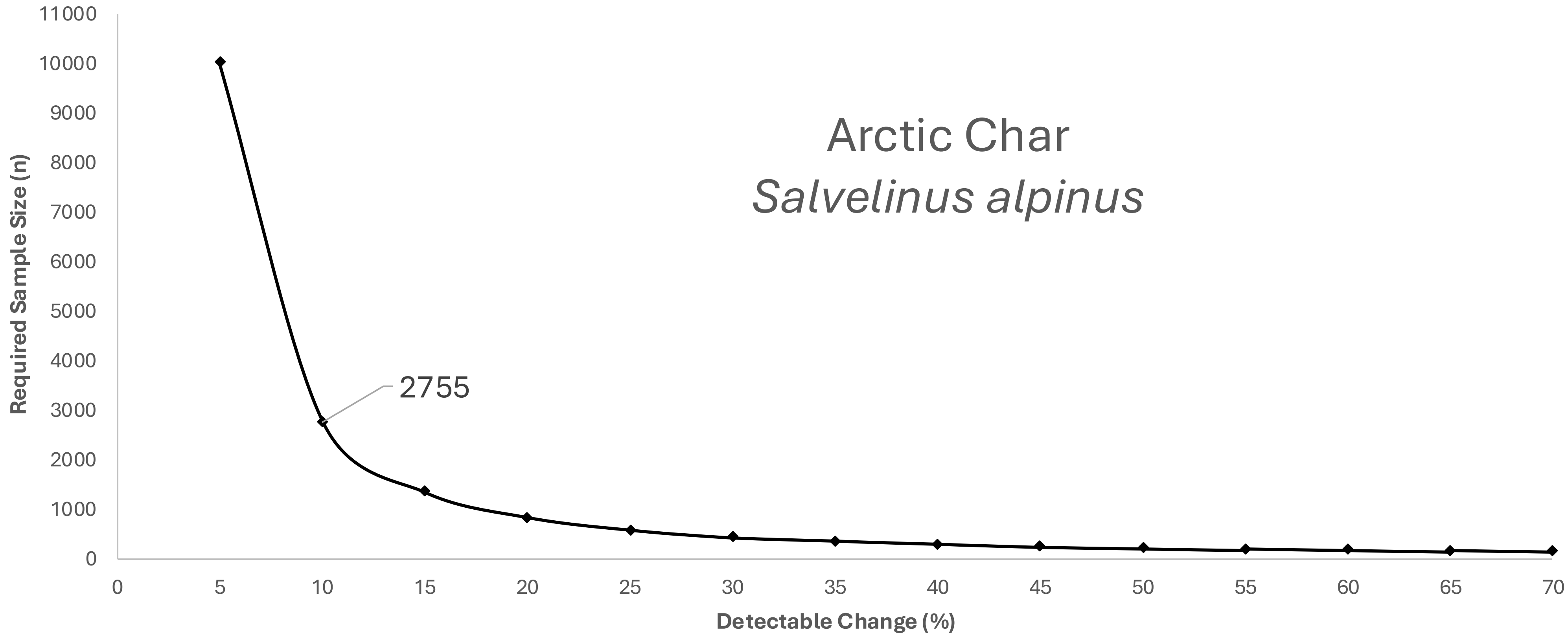
- $z_{\alpha/2}$ is the two-tailed t-score with infinite degrees of freedom and α = 0.05 (95% confidence)
  z_{π} is the left-tailed t-score with infinite degrees of freedom and π = 0.2 (80% power)
- CV is calculated using the mean and standard deviation of microplastics per individual $(\frac{SD}{\bar{x}}) \times 100$ = CV
- μ_I represents the % change of microplastic ingestion to be detected annually (e.g. 105 = 5%, 110 = 10%).

Results



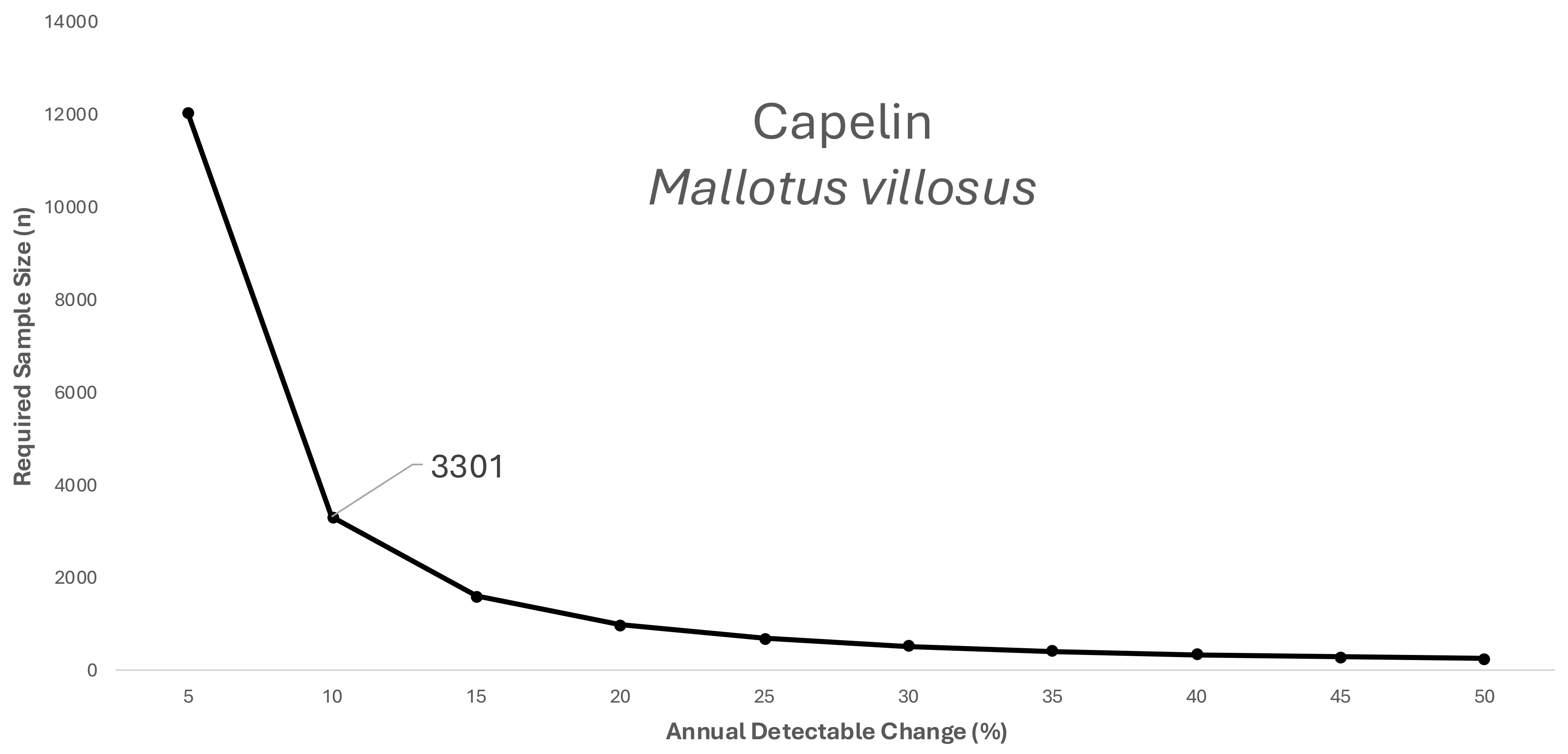
Results

The Arctic:
Nunavut

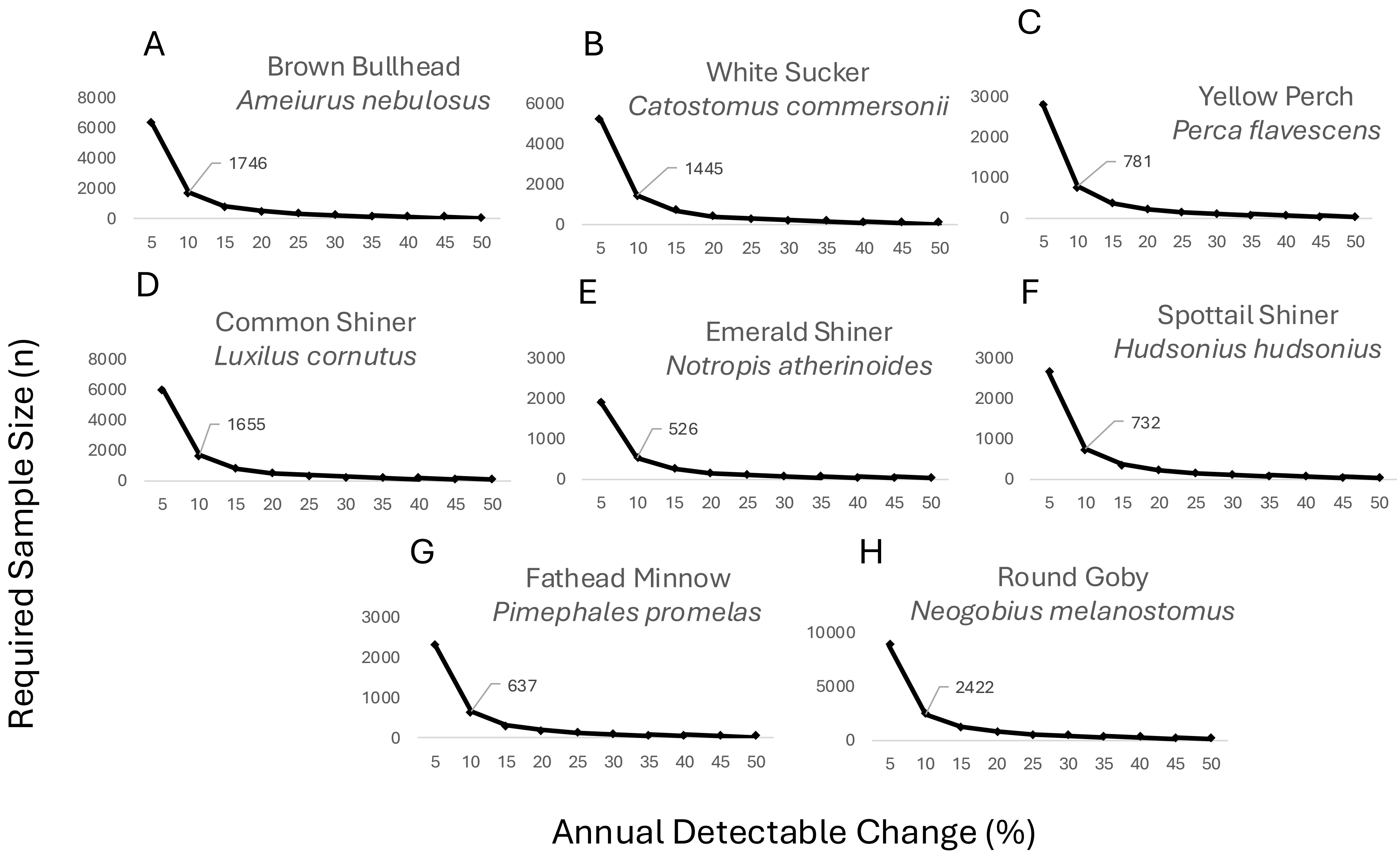


Results

The Atlantic: Iceland

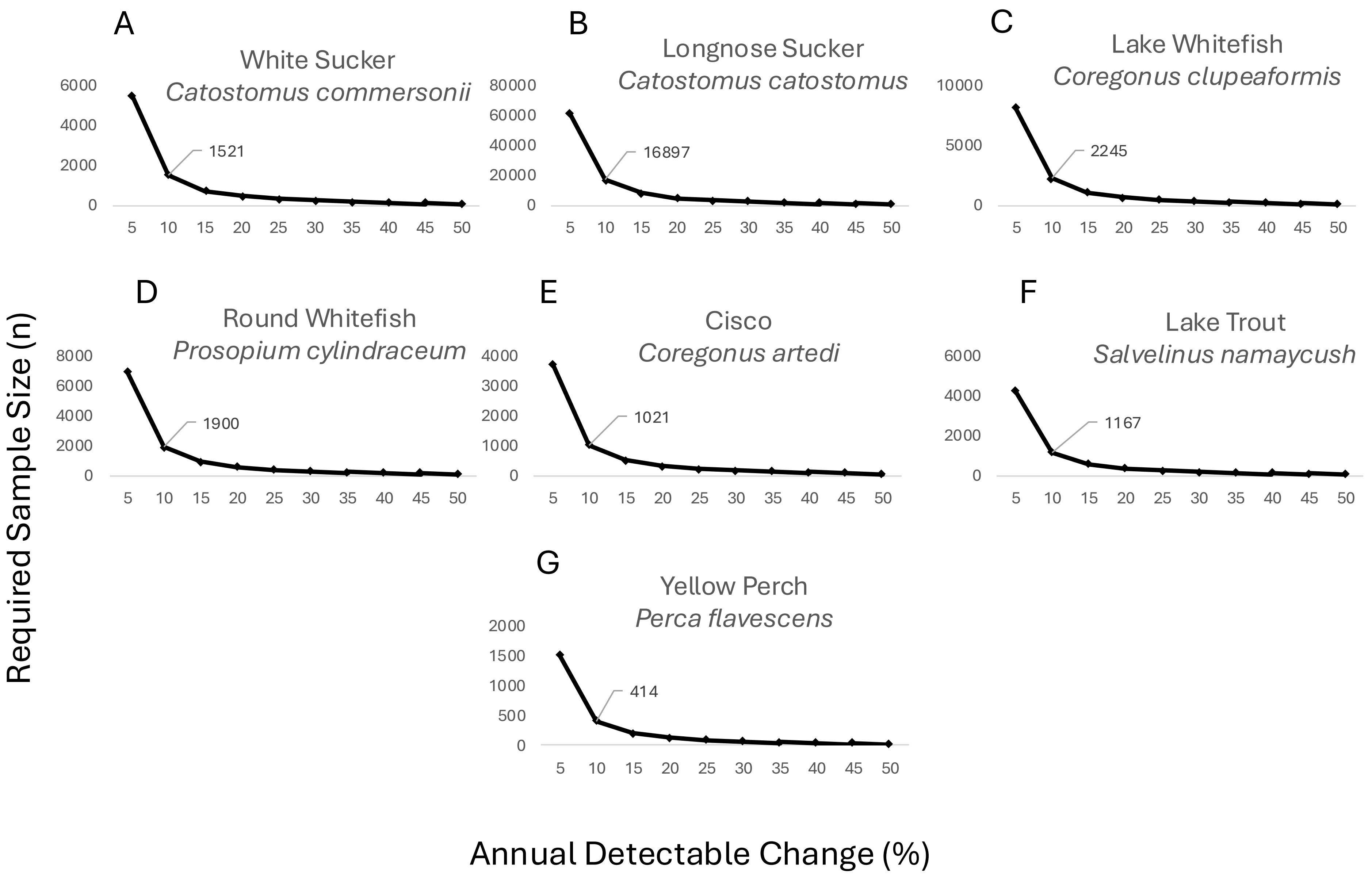


Great Lakes: Lake Ontario



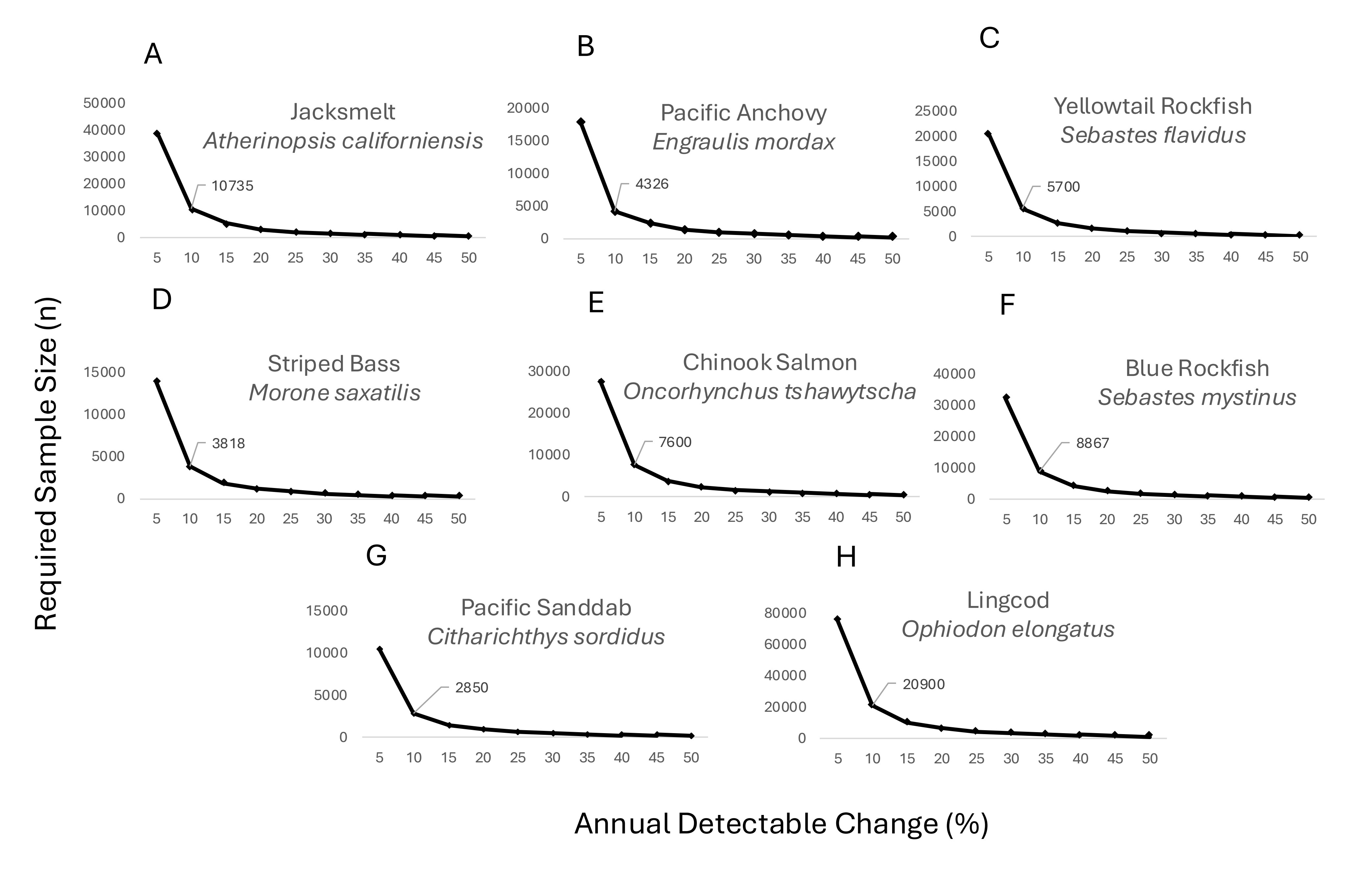
Results

Great Lakes: Lake Superior



Results

The Pacific: California



Discussion

Some problems to work through:

1. How do we get larger samples without more pressure on vulnerable populations?

2. How do you process sample sizes that BIG?

3. Is microplastic ingestion the best marker for monitoring?

Discussion

1.

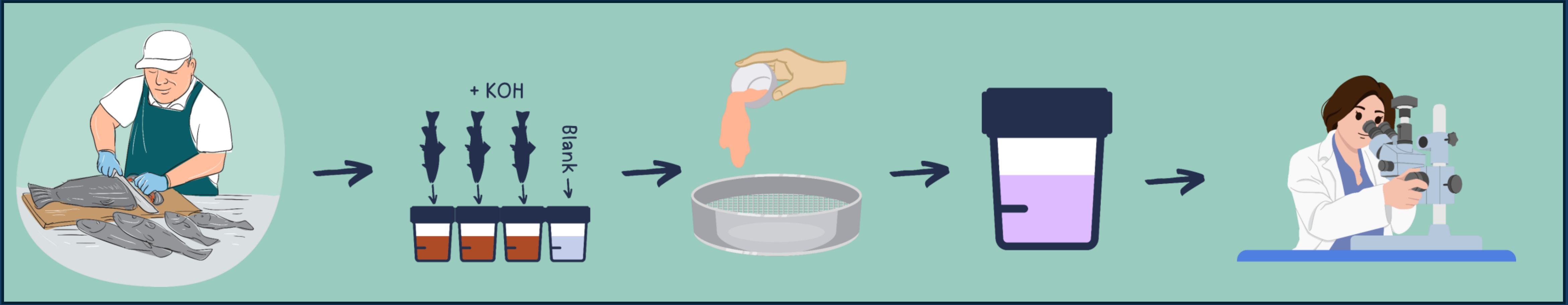
Work with commercial and industrial fisheries

Fish intestinal tracts not sold in market – available for us!

Opportunistic sampling of bycatch species

Discussion

2.

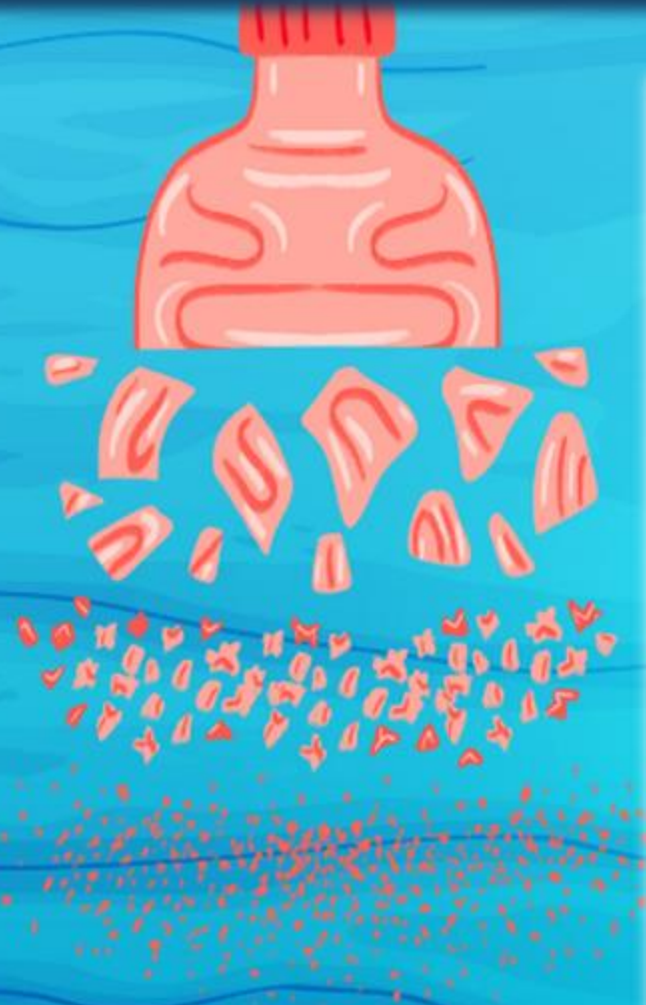


Incentivize participation for large fisheries companies

Make use of volunteers!

Discussion

3.



Environmental Science & Technology

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Article

Evidence of Microplastic Translocation in Wild-Caught Fish and Implications for Microplastic Accumulation Dynamics in Food Webs

Hayley K. McIlwraith,[∥] Joel Kim,[∥] Paul Helm, Satyendra P. Bhavsar, Jeremy S. Metzger, and Chelsea M. Rochman*

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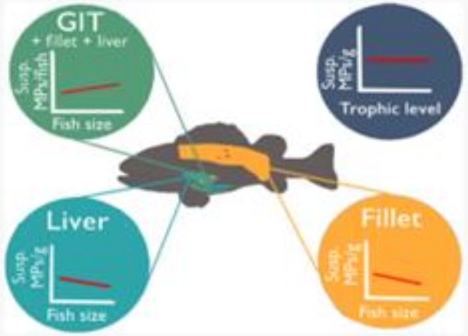
ABSTRACT: The presence of microplastics within the gut of animals is well documented. Whether microplastics bioaccumulate in organisms and biomagnify in food webs remains unclear and relies on the ability of microplastics to translocate to other tissues. Here, we demonstrate the widespread presence of microplastics and other anthropogenic microparticles in the gastrointestinal tract, fillet, and livers of seven species of sportfish from Lake Simcoe, Ontario, Canada. Larger fish had a higher microplastic load compared to smaller fish, but the opposite trend was observed with translocated microplastics standardized by fish mass (i.e., smaller fish contained more translocated particles per gram wet weight than larger fish). Moreover, we observed no evidence of biomagnification as there was no significant relationship between the trophic level and total or translocated microplastics per individual. Overall, this suggests that microplastics are translocating, but that excretion of translocated particles or growth dilution may be occurring rather than bioaccumulation and biomagnification. Moreover, the assemblages of shapes and material types varied among tissues, suggesting that particle characteristics may predict biological fate. Our findings highlight the need for further work to understand the mechanisms of microplastic translocation and excretion and the implications for the dynamics of microplastics accumulation in food webs and human exposure.



KEYWORDS: *plastic, translocation, bioaccumulation, growth dilution, biomagnification, freshwater fish*

Key Takeaways:

No “One Size Fits All” sample size for monitoring

Sample sizes needed to achieve these standards are out of reach

BUT

Include power analysis in monitoring programs

Questions?