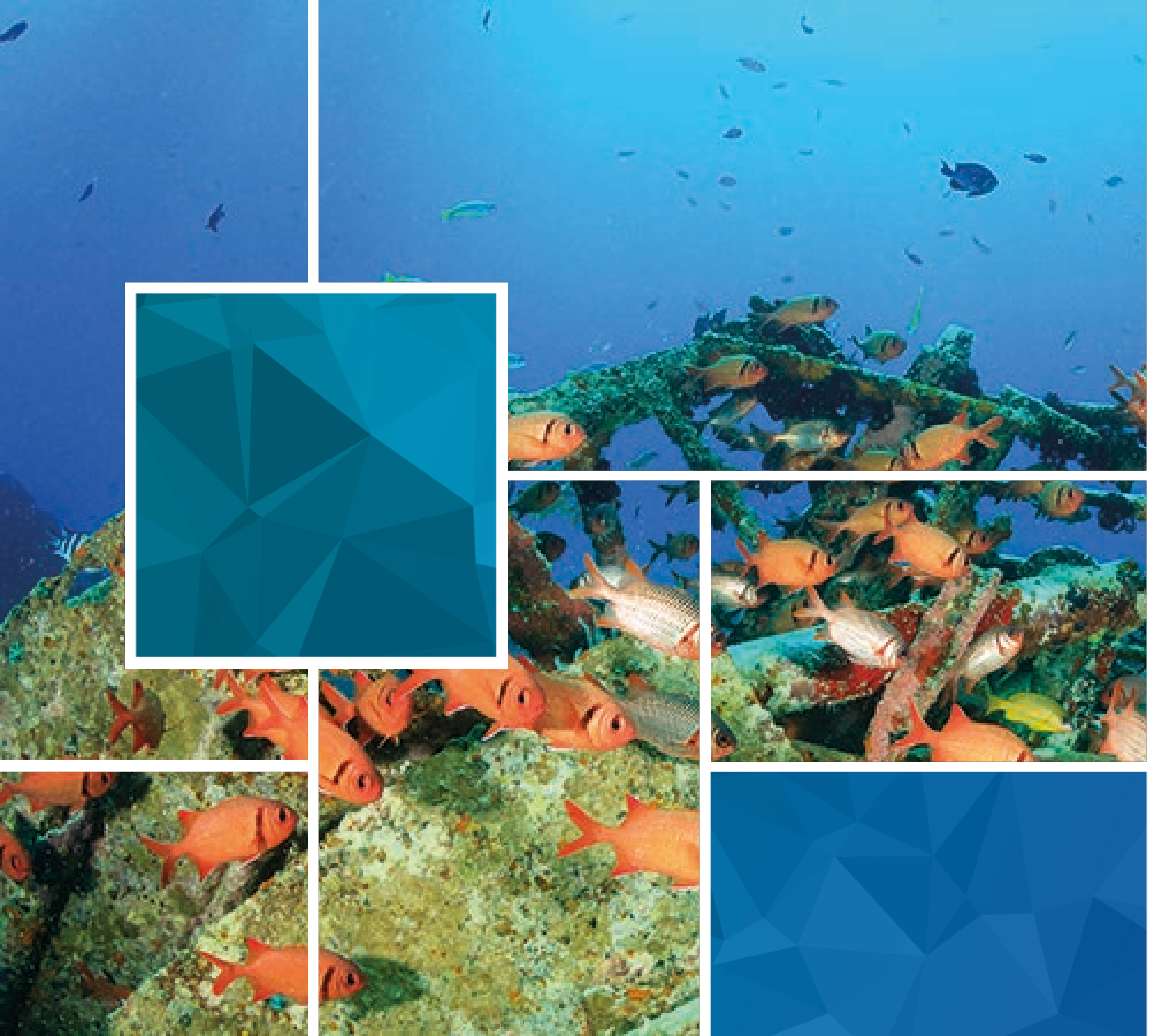


Hydrobiology

INNOVATING OFFSHORE DECOMMISSIONING - *PROTECTING BIODIVERSITY AND MICROPLASTIC GUIDELINE DEVELOPMENT*

Dr Sander Scheffers
Alec Bannam
Matt Germs

Perth
19 February 2025

INTRODUCTION

What is offshore decommissioning?

Removing, repurposing, or converting disused offshore infrastructure.

Why is it important?

Biodiversity protection and sustainable marine resource management.

Addressing emerging environmental concerns such as microplastic pollution.

Scope of the presentation

Innovations in offshore decommissioning.

Biodiversity conservation approaches.

Development of microplastic management guidelines.

DR SANDER SCHEFFERS

PhD Marine Ecology

MSc Marine Biology

Principal Scientist - Hydrobiology

25 Years experience with:

- Ecotoxicology
- Marine Ecology
- Coral Reef Ecology
- Physical & Chemical Oceanography
- Biogeochemistry

100s Of Industry reports, Independent Peer Reviews, 97 Peer-reviewed publications, books.

Organisation for Economic Co-operation and Development (OECD) Expert Steering Committee on *Nanoplastics Safety Testing* – Australian delegate

Society for Underwater Technology (SUT) – Marine Energy Transition & Renewables Sub-Committee

Environmental Consultants Association Committee

OFFSHORE BIODIVERSITY AND DECOMMISSIONING - 1

Artificial Reefs and Marine Life

- Offshore structures can enhance marine biodiversity by acting as artificial reefs-hard substrate.

Balancing Benefits and Risks

- Habitat preservation vs. environmental contamination concerns.
- Fisheries and ecosystem service impacts.

INNOVATIONS IN OFFSHORE DECOMMISSIONING

Key approaches

Rigs to reefs

- Converting offshore structures into marine habitats

Advancements in Ecotoxicology

- Improved testing methods for assessing environmental impacts.

Regulatory Developments

- Emerging global frameworks for sustainable decommissioning

CASE STUDY - RIGS TO REEFS

Success Stories

- Examples of projects demonstrating biodiversity enhancement.
- Scientific evidence supporting ecological benefits.

Challenges

- Regulatory approvals and policy constraints.
- Addressing liability and long-term ecosystem monitoring.

OFFSHORE BIODIVERSITY AND DECOMMISSIONING - 2

Rev Fish Biol Fisheries (2021) 31:1009–1023
https://doi.org/10.1007/s11160-021-09686-4

Check for updates

ORIGINAL RESEARCH

Quantifying fishing activity targeting subsea pipelines by commercial trap fishers

Todd Bond · Dianne L. McLean · Corey B. Wakefield · Julian C. Partridge · Jane Prince · David White · Dion K. Boddington · Stephen J. Newman

Frontiers in Marine Science Follow

Article | Full-text available

Marine life and fisheries around offshore oil and gas structures in southeastern Australia and possible consequences for decommissioning

November 2022 · Frontiers in Marine Science 9
DOI: 10.3389/fmars.2022.979212

Tiffany Sih · Katherine Cure · I. Noyan Yilmaz · Show all 5 authors · Peter Macreadie

1. **Limited overlap exists between fisheries and offshore structures**, with only 10% of species around oil and gas platforms matching those targeted by **commercial** fishers.
2. **Pipelines and platforms support distinct marine communities**, with **pipelines** hosting more invertebrates near the seabed and **platforms** providing vertical habitats & **connectivity** for diverse fish species.

CASE STUDY 1: NORTH-WEST SHELF

THE INFLUENCE OF DEPTH AND A SUBSEA PIPELINE ON FISH ASSEMBLAGES AND COMMERCIALLY FISHED SPECIES

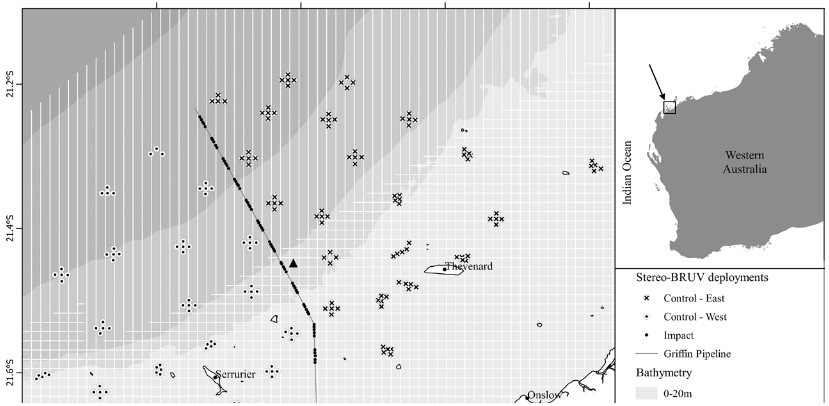
Overview:

• Stereo-BRUVs □ species richness, abundance, and size

• 42.3 km subsea pipeline and adjacent habitats.

• Pipeline depth **=** 9 m (nearshore) to 140 m (offshore)

• Off-pipeline surveys covered 'natural habitats' (i.e. sand, macroalgae, coral reef) from 1–40 km from the pipeline.



Fish Data:

• 14,953 fish total, 240 species (131 on-pipeline, 225 off-pipeline), 59 families (39 on-pipeline, 56 off-pipeline).

• Fish assemblages were similar at depths <80 m but differed >80 m, where off-pipeline habitat was mostly sand.

Bond, T., Partridge, J. C., Taylor, M. D., Cooper, T. F., & McLean, D. L. (2018). The influence of depth and a subsea pipeline on fish assemblages and commercially fished species. *PLoS ONE*, *13*(11). https://doi.org/10.1371/journal.pone.0207703

CASE STUDY 1: NORTH-WEST SHELF

THE INFLUENCE OF DEPTH AND A SUBSEA PIPELINE ON FISH ASSEMBLAGES AND COMMERCIALLY FISHED SPECIES

On-Pipeline Areas:

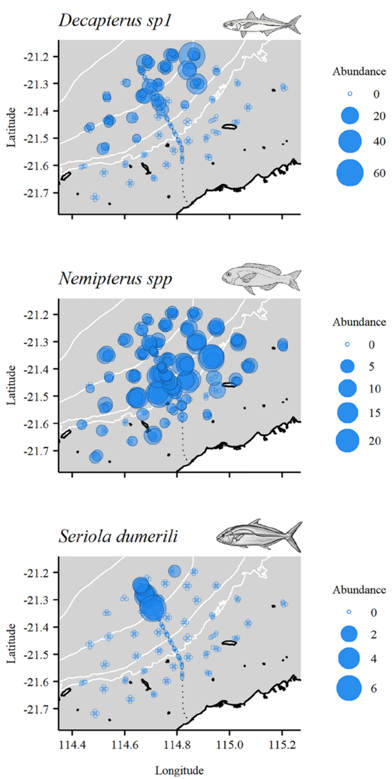
Pipeline supported larger-bodied, commercially valuable species:

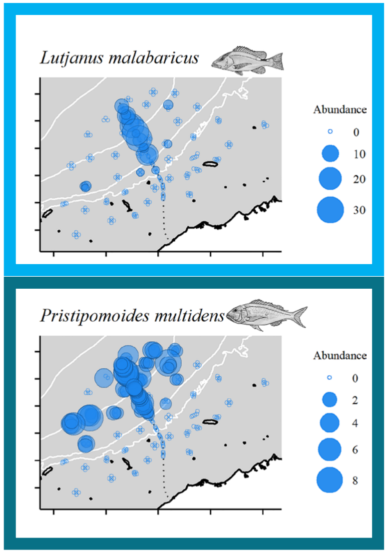
- Goldband snapper (Pristipomoides multidens),Saddletail snapper (Lutjanus malabaricus), Moses' snapper (Lutjanus russellii)

Off-Pipeline Areas:

Had higher abundances of non-commercial species:

- Yellowtail scad (Atule mate), Threadfin bream (Nemipterus spp.), Crescent grunter (Terapon jarbua)





Spatial distribution of the relative abundance of key species in depths >80 m.

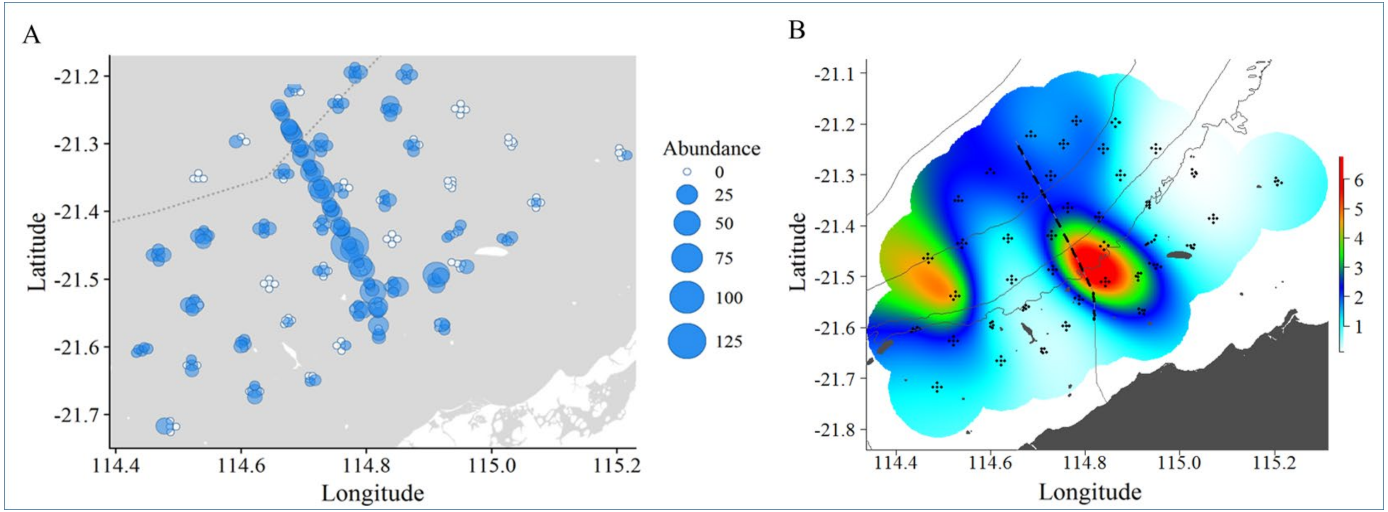
Bond, T., Partridge, J. C., Taylor, M. D., Cooper, T. F., & McLean, D. L. (2018). The influence of depth and a subsea pipeline on fish assemblages and commercially fished species. *PLoS ONE*, *13*(11). https://doi.org/10.1371/journal.pone.0207703

CASE STUDY 1: NORTH-WEST SHELF

THE INFLUENCE OF DEPTH AND A SUBSEA PIPELINE ON FISH ASSEMBLAGES AND COMMERCIALLY FISHED SPECIES

Relative abundance and spatial distribution of biomass of commercial fish species.

- Pipeline had 2–3 times higher commercial catch value per deployment than off-pipeline habitats



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CASE STUDY 1: NORTH-WEST SHELF

THE INFLUENCE OF DEPTH AND A SUBSEA PIPELINE ON FISH ASSEMBLAGES AND COMMERCIALLY FISHED SPECIES

Depth	Location	Relative abundance (mean ± SE)	Species richness (mean ± SE)	Biomass (kg) (mean ± SE)	Mean catch value per deployment ($AUD mean ± SE)
All	Pipeline	12.98 ± 2.49	2.67 ± 0.24	3.91 ± 0.82	32.87 ± 8.21
	Off Pipeline	2.51 ± 0.36	1.02 ± 0.09	1.82 ± 0.31	15.62 ± 2.97
<40 m	Pipeline	10.25 ± 3.43	0.79 ± 0.12	4.10 ± 1.90	33.21 ± 19.10
	Off Pipeline	2.52 ± 0.64	1.14 ± 0.30	1.67 ± 0.32	15.81 ± 5.10
40–80 m	Pipeline	19.08 ± 9.22	3.39 ± 0.50	5.65 ± 2.08	50.40 ± 22.26
	Off Pipeline	1.83 ± 0.55	1.14 ± 0.30	2.31 ± 0.72	16.21 ± 5.11
>80 m	Pipeline	12.07 ± 2.24	3.15 ± 0.31	2.89 ± 0.60	23.86 ± 4.75
	Off Pipeline	2.89 ± 0.41	1.39 ± 0.13	1.75 ± 0.41	14.98 ± 3.84

The mean total biomass (kg) of major commercial species and the mean 'catch value' per deployment ($) of all major commercial species on and off-pipeline for each depth category and the entire study area.

Bond, T., Partridge, J. C., Taylor, M. D., Cooper, T. F., & McLean, D. L. (2018). The influence of depth and a subsea pipeline on fish assemblages and commercially fished species. *PLoS ONE*, *13*(11). https://doi.org/10.1371/journal.pone.0207703

CASE STUDY 2: NORTH-WEST SHELF

FISH ASSOCIATIONS WITH SHALLOW WATER SUBSEA PIPELINES COMPARED TO SURROUNDING REEF AND SOFT SEDIMENT HABITATS

Case study:

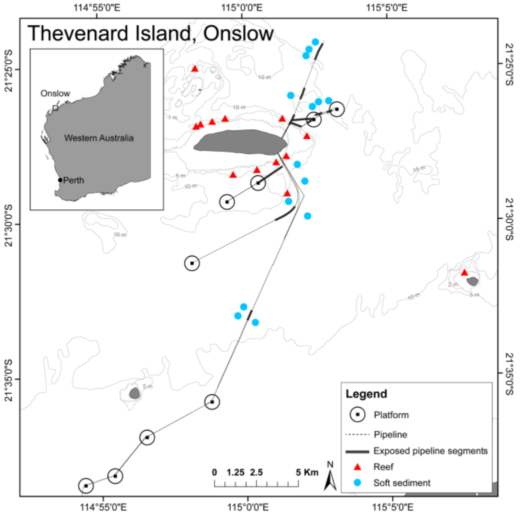
Fish assemblages on inshore subsea pipelines (North-West Shelf, WA) were compared to natural reef and soft sediment habitats using stereo-ROVs.

Fish species richness, abundance, biomass, feeding guilds, and economic value were analysed across habitats.

Pipelines had distinct fish communities with higher abundance and biomass of higher trophic level fish, including commercially and recreationally valuable species.

Biomass on pipelines was:

- 20× greater than soft sediments.
- Similar to natural reefs.
- 3.5× greater than reefs for commercially important species.
- 44.5× greater than soft sediments for commercially important species.



Schramm, K. D., Marnane, M. J., Elsdon, T. S., Jones, C. M., Saunders, B. J., Newman, S. J., & Harvey, E. S. (2021). Fish associations with shallow water subsea pipelines compared to surrounding reef and soft sediment habitats. *Scientific Reports*, *11*(1). https://doi.org/10.1038/s41598-021-85396-y

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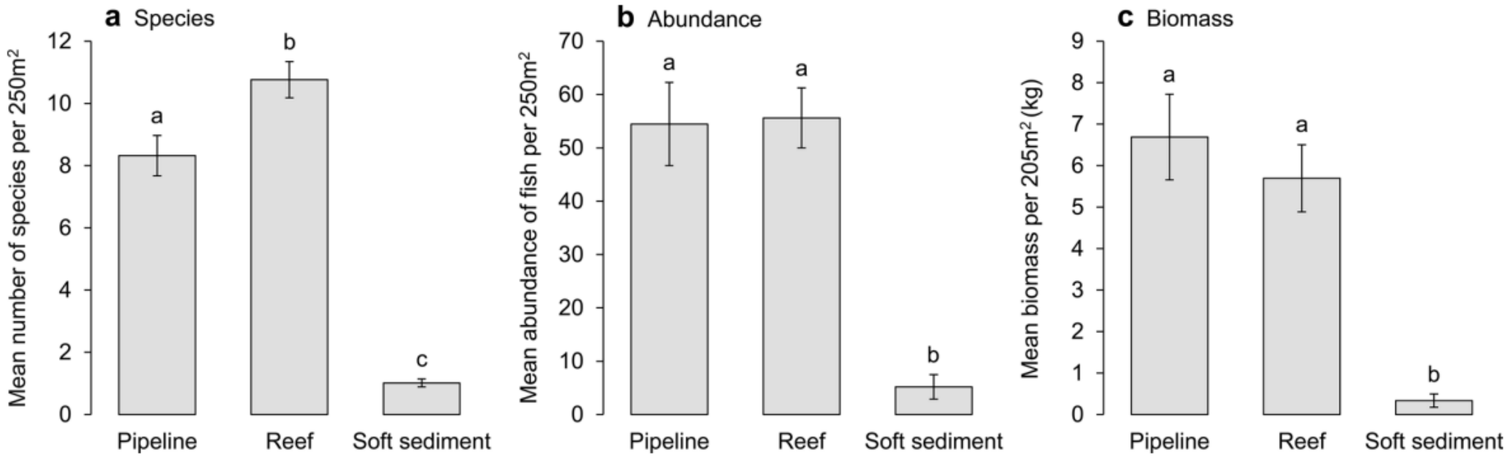


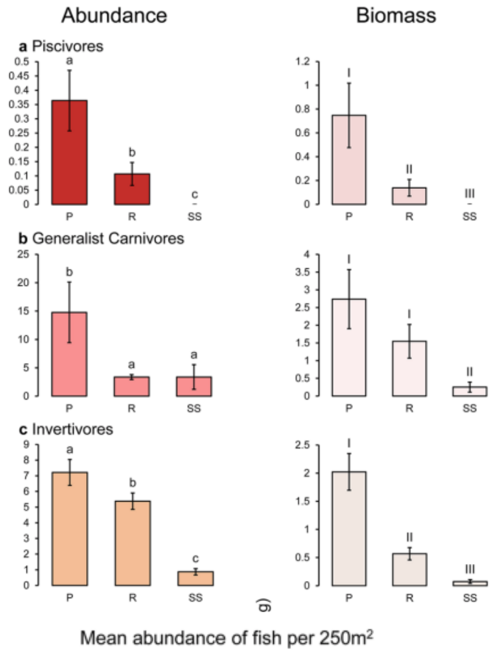
Mean (± SE) number of species (a), abundance (b), and biomass of fish (kg) (c) per transect (50 m×5 m, 250 m2) for pipeline, reef, and soft sediment habitats.

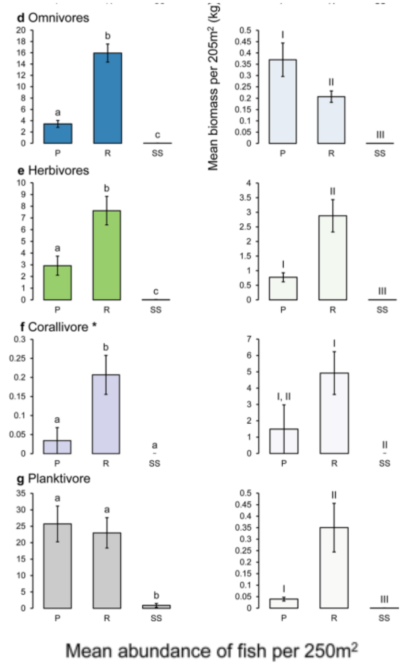
Schramm, K. D., Marnane, M. J., Elsdon, T. S., Jones, C. M., Saunders, B. J., Newman, S. J., & Harvey, E. S. (2021). Fish associations with shallow water subsea pipelines compared to surrounding reef and soft sediment habitats. *Scientific Reports*, *11*(1). https://doi.org/10.1038/s41598-021-85396-y

CASE STUDY 2: NORTH-WEST SHELF

FISH ASSOCIATIONS WITH SHALLOW WATER SUBSEA PIPELINES COMPARED TO SURROUNDING REEF AND SOFT SEDIMENT HABITATS

Mean (±SE) abundance and biomass of fish per transects (50 m×5m×5m) for feeding guilds:





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CASE STUDY 3: WEST AFRICA

MARINE COMMUNITIES ON OIL PLATFORMS IN GABON, WEST AFRICA: HIGH BIODIVERSITY OASES IN A LOW BIODIVERSITY ENVIRONMENT

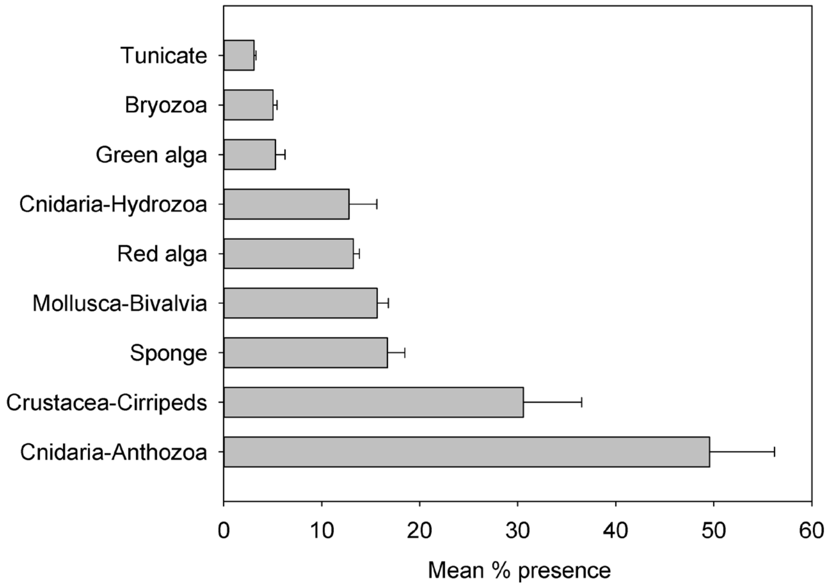
Benthic community differences:

Older, larger northern platforms

- Dominated by solitary cup coral (*Tubastraea* sp.).

Newer, southern or nearshore platforms

- Dominated by barnacle (*Megabalanus tintinnabulum*) with more diverse benthic assemblages.
- No zooxanthellated scleractinian corals found on platforms, though they occur on natural rocky substrates in Gabon.



Friedlander, A. M., Ballesteros, E., Fay, M., & Sala, E. (2014). Marine communities on oil platforms in Gabon, West Africa: High biodiversity oases in a low biodiversity environment. *PLoS ONE*, *9*(8). https://doi.org/10.1371/journal.pone.0103709

CASE STUDY 3: WEST AFRICA

MARINE COMMUNITIES ON OIL PLATFORMS IN GABON, WEST AFRICA: HIGH BIODIVERSITY OASES IN A LOW BIODIVERSITY ENVIRONMENT

Fish Biomass & Assemblages

- Some platforms had fish biomass exceeding one ton.
- Dominant species included:
  - Barracuda (*Sphyraena* spp.)
  - Jacks (Carangidae)
  - Rainbow runner (*Elagatis bipinnulata*)
- 34% of recorded fish species were new to Gabon, 6% new to tropical West Africa.
- Fish assemblages had amphi-Atlantic affinities, suggesting platforms may extend species' distributions into West Africa.

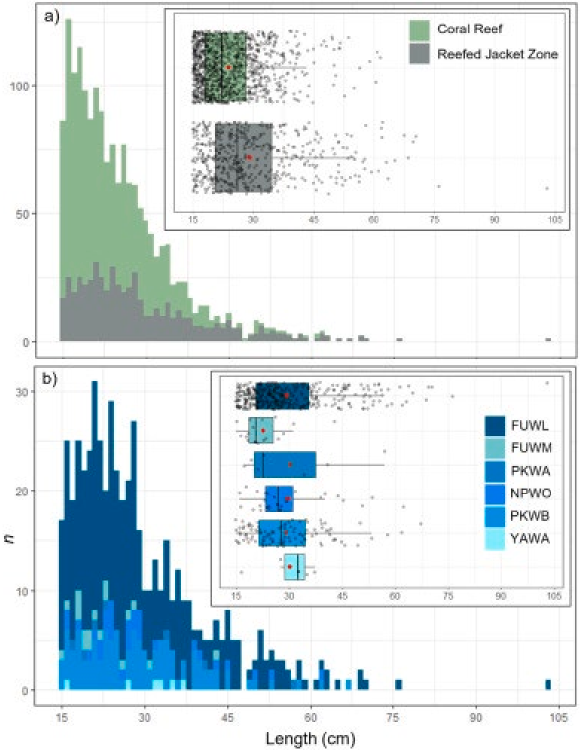
Ecological Implications

- Potential invasive species observed: Snowflake coral (*Carijoa riisei*).
- Oil platforms may act as biodiversity stepping- stones but also as vectors for invasive species

Friedlander, A. M., Ballesteros, E., Fay, M., & Sala, E. (2014). Marine communities on oil platforms in Gabon, West Africa: High biodiversity oases in a low biodiversity environment. *PLoS ONE*, *9*(8). https://doi.org/10.1371/journal.pone.0103709

CASE STUDY 4: GULF OF THAILAND

AN ACOUSTIC-OPTIC COMPARISON OF FISH ASSEMBLAGES AT A RIGS-TO-REEFS HABITAT AND CORAL REEF IN THE GULF OF THAILAND



Distributions of the lengths of fishes ≥15 cm at a) the coral reef Hin Bai and the entire Reefed Jacket Zone (RJZ), and b) at each of the six platforms comprising the RJZ.

Sibley, E. C. P., Madgett, A. S., Elsdon, T. S., Marnane, M. J., Harvey, E. S., Songploy, S., Kettradad, J., & Fernandes, P. G. (2023). An acoustic-optic comparison of fish assemblages at a Rigs-to-Reefs habitat and coral reef in the Gulf of Thailand. *Estuarine, Coastal and Shelf Science*, *295*. https://doi.org/10.1016/j.ecss.2023.108552

MICROPLASTICS AND OFFSHORE INFRASTRUCTURE

Sources of Microplastics in Offshore Environments

- Degradation of coatings, polymer-based components, and operational waste.
- Degradation timelines / size fractions

Pathways and Risks

- Chemical and/or Mechanical effects
- Transport via water currents, biofouling, and sediment deposition.
- Hydrodynamics of the region
- Impact on marine organisms and broader ecosystem health.

ECOTOXICOLOGICAL IMPACTS OF MICROPLASTICS

Biological Effects

- Ingestion leading to food dilution /satation.
- Tissue translocation and bioaccumulation.
- Species sensitivity variations (Mehinto et al. 2022 findings).

Regulatory Thresholds

- Establishing limits for microplastic exposure.
- Defining levels of environmental concern.

RISK-BASED MANAGEMENT FRAMEWORK FOR MICROPLASTICS

Framework Approach	Threshold Definitions			
Utilising Species Sensitivity Distribution (SSD) modelling.	Threshold 1: Investigative monitoring (lowest concern).	Threshold 2: Discharge monitoring.	Threshold 3: Management planning.	Threshold 4: Source control measures (highest concern).

DEVELOPING OFFSHORE MICROPLASTIC GUIDELINES

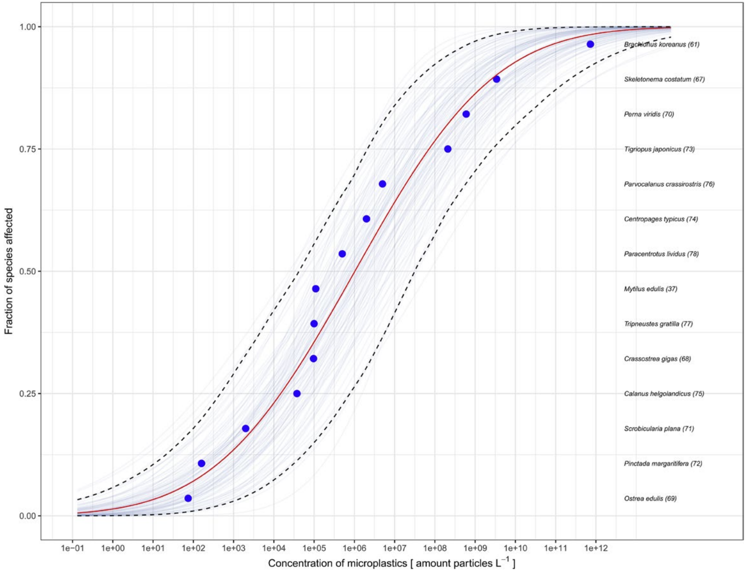
Regulatory Alignment

- Integrating regulatory frameworks into industry practices.

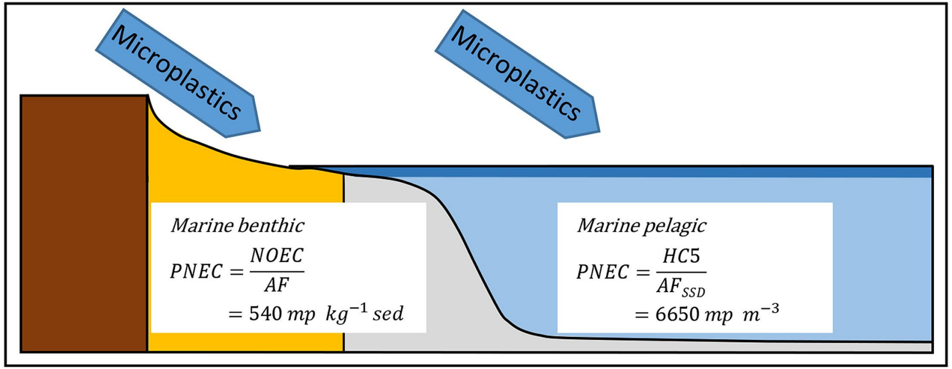
Guideline Development using ANZG Values

- Step 1: Identify environmental values and ecosystem protection levels.
- Step 2: Compile relevant microplastic ecotoxicology data.
- Step 3: Apply SSD modelling to determine guideline values.
- Step 4: Validate threshold values against field data.
- Step 5: Implement guidelines in offshore decommissioning policies.

SPECIES SENSITIVITY CURVES



Species sensitivity distribution (SSD) for buoyant microplastics (in particles L−1).
Blue dots are NOEC



Article | Full-text available

Probabilistic environmental risk assessment of microplastics in marine habitats

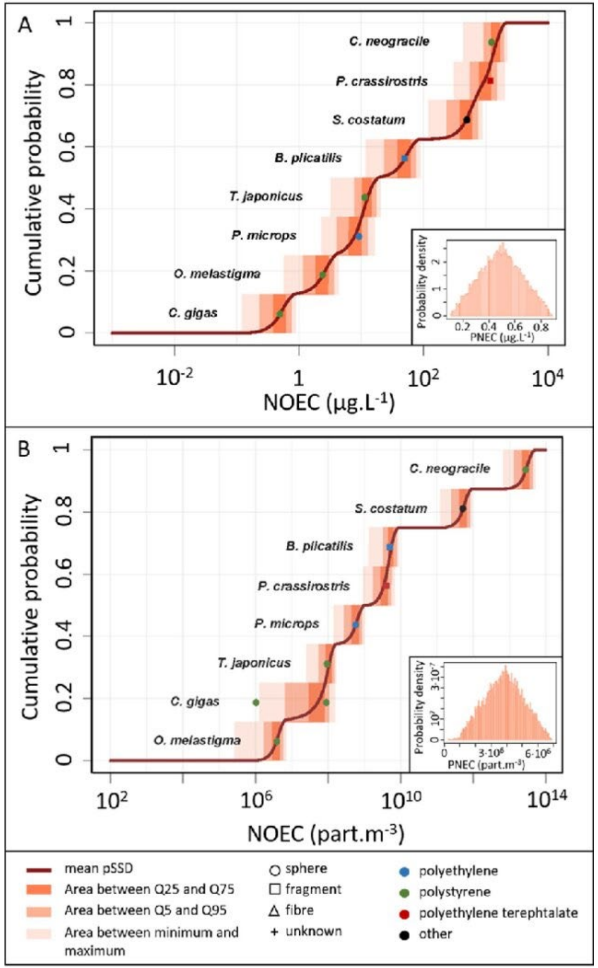
January 2021 · Aquatic Toxicology 230:105689
DOI: 10.1016/j.aquatox.2020.105689

Veronique Adam · Alex von Wyl · Bernd Nowack

Key figures of probability distributions associated with measured environmental concentrations reported from coastal and open waters (part m^{-3}). Q5, Q25, Q75, Q95: 5th, 25th, 75th, 95th quantiles, respectively.

Water body	Q5	Q25	Mean	Median	Q75	Q95
Worldwide	1.3·10−2	2.6·10−1	1.5·103	1.6	1.5·102	2.7·103
Coastal waters	1.7·10−2	2.4·10−1	1.6·103	1.9	2.4·102	2.6·103
Open waters	1.0·10−2	4.010−1	4.7·102	1.2	2.1·101	2.9·103
Atlantic Ocean	2.9·10−2	2.4·10−1	3.6·103	1.3	5.3·101	4.7·103
Coastal waters	3.0·10−2	2.4·10−1	2.5·103	8.8·10−1	2.4·101	2.5·103
Open waters	2.5·10−1	8.0·10−1	4.9·101	1.7	2.7·101	2.0·102
Arctic Ocean	2.5·10−1	4.0·10−1	2.1·101	1.0	2.1·101	9.5·101
Coastal waters	NA	NA	NA	NA	NA	NA
Open waters	2.5·10−1	4.0·10−1	2.1·101	1.0	2.1·101	9.5·101
Mediterranean Sea	5.0·10−3	1.0·10−1	2.4	4.5·10−1	1.6	9.0
Coastal waters	4.8·10−3	7.2·10−2	1.8	2.8·10−1	1.1	5.4
Open waters	3.0·10−1	9.5·10−1	3.1	1.7	3.2	1.2·101
Pacific Ocean	3.0·10−2	2.2	2.8·103	2.0·102	1.2·103	6.5·103
Coastal waters	3.3·10−1	1.2·101	3.1·103	2.2·102	1.1·103	4.6·103
Open waters	3.0·10−3	3.0·10−2	1.8·103	1.8	2.2·103	9.1·103

Current risks from microplastics in marine environments are **unlikely** but cannot be completely ruled out. *However, data gaps in microplastic size, shape, and polymer type between hazard studies and real-world exposure limit the accuracy of risk assessments, emphasizing the need for standardized monitoring and regulatory action*



CONCLUSION & RECOMMENDATIONS

Key Takeaways

- Offshore decommissioning presents biodiversity conservation opportunities.
- Microplastic risk management is critical for sustainability.
- Currently, microplastics are not a danger in marine environment
- More research on non-metals needs to done

Future Directions

- Industry-wide adoption of risk-based microplastic thresholds.
- Further research into microplastic transport and long-term ecological effects.
- Alignment with ANZG Guidelines: Ensuring robust scientific backing for offshore microplastic management.

DISCUSSION & QUESTIONS

1. **Stakeholder engagement and industry collaboration.**
2. **Given the increasing regulatory focus on sustainability, what do you see as the biggest challenge in implementing microplastic guidelines in offshore decommissioning projects?**

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