



 **ARC Marine®**
ACCELERATING REEF CREATION

Preliminary evidence of early Reef Cube® enhancements to mobile benthic ecosystems

- Sam Hickling. Chief Scientific Officer at ARC Marine Ltd., worked at ARC since 2017.
 - I research nature-inclusive and sustainable design, marine ecology.
 - Based in Torbay, Devon.
 - BSc Zoology Uni of Reading (graduated 2013)
 - MSc Oceanography Uni of Southampton (graduated 2017)
 - Volunteered at ARC Marine Ltd. 2017.





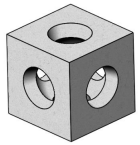
1. Low carbon plastic free marine concrete = Marinecrete
2. Design & manufacture of nature inclusive solutions
3. Monitoring of ecosystems



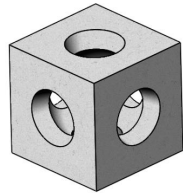
Image credit: Brixham Laboratory <https://www.brixham.space/>



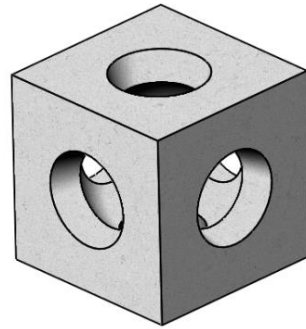
150mm
5kg



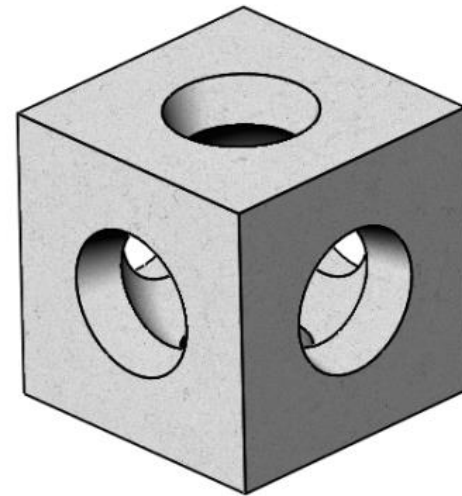
250mm
15kg



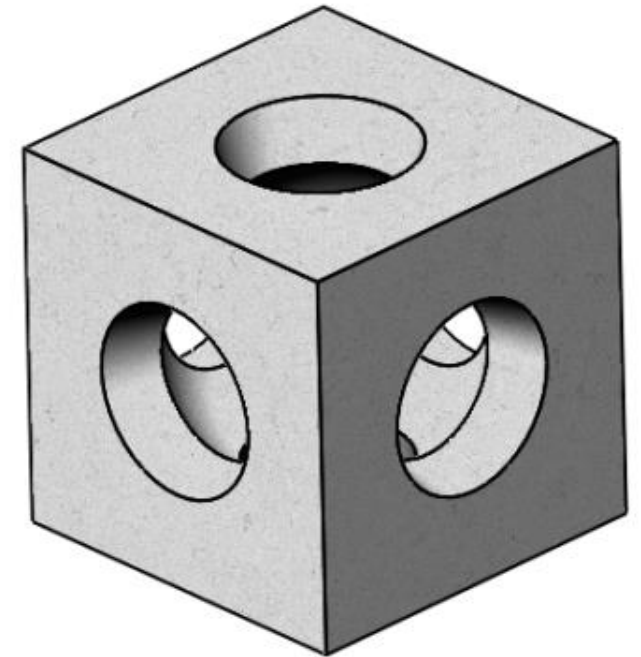
300mm
40kg



500mm
165kg



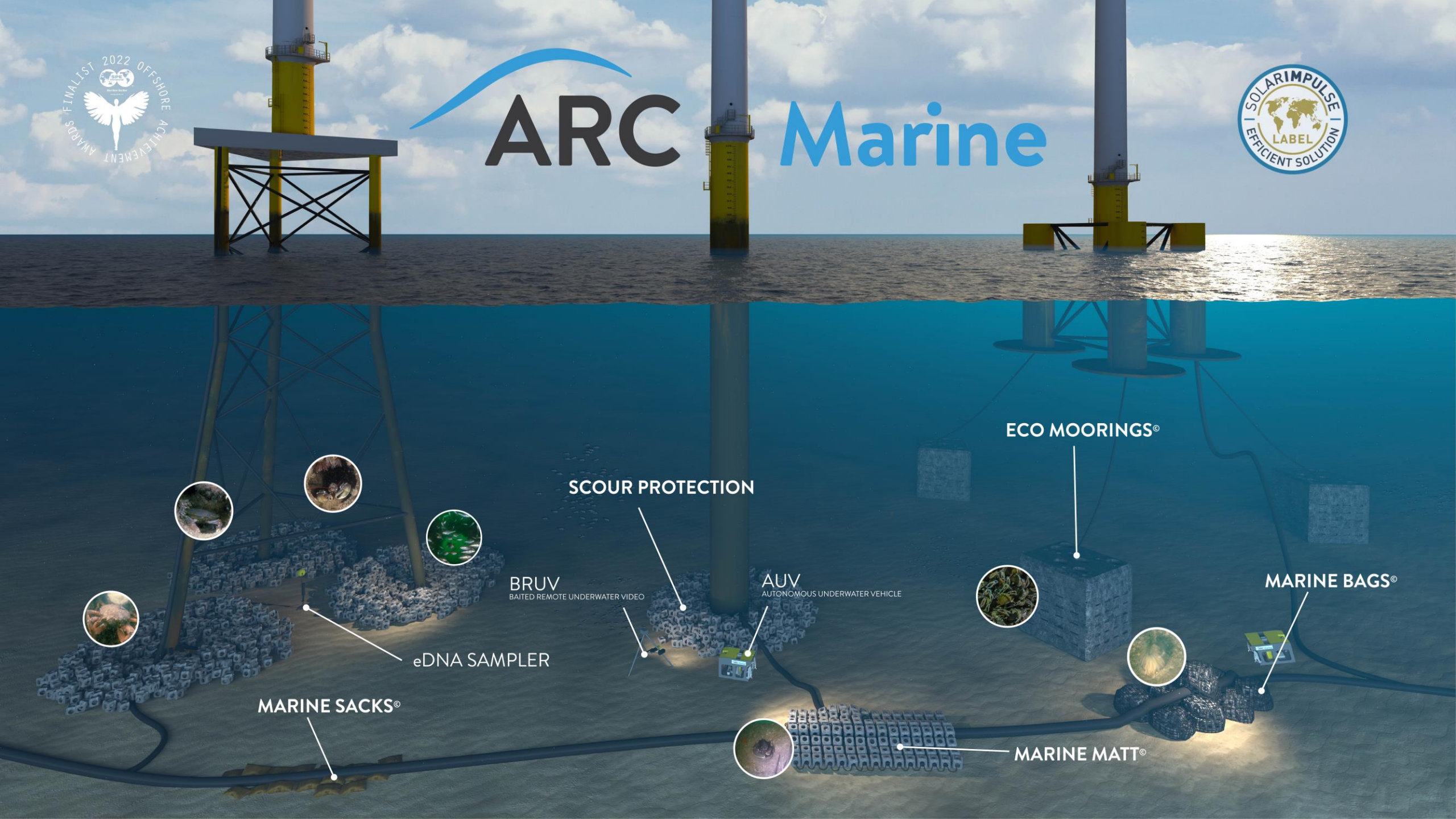
1m
1.3T



1.5m
5 T



ARC Marine



SCOUR PROTECTION

ECO MOORINGS®

MARINE BAGS®

MARINE MATT®

BRUV
BAITED REMOTE UNDERWATER VIDEO

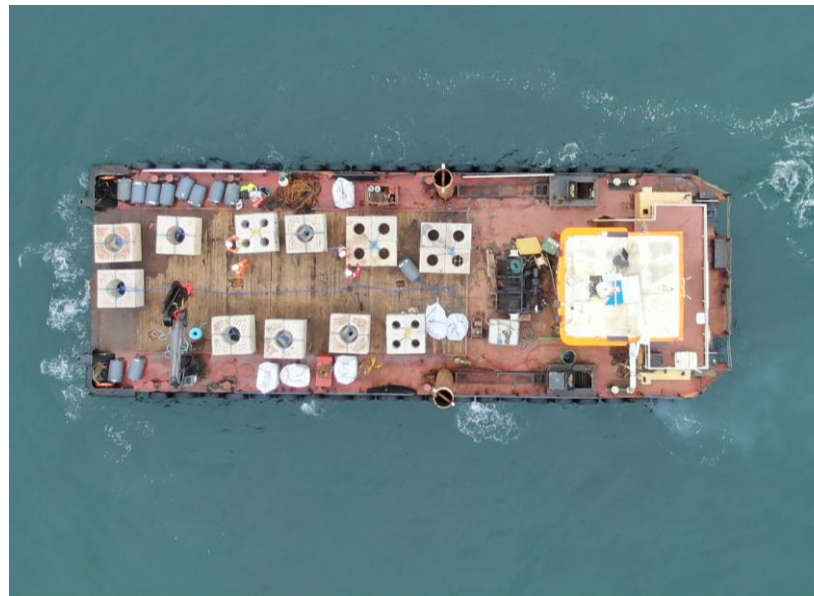
AUV
AUTONOMOUS UNDERWATER VEHICLE

eDNA SAMPLER

MARINE SACKS®

Reef Enhancement of Fisheries and Aquaculture Sites (REFAS)

- In Torbay, Devon, UK.
- Funding through CEFAS and DEFRA via the Seafood Innovation Fund (SIF).
- Feasibility project (REFAS 1) and a more comprehensive R & D project (REFAS 2)
- Objectives are to enhance lobster and crab abundance; and biodiversity nearby to an innovative scallop ranch.





Legend

- Scallop Ranch Corners
- REFAS 1
- REFAS2



0 1 2 km



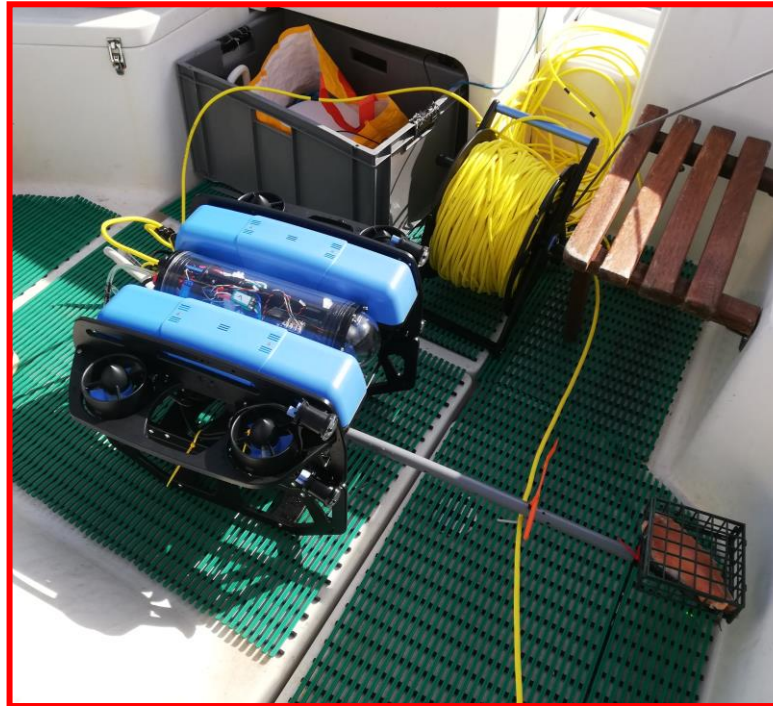
REFAS 2 Research Methods

- Study designs Before After Control Impact (BACI) and Before After Gradient (BAG)
- Research methods:
 - Pot fishing
 - Baited Remote Underwater Video Stations (BRUVS)
 - Sedimentary environmental DNA (eDNA) analysis – Applied Genomics
- Baselines and preliminary datasets established at the R and D site



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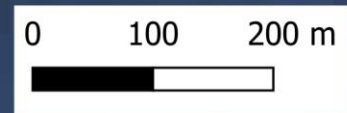
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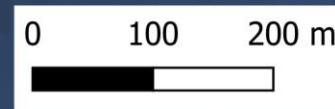
Legend

- + Spring 2021 pre-build non-reef sample sites
- + Spring 2021 pre-build reef sample sites
- Planned REFAS 2 Cluster Positions
- Scallop ranch corner boundaries



Legend

- Autumn 2021 Post-build non-reef sample sites
- Autumn 2021 Post-build reef sample sites
- Scallop ranch corner boundaries



Reef Enhancement of Fisheries and Aquaculture Sites (REFAS) BRUVs Analysis

- Investigating mobile species
- Quantify each species as Max(N) per 30 minute recording period
- Day and night
- Analyse and compare:
 - Species richness
 - Diversity indices
 - Rarefaction curves
 - Community composition
- Comparisons between before and after reef build of:
 - Distance from reef
 - Reef vs non-reef

Before – March 21



VS

Non-reef (Sandy mud)



VS

After – September 21



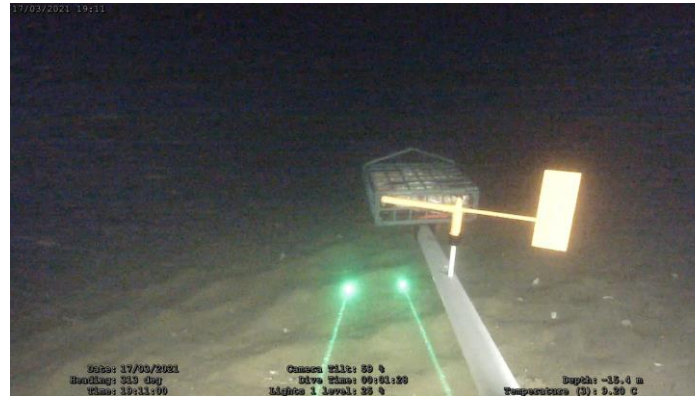
VS



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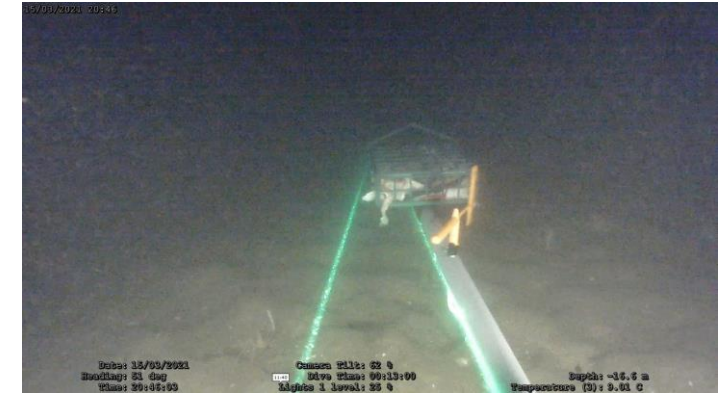
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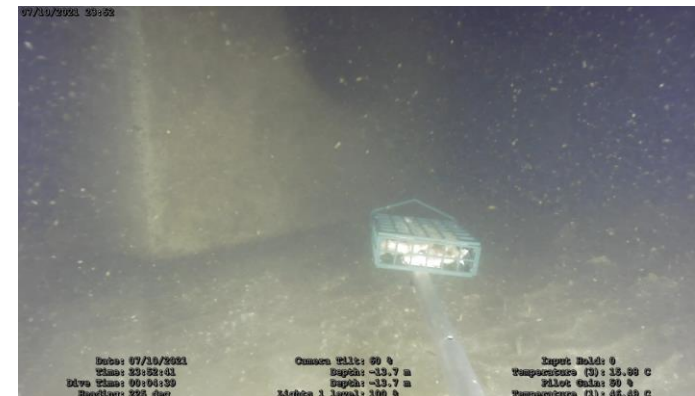
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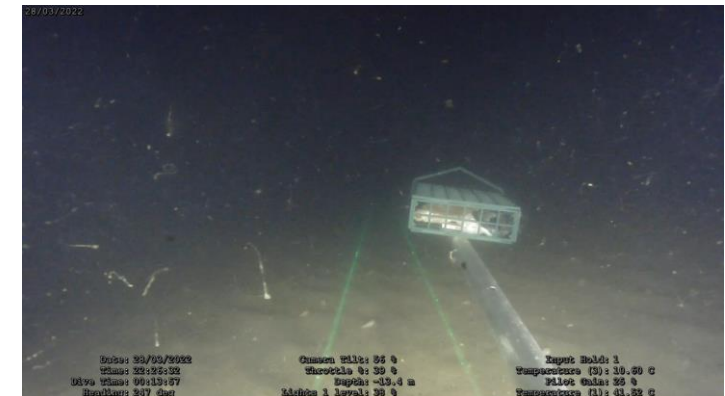


VS

After – September 21



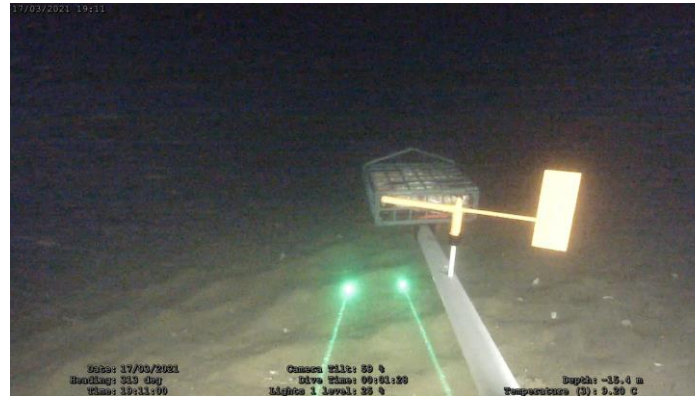
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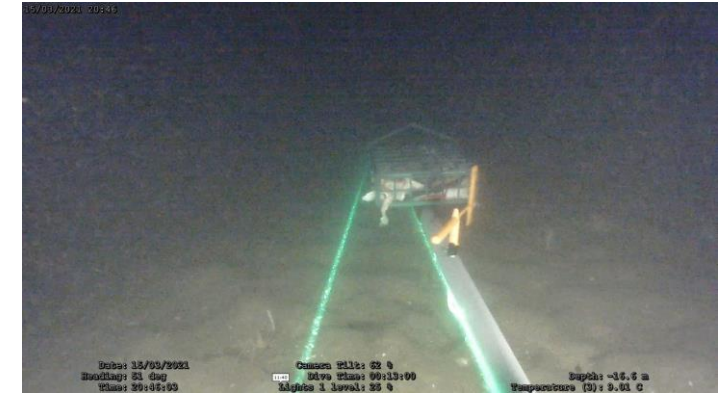
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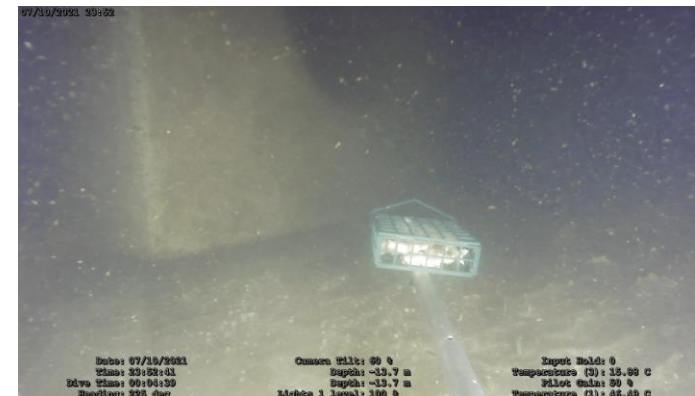


VS



After – September 21

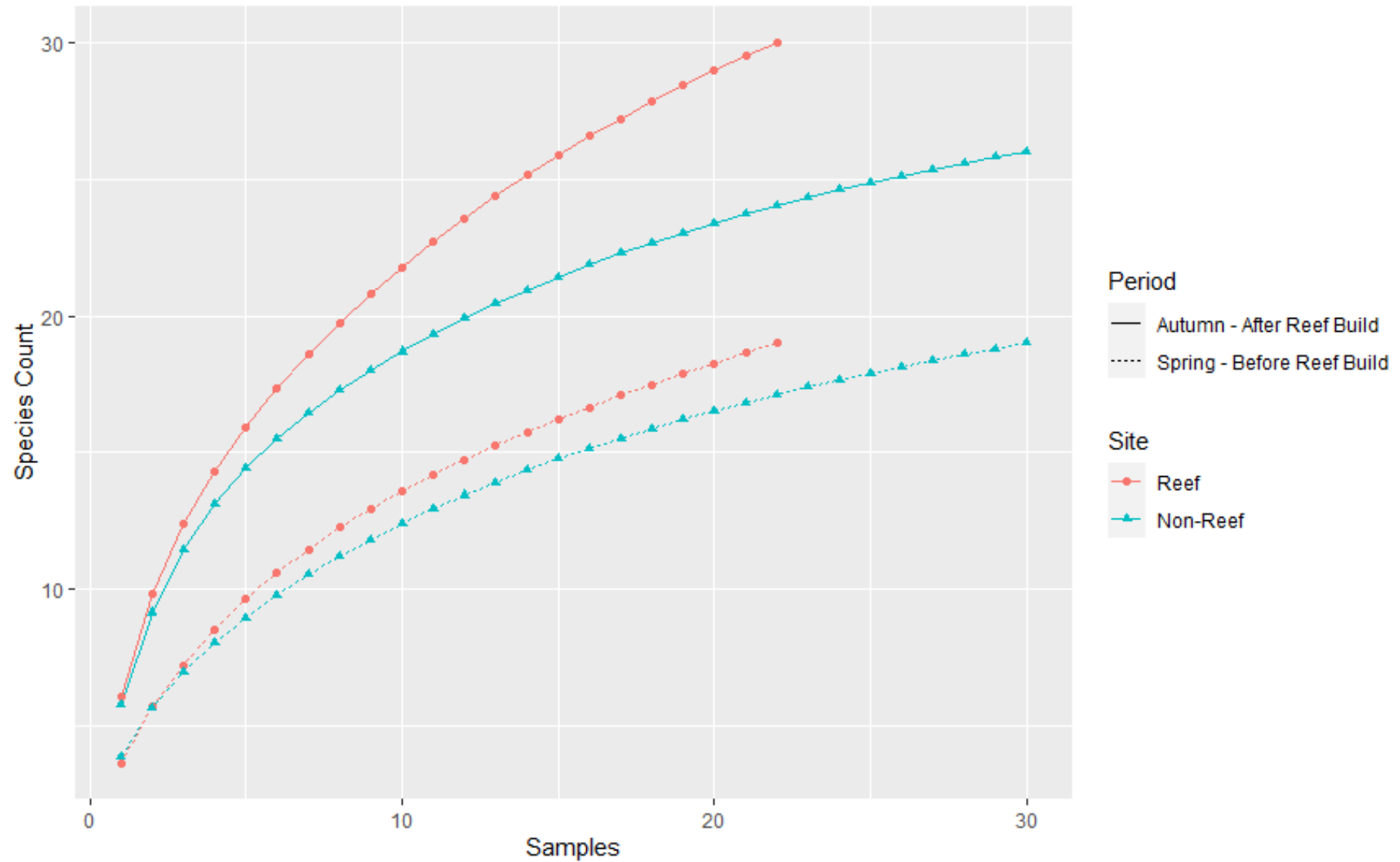
VS



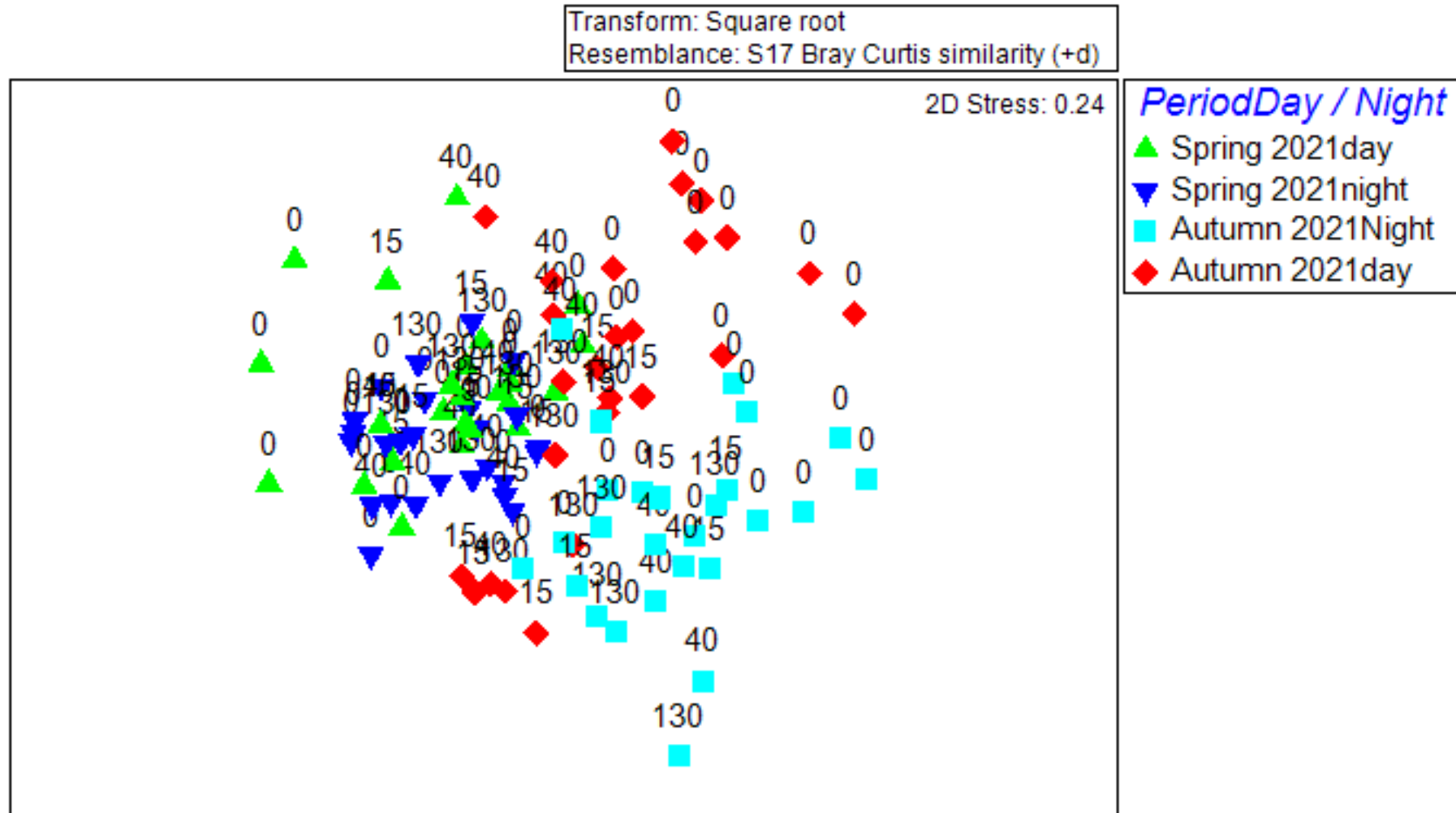
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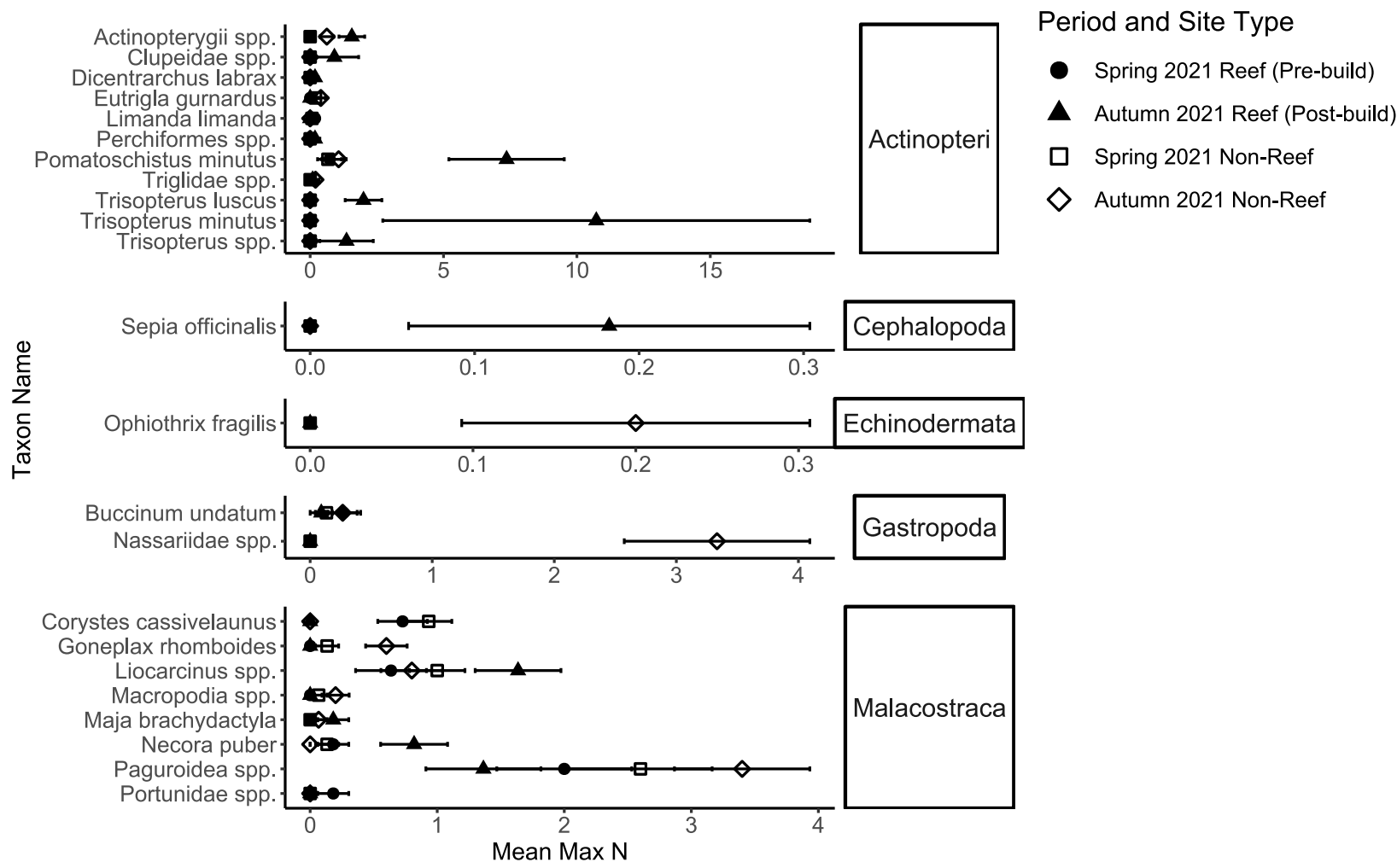
Rarefaction curves for site types and period. Curves end at the total number of samples



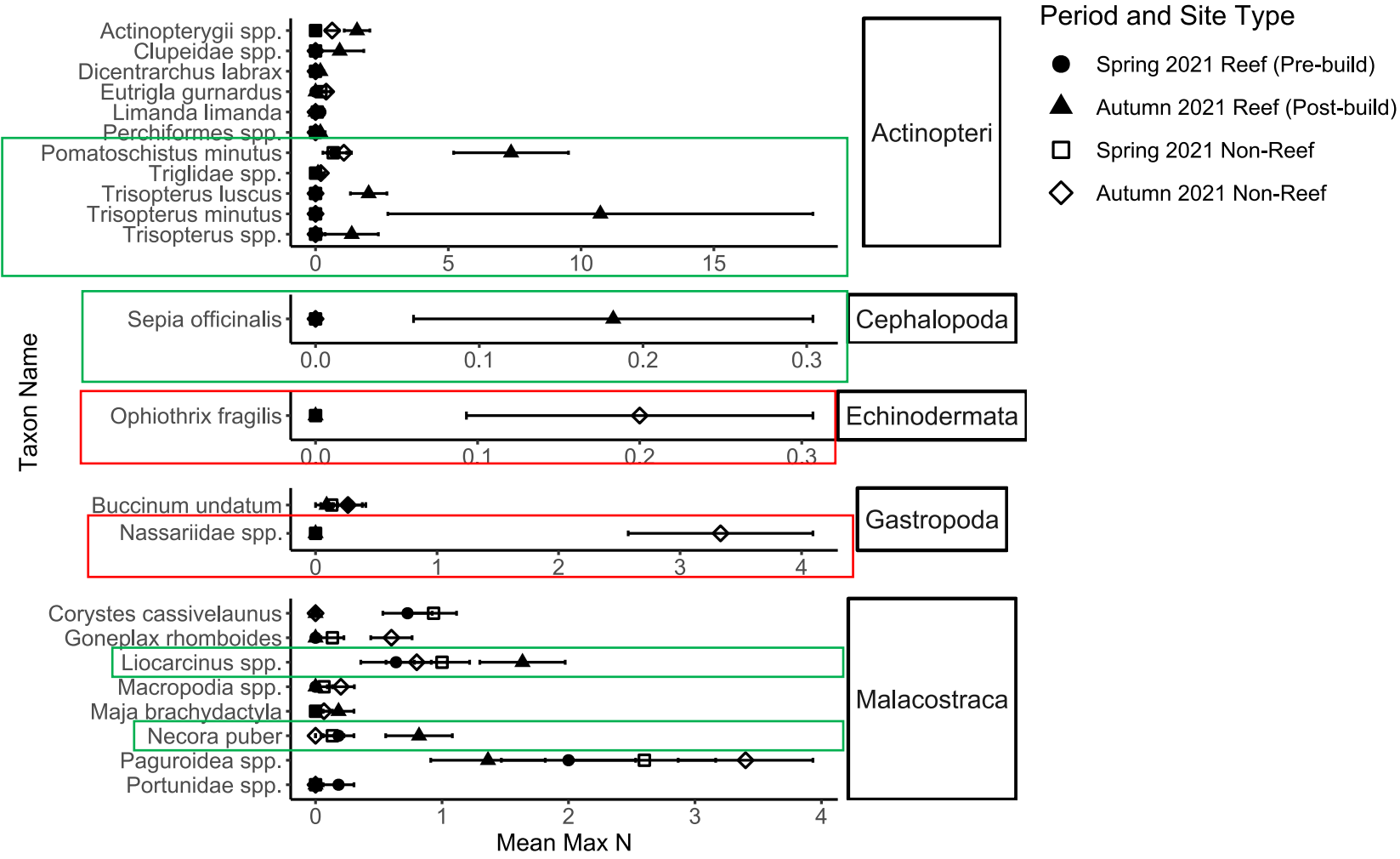
Multi Dimensional Scaling (MDS) plot indicating diversification of sample communities.



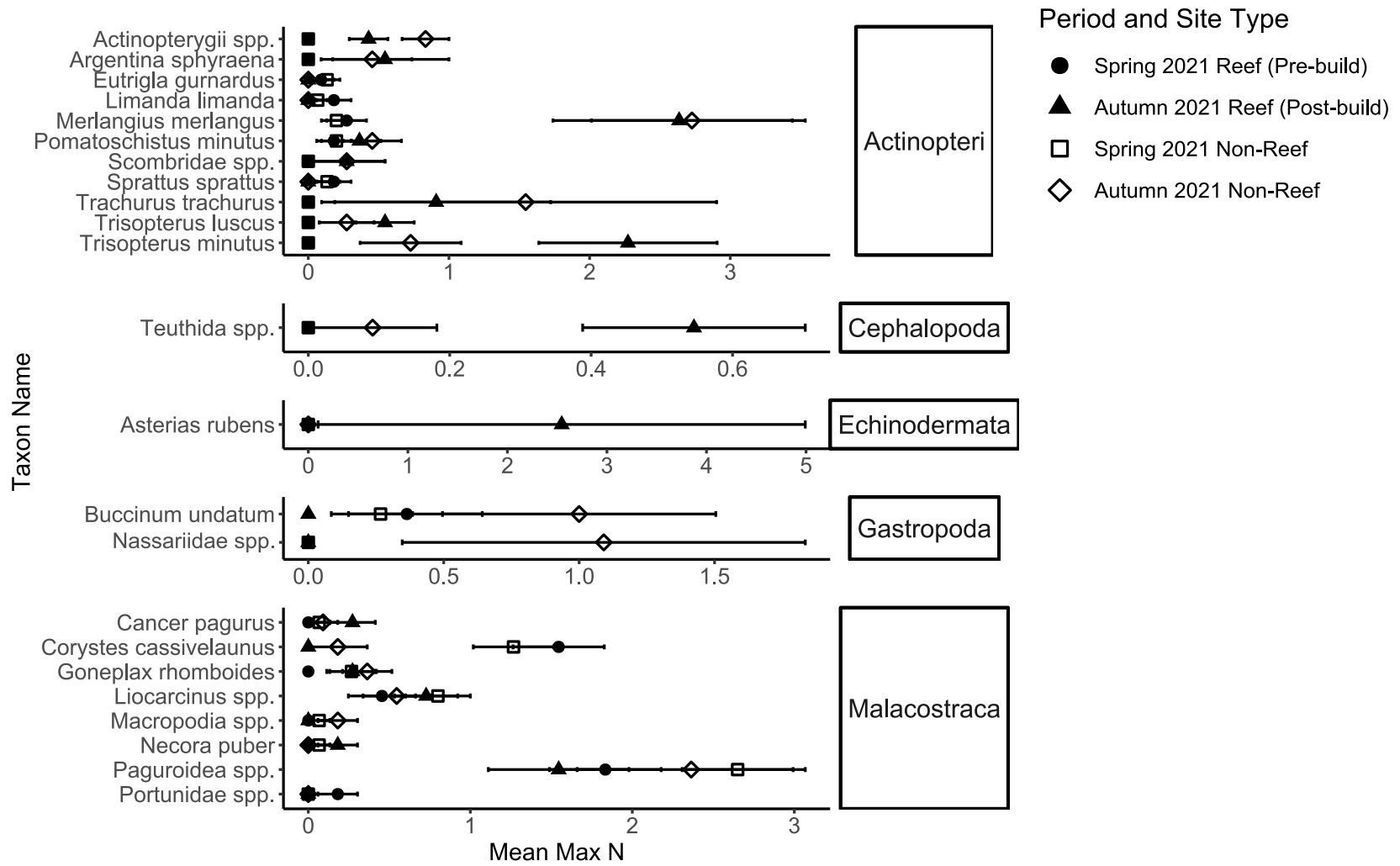
Species that contributed the most to community differences in the day



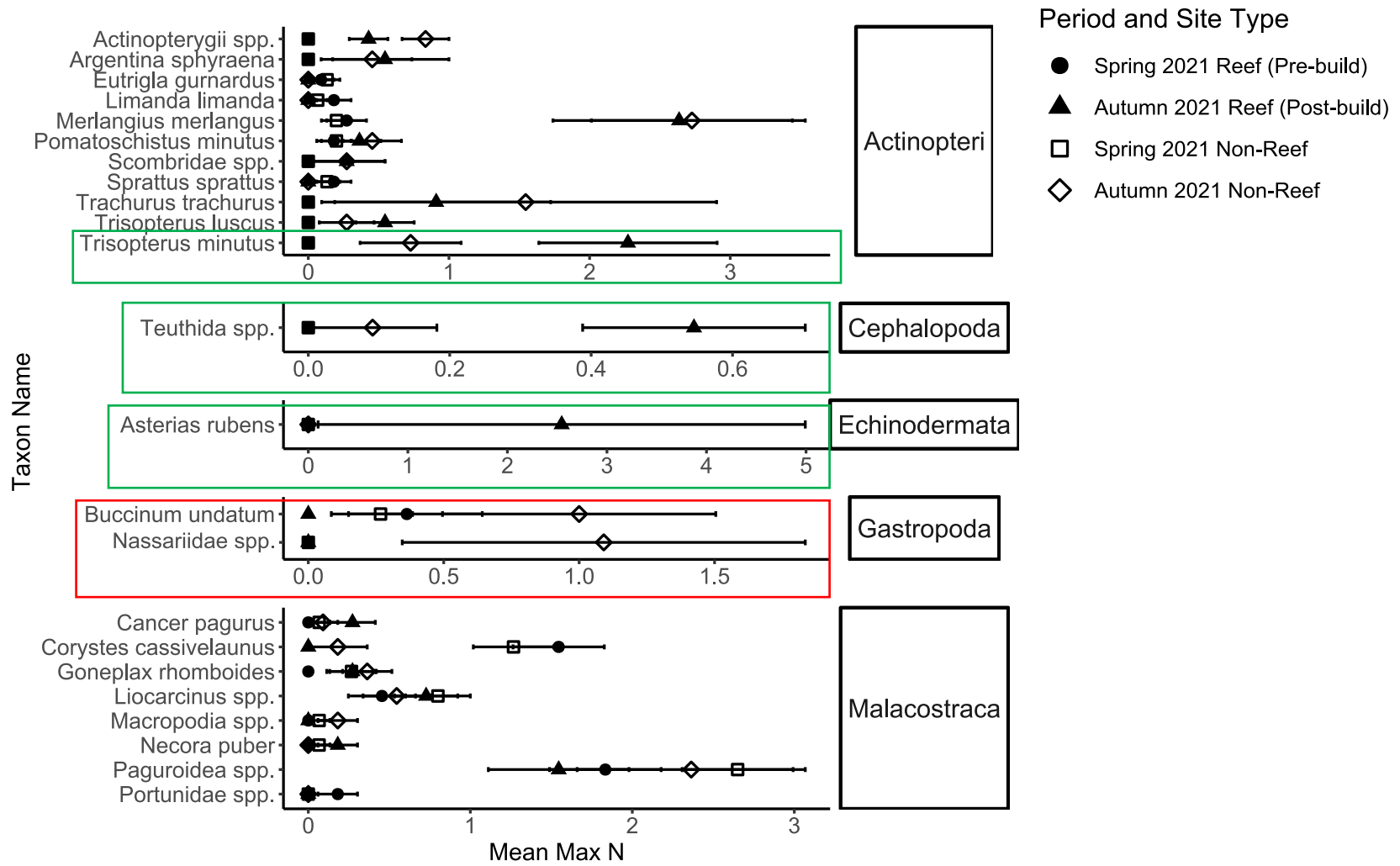
Species that contributed the most to community differences in the day



Species that contributed the most to community differences in the night

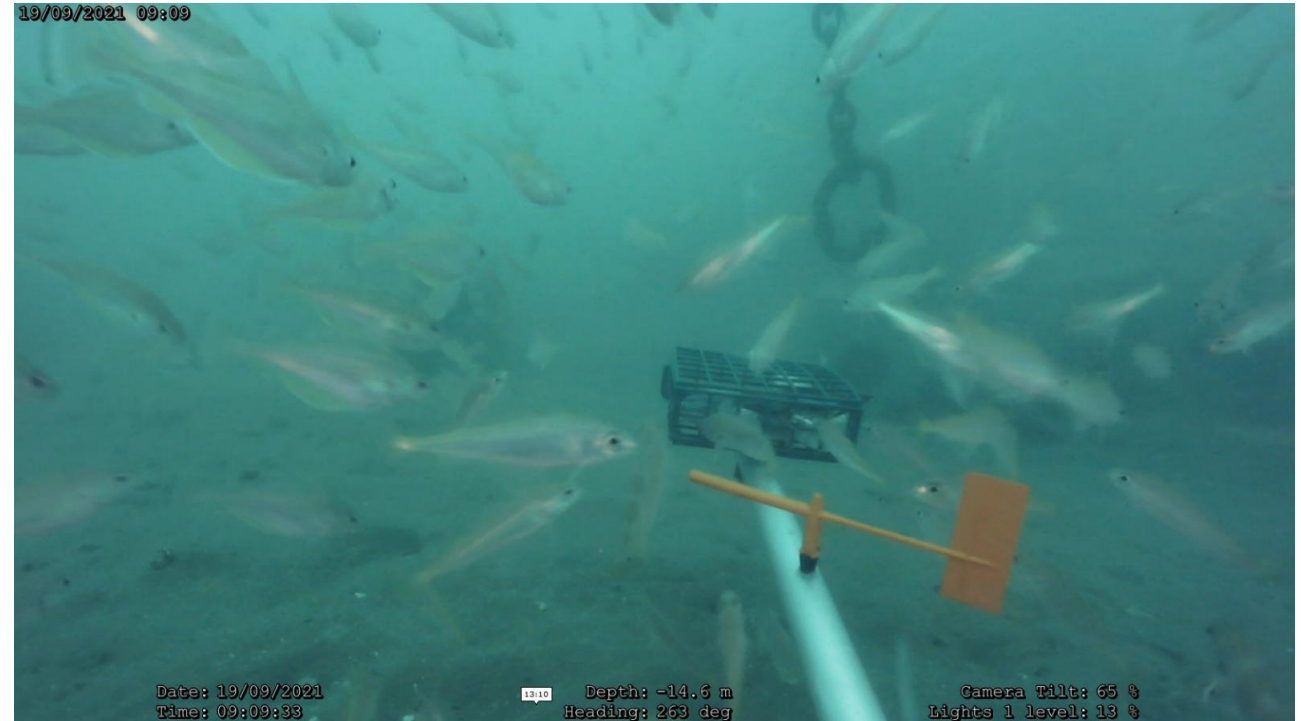


Species that contributed the most to community differences in the night



Reef Enhancement of Fisheries and Aquaculture Sites (REFAS) BRUVs Analysis. To Summarize:

- Significant change in biodiversity from before to after reef build:
 - Two distinct communities four months after the build in Autumn. Appears to be limited to the immediate vicinity of the Reef Cubes.
- At the reef sites:
 - Higher abundance overall, higher total species pool.
 - Higher instances of fish, cuttlefish, squid, velvet crab, harbour crabs and common star fish.
 - Lower instances of whelks and possibly hermit crabs.
 - Shoaling of Trisopterus fish species key finding exhibited also in the North Sea.



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Image credit: Bureau Waardenburg (2021)

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Thank You For Listening.

Thank you to:

Colleagues at ARC Marine Ltd.

**James Murphy for continued research
partnership**

CEFAS for research funding