

Tracking Trends in Urban Ecology: A Comparative Review of Marine, Terrestrial, and Freshwater Systems

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TESC 495

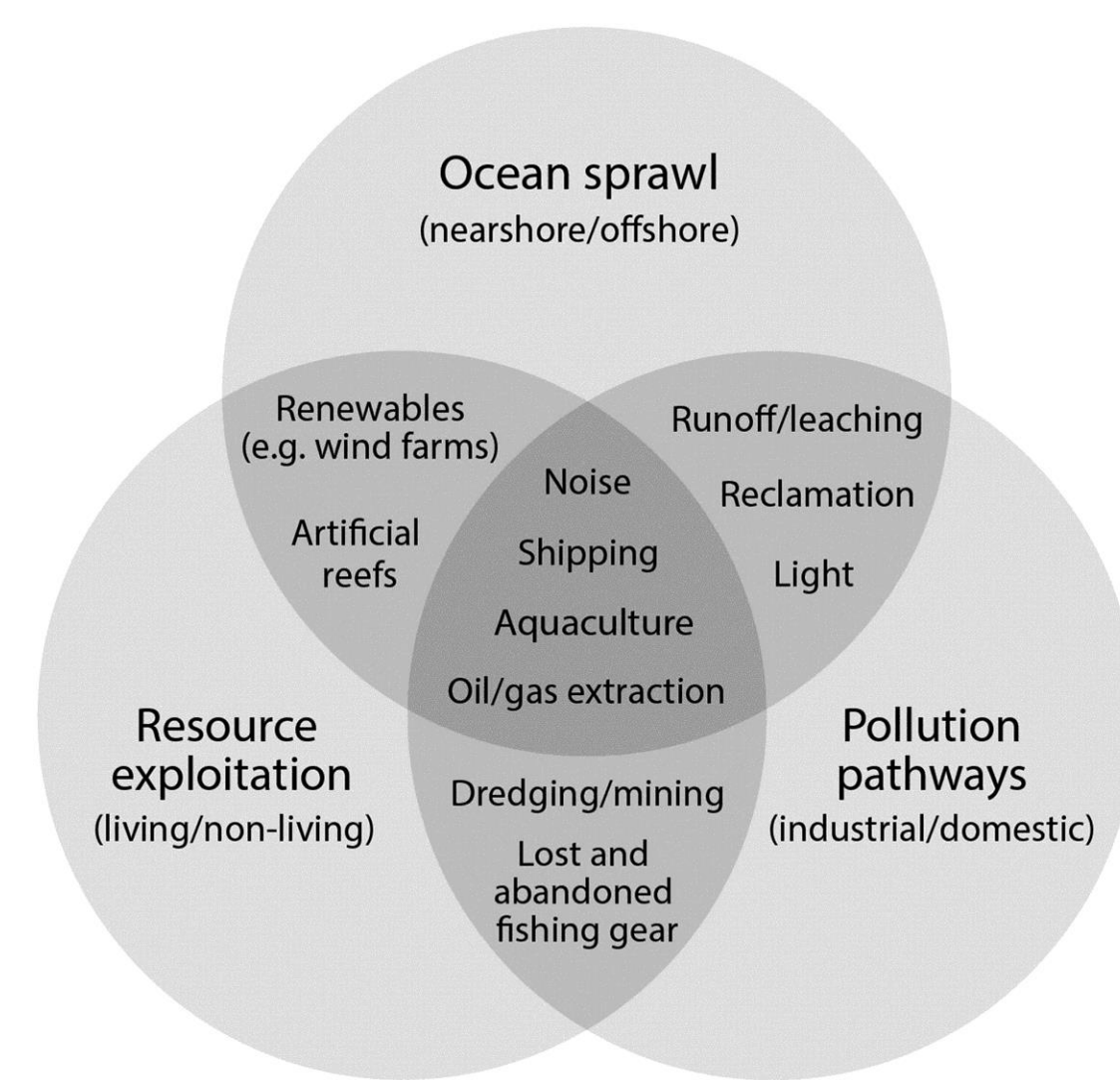


Introduction

Over 40% of the world's population now lives within 100 kilometers of the coast, and accelerating urbanization is transforming marine environments through the addition of artificial structures, altered nutrient flows, novel pollution pathways, and transformed habitats (Fig. 1).

Figure 1: Three main processes associated with urbanization in marine environments.

Source: [Todd et al. \(2019\) Oikos 128:9.](#)



Urban ecology emerged nearly half a century ago to address the ecological consequences of urbanization and to inform sustainable city planning. However, its historical development has been largely shaped by terrestrial and freshwater systems.

Our study asks:

Are marine ecological studies less likely to be urban-focused than their terrestrial and freshwater counterparts?

To answer this, we conducted an AI-assisted review of peer-reviewed ecological research articles published across 22 journals. We queried a large language model in order to classify each article by ecosystem type and performed randomized checks of AI assignments to assess accuracy rate.

We then ascribed articles as 'urban-related' or NOT 'urban-related' based on a series of keywords which had previously been used to designate urban ecology works (Flaminio et al. 2024).

By quantifying the representation of urban studies across ecosystem types, we aim to identify whether there is a persistent bias against marine-focused papers in contemporary urban ecology research—and what implications that might hold for the future of the field.

Methods

To evaluate this question, we:

1. Built a database of 70,286 articles from 22 leading ecology journals.

Abstracts and metadata for each article were accessed through the CrossRef API using the R package rcrossref.

2. Classified each article into one of four ecosystem types using GPT-3.5: marine, freshwater, terrestrial, or uncertain.

Queries used a standardized prompt and were performed via ChatGPT's API using an R script. A subset (2.5%) of results was independently reviewed by human coders. Comparison between AI and human reviewers revealed a low AI misclassification rate of 0.6%. Based on these comparisons and a partial audit of human classification errors, we conservatively assumed a 5% overall misclassification rate, which informed sensitivity analyses (below).

3. Identified urban-focused studies via keywords

To determine whether a study was urban-focused, we applied a keyword-based approach inspired by Flaminio et al. (2024). Our keyword set was expanded to capture a broader range of urban-related themes in marine systems, including terms associated with ocean sprawl, artificial structures, pollution pathways, and urbanized coastlines. Articles were labeled as urban if they contained one or more of these keywords in the title or abstract, and non-urban otherwise.

4. Used a mixed-effects logistic regression model to test whether marine studies were less likely to be urban-focused.

The model predicted the likelihood of a study being urban-focused based on study type (marine, freshwater, or terrestrial) and publication year as fixed effects, with journal included as a random intercept to account for variation across journals. The final model structure was:

$$\text{Urban-Focused (binary)} \sim \text{Study Type} + \text{Year} + (1 \mid \text{Journal})$$

This model was selected after comparing a suite of candidate models using Akaike's Information Criterion (AIC).

5. Conducted Monte Carlo sensitivity analysis

To test the robustness of our findings to potential classification error, we performed a Monte Carlo-style sensitivity analysis (100 simulations with 5% random reclassification).

Results

Marine studies were significantly less likely to be urban-focused than their terrestrial and freshwater counterparts. This finding was consistent across 100% of sensitivity iterations.

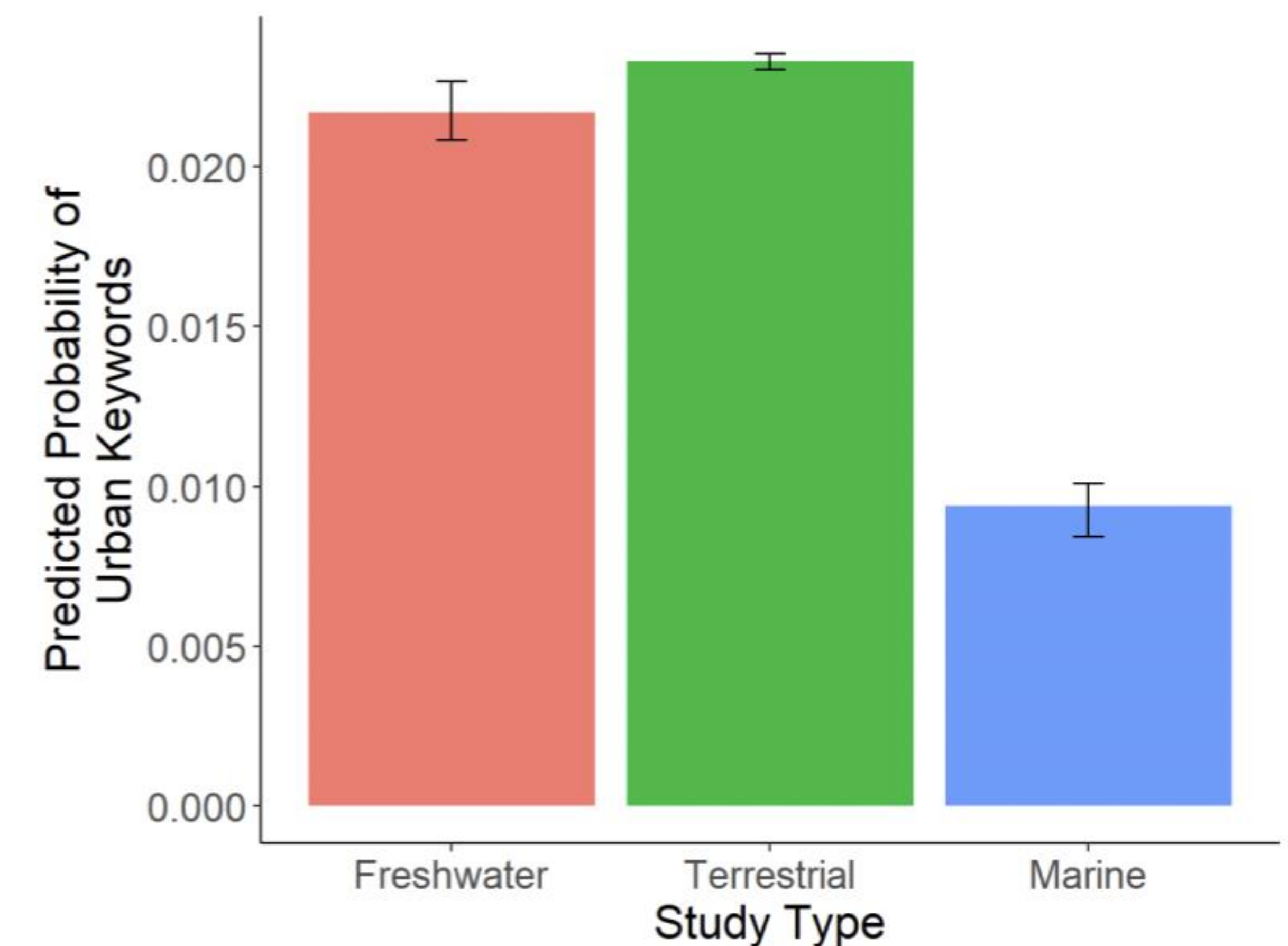


Figure 2: Comparison of predicted probability of urban keywords including "freshwater", "terrestrial" and "marine" shows a significantly lower odds of Marine being urban focused. In 100% of the iterations, the study type was significant.

Over time, marine studies were significantly less likely to be urban-focused than terrestrial and freshwater studies ($p < 0.0001$).

Conclusion

Urban-focused research remains a small portion of the ecological literature we reviewed and tends to focus primarily on terrestrial and freshwater environments, despite growing awareness of the impacts of urbanization in the marine realm. To address this, we recommend:

- Increased funding and logistical support for urban marine fieldwork
- Expanded editorial prioritization of urban marine ecology
- Reframing marine ecology training and outreach to include urban environments as essential research frontiers

References

Flaminio et al. (2024) The urban in ecology: A quantitative textual analysis of the scientific literature over a century. *Urban Ecosystems* 27: 2531—2542.